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ASSESSMENT OF EXISTING DATA BASES FOR HIGHWAY SAFETY ANALYSIS

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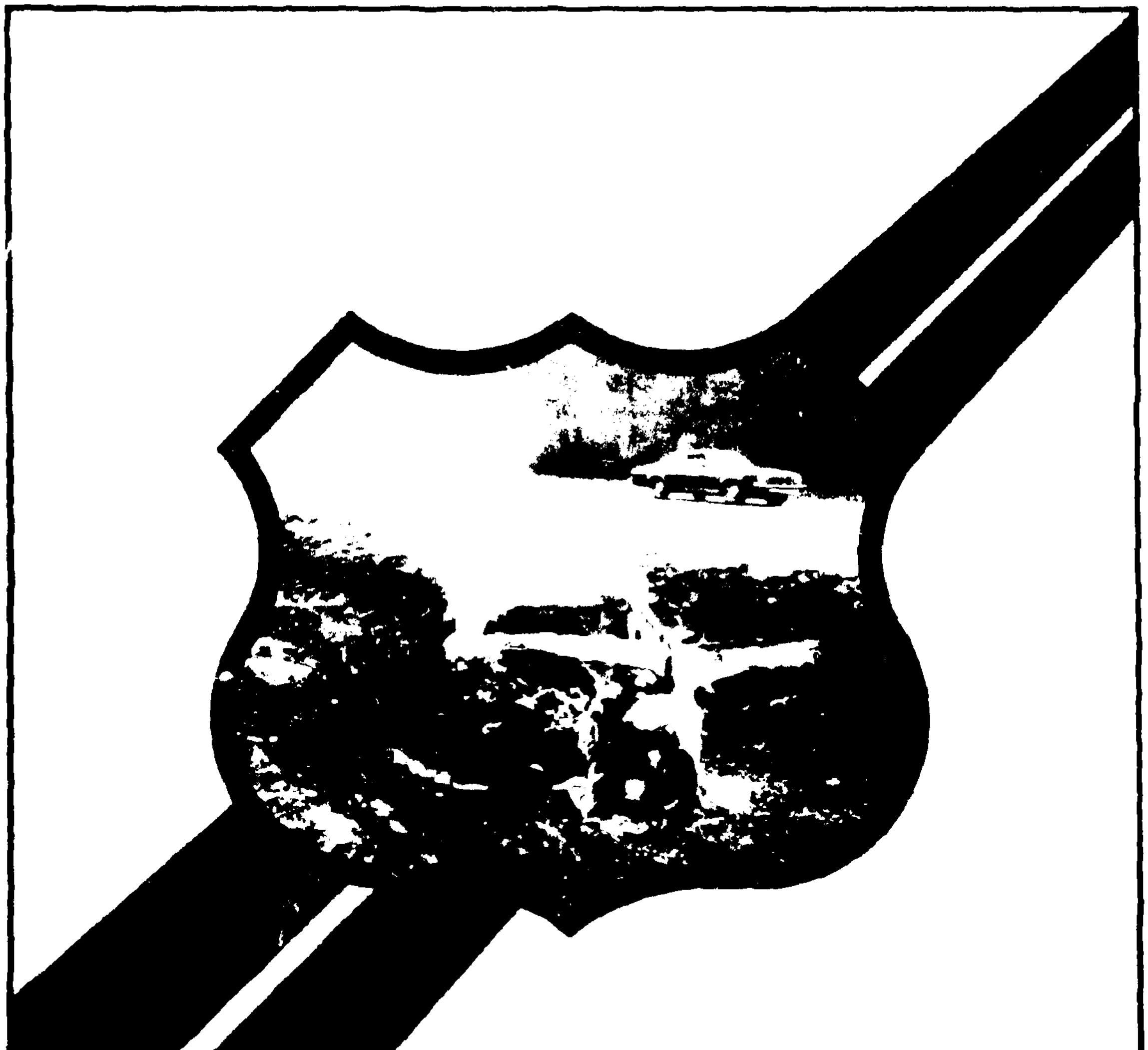

FOREWORD

Highway officials at the Federal, State, and local levels are faced with the continuing task of assessing the potential safety impacts of proposed programs, policies, and alternatives in the construction and maintenance of the highway systems. In order to ensure that their decisions are proper and in the most cost-effective manner possible, it is imperative that they be provided with the necessary supporting data to conduct the appropriate safety analysis from the identification of problems, causal factors, and countermeasures to the evaluation of the effectiveness of the countermeasures.

This report presents the results of a study that:

1. Assessed the applicability and utility of existing large national data bases to highway safety analysis from the standpoint of FHWA;

2. Developed alternatives that may enhance the applicability and utility of these data bases; and

3. Evaluated the recommended alternatives.

The study results are intended for consideration in efforts to improve the capability and utilization of existing data bases and to offer a basis for improvements in ongoing and future data collection efforts so as to better serve the information needs in highway safety analyses.

This report is being distributed to each region, division, and State highway agency.

Stanley R. Byington, Director
Office of Safety and Traffic Operations R&D

NOTICE

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16. Abstract

The objectives of this study are to: (1) Assess the applicability and utility of existing large national data bases to highway safety analysis from the standpoint of FHWA; (2) Develop alternatives that may enhance the applicability and utility of these data bases; and (3) Evaluate the recommended alternatives. The study results are intended for consideration in efforts to improve the capability and utilization of existing data bases and to offer a basis for improvements in ongoing and future data collection efforts so as to better serve the information needs in highway safety analyses.

Existing data bases were identified and grouped into seven categories according to a categorization scheme. Seven data bases, one for each category, were then selected for study. The various components of highway safety analysis, as used in this study, are defined and characterized. The applicability and utility of these selected data bases for use in highway safety analysis were evaluated based on available documentation. Conceptual alternatives that would improve or enhance the capabilities and utility of existing data bases to better serve the information needs of highway safety analysis were developed. These identified alternatives were studied and analyzed for their feasibility and practicality and appropriate recommendations were made.

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CHAPTER 1. INTRODUCTION AND RESEARCH APPROACH

1.1 Introduction

Highway officials at the Federal, State, and local level are faced with the continuing task of assessing the potential safety impacts of proposed programs, policies, and alternatives in the construction and maintenance of the highway system. In order to ensure that their decisions are proper and made in the most cost-effective manner possible, it is imperative that they be provided with the necessary supporting data to conduct the appropriate safety analyses, from the identification of problems, causal factors, and countermeasures to the evaluation of the effectiveness as well as the unintended effects of the countermeasures.

Various data bases (banks) have been created and are maintained at the Federal, State, and local level for a variety of reasons. Some of the data bases are intended for record-keeping purposes with no consideration given to analysis requirements. Others are designed for a specific purpose and are of little use elsewhere. There is a definite need for a critical review of these existing data bases in their ability to meet the information needs of highway safety analyses.

1.2 Study Objectives and Scope

The specific objectives and scope of work for this study are as follows:

- Assess the utility of large data bases, in their present form, in monitoring the safety implications of highway programs, policies, or alternatives at both the system-wide level and the site-specific level.
- Develop alternatives involving combinations of existing data resources and/or modifications of these existing data systems that will increase their value in the analysis of highway safety issues.
- Define clearly the advantages and limits of selected large data bases in their existing forms and in the proposed alternate forms for highway safety analysis purposes at both system-wide and site-specific levels.

The study results are intended for consideration in an effort to improve the capability and utilization of existing data bases and to offer a basis for improvement of ongoing and future data collection efforts so as to better serve the information needs in highway safety analyses.

1.3 Research Approach

The scope of this study involved a study of the utility of existing data resources in the evaluation of highway safety problems. Highway safety, as used in this study, refers to those traffic safety areas which, at the national level, are of prime concern to the Federal Highway Administration (FHWA) as opposed to the National Highway Traffic Safety Administration (NHTSA). The emphasis was on large data bases that are national in scope and are intended for general purposes.

A review was conducted of existing data bases. Seven data bases were selected for study. The applicability and utility of these selected data bases for use in highway safety analysis in general, and the Resurfacing, Restoration and Rehabilitation (RRR) program in particular, were evaluated using available documentation.

Conceptual alternatives that would improve or enhance the capabilities and utility of existing data bases to better serve the information needs of highway safety analysis were developed. These identified alternatives were studied and analyzed for their feasibility and practicality and appropriate recommendations were made.

Highway safety analyses, as used in this study, are defined in Chapter II, followed by a presentation on the process used to identify and select existing data bases for review and analysis. The criteria used for evaluating the selected data bases and the evaluation results are summarized in Chapter III. The conceptual alternatives identified, together with assessments on their feasibility and practicality, are described in Chapter IV. Finally, conclusions of the study and recommendations are presented in Chapter V.

CHAPTER II. IDENTIFICATION AND SELECTION OF EXISTING DATA BASES FOR REVIEW AND ANALYSIS

2.1 Highway Safety Analysis

Prior to discussions on the identification, selection, and evaluation of the existing data bases, it is necessary to first define the various components of highway safety analysis that are of interest to the Federal Highway Administration (FHWA). A characterization scheme for highway safety analysis is shown in figure 1.

For the purpose of this study, highway safety analysis can be categorized as either analysis or implementation. Analysis refers to the use of the data bases to address problems and questions from the standpoint of research and development, evaluation, and analysis. Implementation, on the other hand, is related to the development of warranting criteria and project selection based upon the warrants.

Assessment of the data bases is strictly from the analysis standpoint and excludes implementation. First, the development of warranting criteria does not necessarily make use of the data bases directly, but rather uses the results from the analysis as an input, which must then be balanced against political and economic constraints. Project selection is almost exclusively carried out at the State and local levels while the data bases of interest to this study are at the national level.

As shown in figure 1, highway safety analysis can be characterized by four factors:

(1) Type of Analysis

Problem Identification
Cross-Sectional Evaluation
Longitudinal Evaluation

(2) Unit of Analysis

Location
Accident

(3) Purpose

Problem Identification - System-Wide vs. Site-Specific
Cross-Sectional Evaluation - Comparative Evaluation vs. Relationship/Predictive Modeling
Longitudinal Evaluation - Evaluation

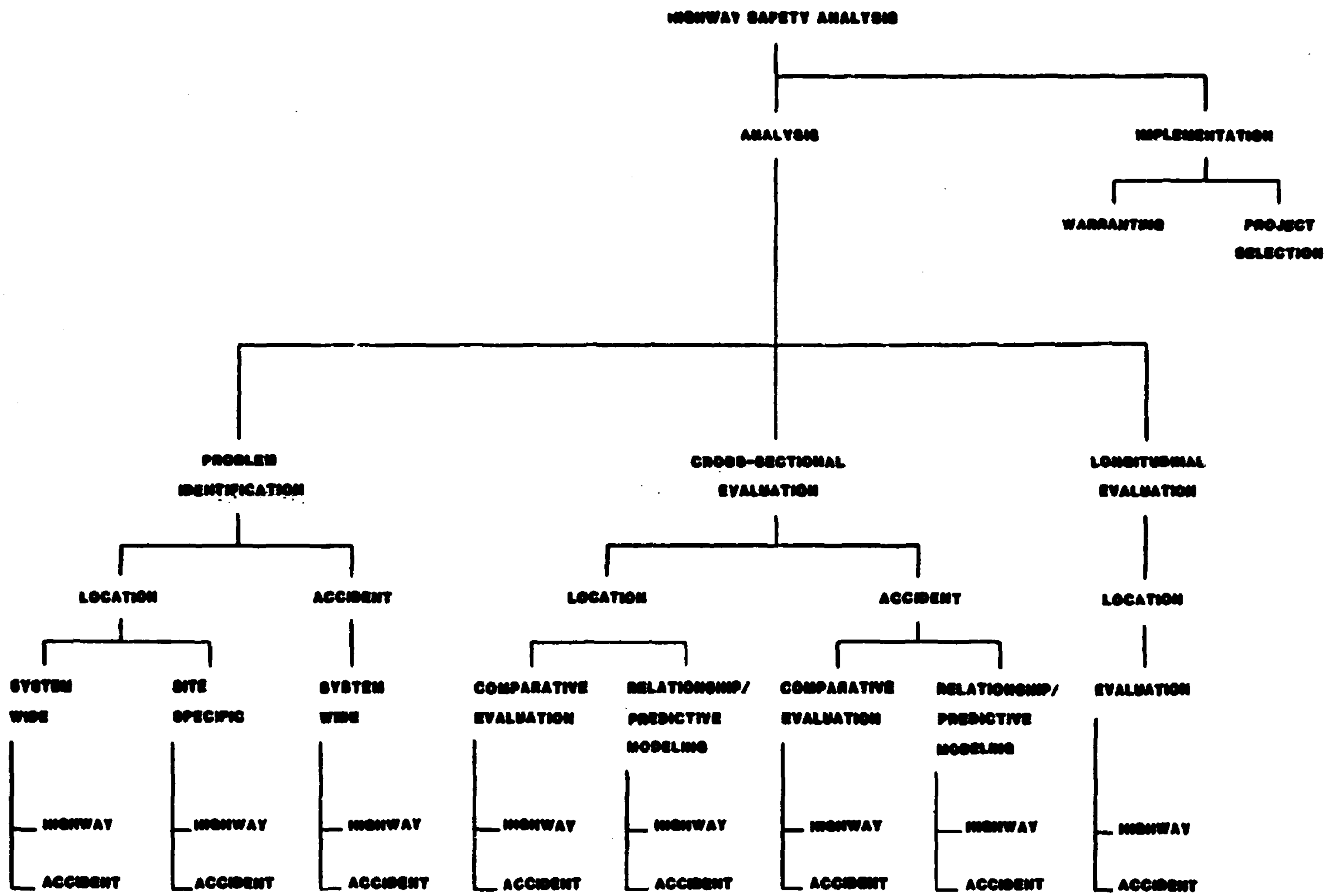

Figure 1. Characterization Scheme for Highway Safety Analysis.

(4) Specificity

Highway
Accident

There are three basic types of analysis that are commonly used in highway safety analysis:

(1) Problem identification. The determination of whether a safety problem exists and the extent of the problem.

(2) Cross-sectional evaluation. The evaluation of the effects or relationships of various factors to accidents using information from a given point in time.

(3) Longitudinal evaluation. The evaluation of the effect of a given treatment (e.g., a countermeasure or a modification to a highway/environmental factor) on accidents at different points in time.

Each of these three types of analysis is further characterized by the unit of analysis, purpose, and specificity.

The unit of analysis can be either a location or an accident. A location is defined as a roadway section, a point on the roadway, or a physical feature of the roadway, such as a bridge. An accident refers to either an accident or a vehicle involved in an accident. The unit of analysis corresponds with the dependent variable used in the analysis. A location-based analysis is related to accident frequency or rate while an accident-based analysis is related to accident severity.

The purpose of analysis refers to the objective of the analysis, i.e., what the analysis is intended to accomplish. It varies according to the type of analysis being conducted.

The specificity of analysis refers to the needed level of detail in the analysis. This includes the subsetting or constraining of the data (e.g., fatal accidents only, or two-lane rural highways only), and the inclusion of variables (e.g., highway type, accident type, etc.). The specificity can be defined by highway-related variables (e.g., highway type, curve/tangent, number of lanes, etc.), or by accident-related variables (e.g., weather and surface condition, accident type, vehicle type, injury severity, etc.).

For problem identification analyses, the unit of analysis can be either location or accident. The purpose can be system wide (program level) or site specific (project level), and the specificity of the data can be by highway and/or by accident variables. Note that accident-based analysis is not applicable at the site-specific level. By definition, a site-specific analysis refers to a location or locations, and not to an accident or accidents.

In problem identification analyses, the question asked is always related to accident experience, be it accident frequency, rate, or severity, for a given set of conditions. Also implicit in the question is the comparison with a certain baseline to determine if a safety problem exists for the given set of conditions under consideration and then the extent of the problem.

For cross-sectional evaluation, the unit of analysis is again location or accident and the specificity can be defined by highway or accident variables. The purpose of the analysis can be grouped into two general categories:

(1) Comparative evaluation - To compare the safety performance or effects on accidents between two or more different sets of conditions. For example, the accident rates of bridges with or without shoulders are compared to determine the safety effects of shoulder presence on bridges, or the comparison of accident severity between breakaway and nonbreakaway luminaires.

(2) Relationship/Predictive modeling - To determine or predict the effect of certain conditions or parameters on the frequency, rate, or severity of accidents. For example, what is the effect of lane width and traffic volume on accident rate? What is the expected severity of impacts with pole structures based on impact conditions, or the expected accident rate for utility pole impacts based on roadway and roadside characteristics?

For longitudinal evaluation, the objective is to assess the safety effects of a given treatment before and after its implementation, e.g., the effectiveness of reflective raised pavement markers on curves during darkness. From FHWA's point of view, the unit of analysis is necessarily location and the purpose is always evaluation. The specificity can again be characterized by highway or accident variables.

The characterization scheme for highway safety analysis can best be explained with illustrative examples. One example is provided for each of the 16 combinations of factors, as shown in table 1. The examples are all structured around a central theme of safety at bridge sites to illustrate the various questions and analyses that can be addressed within a given topic. Brief discussions on these illustrative examples for each type of analysis are provided in Appendix A.

Table 1. Illustrative Examples for Various Components of Highway Safety Analysis.

Type of Analysis	Unit of Analysis	Purpose	Specificity	Example Question
Problem Identification	Location	System Wide	Highway	1. What are the accident rates for bridge sites by highway type and bridge width?
			Accident	2. What are the accident rates for trucks with gross weight of over 10,000 pounds at bridge sites?
		Site Specific	Highway	3. Which are the top 50 bridge sites with the highest accident frequency on two-lane rural highways in the State of Texas for the three-year period of 1982 to 1984?
			Accident	4. Which bridge sites in the State of Texas had at least two fatal accidents within the three-year period of 1982 to 1984?
	Accident	System Wide	Highway	5. What are the accident severities for bridge accidents by highway type and bridge width?
			Accident	6. What is the severity of bridge accidents involving large trucks (i.e., tractor semi-trailer and double bottom tractor-trailer trucks)?
Cross Sectional Evaluation	Location	Comparative Evaluation	Highway	7. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24 feet wide on two-lane rural highways?
			Accident	8. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24 feet wide for double bottom tractor-trailer trucks?
		Relationship/ Predictive Modeling	Highway	9. What is the relationship between accident rates and bridge width for various highway types?

Table 1. Illustrative Examples for Various Components of Highway Safety Analysis (continued).

Type of Analysis	Unit of Analysis	Purpose	Specificity	Example Question
			Accident	10. What is the relationship between fatal accident rate and relative bridge width?
	Accident	Comparative Evaluation	Highway	11. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?
			Accident	12. Is the severity of bridge accidents higher for double bottom tractor-trailers as compared to tractor semi-trailers?
		Relationship/ Predictive Modeling	Highway	13. Do the impact conditions (i.e., impact speed and angle) for bridge rail accidents vary as a function of bridge shoulder width on two-lane rural highways?
			Accident	14. What is the relationship between the vehicle curb weight and injury severity for bridge rail accidents involving passenger cars?
Longitudinal Evaluation	Location	Evaluation	Highway	15. Does widening the approach roadway to a bridge without corresponding widening of the bridge itself create a hazardous condition for various highway types?
			Accident	16. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?

2.2 Identification of Data Bases

A large number of data bases are available at the Federal, State, and local levels, from completed studies and from ongoing data collection efforts. These data bases are created for a variety of reasons. Some of the data bases are intended for record-keeping purposes with no consideration given to analysis requirements; some are designed for a specific purpose and are of little use otherwise; and others are intended for more general applications. It is therefore necessary to first establish some screening criteria in identifying candidate data bases for consideration in the study.

It should be borne in mind that one of the study objectives is to assess the utility, appropriateness, and adequacy of large data bases for use in highway safety analysis in general and the Resurfacing, Restoration and Rehabilitation (RRR) program in particular. The emphasis is therefore on large data bases that are national in scope and are intended for general purposes. Accordingly, the following screening criteria were established to identify candidate data bases:

- The data base must be appropriate for assessing the safety impacts of highway safety programs, policies, and alternatives in its present form, or after modifications.
- The data base must be large enough to provide an adequate sample size for analysis.
- The data base must be national in scope or at least provide a reasonable geographical representation.
- The data base must be relatively recent or part of an ongoing data collection effort.

The above mentioned criteria provide an initial screening of data bases that are eligible for further consideration. Identification of the candidate data bases was accomplished through a limited literature review, supplemented by contacts with selected Federal Highway Administration (FHWA) and National Highway Traffic Safety Administration (NHTSA) personnel. A list of the candidate data bases is shown in Appendix B. This list is by no means all inclusive, but it certainly includes all the major data bases that are of interest to this study.

As may be expected, the candidate data bases are mostly from the Federal level since data bases created at the State and local levels would not be national in scope. However, it is possible to combine data bases from several States to provide the needed geographical representation. Thus, State data bases from a generic viewpoint also are included in the list of candidate data bases.

2.3 Categorization of Data Bases

After the candidate data bases are identified, it is necessary to first categorize them by their characteristics. As will be explained later, this categorization process is central to the selection of data bases for detailed review in this study. The data bases are categorized according to the following criteria:

(1) Application

Primary
Secondary

(2) Purpose

Primary - General Purpose vs. Special Purpose
Secondary - Exposure vs. Inventory

(3) Unit of analysis

Location
Accident

(4) Level of detail

Police Level
Enhanced Police Level
In-Depth

The first consideration is the application of the data base from the standpoint of safety analysis which can be termed as either primary or secondary. A primary data base is one that can be used directly for safety analysis. In comparison, a secondary data base can only be used indirectly for safety analysis as a supplement to a primary data base.

The second consideration is the intended purpose of the data base. For a primary data base, the purpose is termed as either general or special. A general purpose data base is created for general use and not for any specific application. There are very few general purpose data bases in existence. Most data bases are special purpose in nature, i.e., created with a specific purpose in mind. A general purpose data base is useful or a wide variety of applications, but lacks specificity on any particular topic or question. It has to contain a large number of data elements in order to be general in nature, but not enough in any single area.

On the other hand, a special purpose data base contains all the required data elements for the specific question or topic under study, but little else. Sometimes it may be possible for a special purpose data base to be used for addressing other questions or topics that are similar in nature to the one that the data base was created for, but such applications are usually limited.

For a secondary data base, the purpose is classified as either exposure or inventory. An exposure data base provides information on the extent to which a vehicle or an occupant is subjected to the possibility of an accident or its consequences. An inventory data base provides an inventory or count of some physical features of the roadway. The emphasis of this study is clearly on primary data bases and secondary data bases will not be considered except as supplemental sources of information for primary data bases. Also, the third and fourth categorization criteria will only apply to primary data bases.

The third consideration is the unit for which the data base is used in highway safety analyses, as discussed previously. The unit of analysis corresponds with the unit used for the data record. The two units of analysis are location and accident. Each data record in a location-based data base contains information on a location which may be a roadway section, a point on the roadway, or a physical feature of the roadway, such as a bridge. In comparison, each data record in an accident-based data base contains information on an accident.

It should be pointed out that the two units of analysis are not necessarily mutually exclusive even though most of the existing data bases are structured for use with only one unit of analysis. It is possible to design a data base that would allow for the use of both units of analysis. This is one of the considerations used in developing conceptual alternatives that will be discussed in Chapter IV of the report.

The fourth and last consideration is the level of detail available on the accident data. There are basically three levels of detail: police level, enhanced police level, and in-depth. Police level accident data are obtained directly from police accident reports. They are readily available and are maintained on a continuous basis. However, there are various well-documented problems associated with police level accident data, such as the lack of detail, inaccuracy, inconsistency in definitions and nomenclature, and reporting criteria.

Enhanced police level accident data, as implied by its name, are still based on police accident reports, but enhanced by the addition of supplemental information and better quality control. The Fatal Accident Reporting System (FARS) is an example of an enhanced police level accident data base in which police accident reports on fatal accidents are supplemented with additional data elements, such as vehicle, driver, and medical data.

In-depth accident data are collected by trained accident investigators in much greater detail than the police level or enhanced police level accident data and are tightly controlled to ensure accuracy and consistency. The costs associated with the collection of in-depth accident data are very high and thus limit the sample size of the data base. Also, since police accident reports are used as the starting point for sampling the accidents to be investigated in depth, the problem of reporting criteria remains, i.e., unreported accidents, different reporting thresholds within and among the States, etc.

Figure 2 illustrates how the four parameters are combined into the categorization scheme. Note that only those combinations with existing data bases are included in the categorization scheme. This does not mean that combinations not included in the categorization scheme are inappropriate, but just a reflection of what is currently available. Examples of data bases in the various categories according to the categorization scheme are provided in Appendix B.

2.4 Selection of Data Bases

Once the candidate data bases are categorized, the selection process is very straightforward. First, as mentioned previously, secondary data bases are not of prime concern to this study and will not be studied individually, but only as supplements to primary data bases.

Secondly, there are only three general purpose primary data bases currently in existence and, being the major emphasis of this study, they will all be included for further review and analysis:

(1) Highway Performance Monitoring System (HPMS) - location-based, police level accident data.

(2) National Accident Sampling System (NASS) Continuous Sampling Subsystem (CSS) - accident-based, in-depth accident data.

(3) Fatal Accident Reporting System (FARS) - accident-based, enhanced police level accident data.

Although not part of a national accident data base in the strict sense of the word, State accident data files, particularly those integrated with roadlog, traffic, and other roadway and roadside data, are adaptable for use in highway safety analysis at the State level. With some modifications and integration, a national data base could conceivably be created from State records. This alternative will be considered and evaluated as part of this study. State accident data files are therefore included under the category of general purpose police level accident data base.

The only area requiring consideration in the selection of data bases for further study are the special purpose primary data bases. They are of interest to the study since they provide the required details on specific questions and topics not available

CATEGORIZATION SCHEME

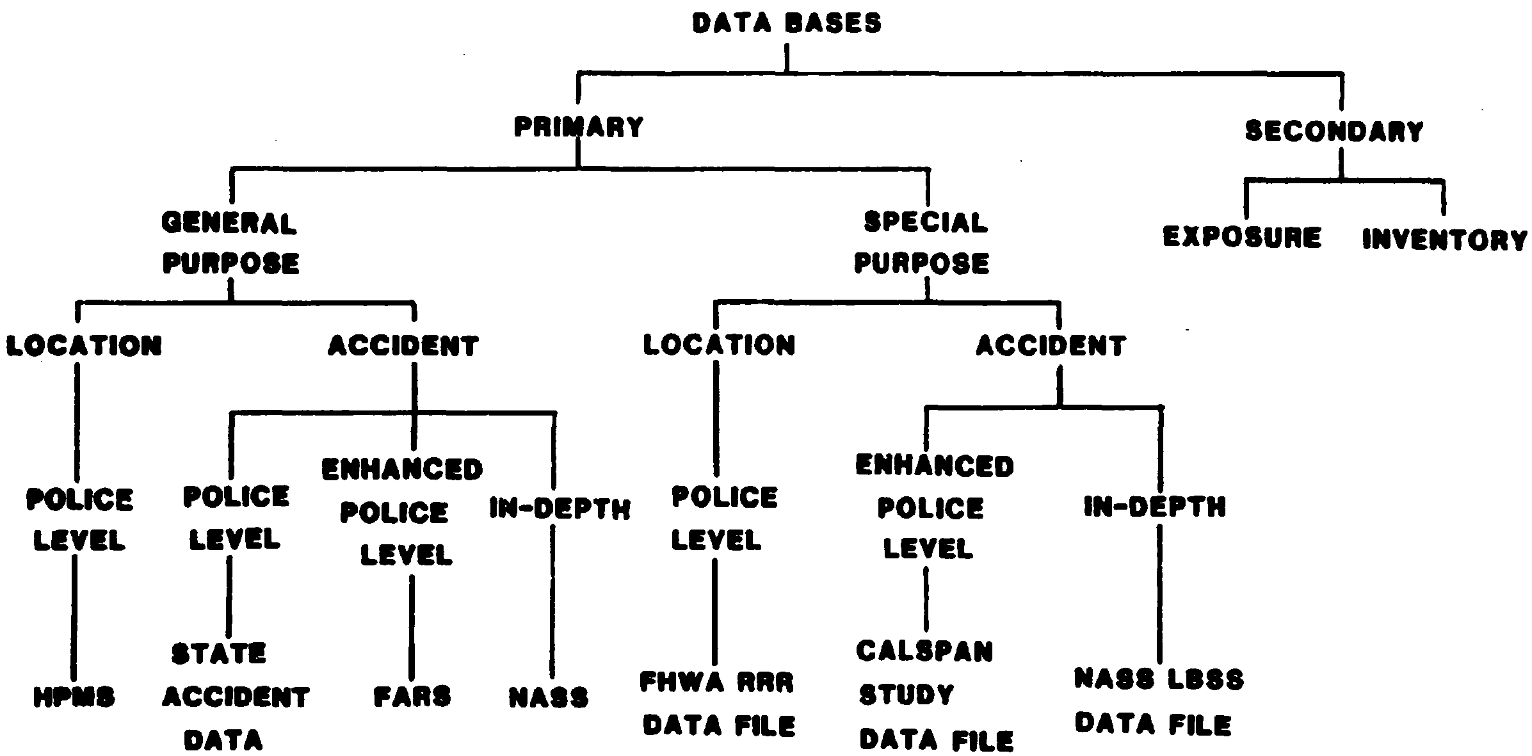

Figure 2. Categorization Scheme for Data Bases.

from general purpose data bases. However, their scope of application is limited to the specific questions or topics they are created for, and little else. Also, there are many special purpose data bases and it would not be possible to include them all. Only one data base is therefore selected for each of the three categories. The three special purpose primary data bases selected for further study are:

(1) FHWA RRR data file - location-based, police level accident data.

(2) Calspan study data file - accident-based, enhanced police level accident data.

(3) NASS Longitudinal Barrier Special Study (LBSS) data file - accident-based, in-depth accident data.

The reasoning behind the choice of these three special purpose data bases is rather simple. Since monitoring the safety impacts of RRR activities is an area of emphasis in this study, the choice of the FHWA RRR data file from among the various location-based, police level accident data files seems logical. The Calspan data file is the most recent available under the category of special purpose enhanced police level accident data base, although it is already eight years old (1975-1976). The NASS LBSS is the best choice in the category of special purpose in-depth accident data bases since it is an ongoing data collection effort as well as an integral part of the NASS system.

CHAPTER III. EVALUATION OF SELECTED DATA BASES

As discussed in Chapter II, seven data bases were selected for review and evaluation in the study, including:

(1) Highway Performance Monitoring System (HPMS).

(2) State accident data bases - Texas and Utah.

(3) Fatal Accident Reporting System (FARS).

(4) National Accident Sampling System (NASS) Continuous Sampling Subsystem (CSS).

(5) FHWA RRR data file.

(6) Calspan study data file.

(7) NASS Longitudinal Barrier Special Study (LBSS).

These selected data bases are critically reviewed and analyzed as to their utility and adequacy in addressing the information needs of highway safety analysis. The major activities involved are as follows:

(1) Collect av ilable documentation on the selected data bases,

(2) Define the evaluation criteria for assessing the utility and adequacy of the selected data bases according to the information needs of highway safety analysis as defined in this study, and

(3) Assess the utility and adequacy of the selected data bases according to the evaluation criteria developed.

Results on each of the three major activities are presented in the following sections.

3.1 Documentation

For each selected data base, the following materials were collected, as appropriate:

- Copy of the data base or, in the case of ongoing data collection programs, the latest three years of data.
- Copies of all documentation on the data base.
- Copies of published and pending reports on the data base, including those in which the data base is applied indirectly.

Persons responsible for the selected data bases were contacted for their assistance in providing the needed documentation. A list of materials gathered and evaluated for the study is shown in Appendix C.

3.2 Evaluation Criteria

Each selected data base is evaluated according to its utility and adequacy in addressing the information needs of the 16 types of highway safety analysis discussed previously in Chapter II. The evaluation criteria used are as follows:

1. Applicability

2. Utility

    a. Breadth of representation.
    b. Sample size.
    c. Level of detail.
    d. Accuracy and consistency.
    e. Flexibility.

Brief descriptions of the evaluation criteria are presented in the following subsections.

3.2.1 Applicability

The applicability of a data base refers to the types of highway safety analysis the data base can be used for. The only criterion used in the assessment is whether the data base can be used for a particular analysis. No consideration is given to the utility of the data base, which is to be evaluated separately.

The State accident data bases are evaluated on the assumption that the accident data files are linked or integrated with the roadway inventory files. Even though some States may not currently have their accident and roadway inventory files integrated, it is believed that such capability exists for most of the States, provided that the accident and roadway inventory files are computerized and have a common location reference system between the files. If that is available, it is then a relatively simple task to link the files together.

It should also be pointed out that the level of detail available from computerized roadway inventory files varies greatly among the States. For a roadway inventory file to be useful, it should contain, as a minimum, some basic data on the roadway, e.g., functional class, number of lanes, divided/undivided, access control, roadway, lane, and shoulder width, etc., and traffic volume. Other data elements, such as roadway geometrics, traffic characteristics, roadside features, etc., are desirable, but rarely available from roadway inventory files.

For the three special purpose data bases, the evaluation of applicability is confined to the specific areas the data bases are designed for, i.e., RRR projects for the FHWA RRR data file, single-vehicle, ran-off-road accidents for the Calspan study data file, and longitudinal barrier accidents for the NASS LBSS data file. Also, the FARS data base is considered only from the standpoint of fatal accidents and fatalities.

3.2.2 Utility

The utility of a data base refers to the question of how good the data base is in satisfying the information needs of the applicable analyses. This can be assessed in terms of:

- Breadth of representation.
- Sample size.
- Level of detail.
- Accuracy and consistency.
- Flexibility.

The breadth of representation refers to the geographical distribution and sampling scheme for the data, i.e., where and how the data are collected. The geographical distribution can be national, State, or local. The sampling scheme can be a census, statistical, or a sample of convenience. A census includes the entire population of interest, e.g., all fatal accidents in the nation, or all reported accidents on State maintained highways, etc. A statistical sample allows the sampled data to be projected back to the population of interest for representative estimates. The sampling scheme could be based on location or accident. A sample of convenience does not provide data that are representative of the population, but depends on other controlling factors for analysis.

The sample size of a data base determines the extent and detail of analysis possible with the data base, i.e., the categorization or subsetting of data. It also affects the precision of any estimates made from the data and the power of statistical tests. For an ongoing data collection effort, either the sample size available on an annual basis or over the entire program is considered in the evaluation.

The level of detail refers to the amount of information available from a data base. The evaluation criteria include:

1. Total number of data elements available per record and the number of usable data elements available for:

   a. Highway characteristics, and
   b. Accident characteristics.

2. Specificity of data element, i.e. number of levels available per data element.

The accuracy and consistency of a data base refers to the level of quality control in the data collection effort. In other words, are the collected data accurate or are there major sources of inaccuracy that could threaten the validity of the data. Also, are the collected data quality checked to make sure that the data are accurate and consistent?

The flexibility of a data base refers to its ease of use and integration with other data files. The ease of use is evaluated from the user standpoint on availability, completeness, and ease of understanding of documentation pertaining to the data base. Another consideration in the evaluation is the extent of data processing required to create an analysis file from the data base, including case selection and data recoding or reformatting.

It is often necessary to integrate or merge other data files into the data base for data variables that are not available from the data base itself in order to create a new data file for analysis. The evaluation criteria include the availability of identification variables for merging with other data bases and the extent of data processing required.

3.3 Summary of Evaluation Results

Each of the seven selected data bases was evaluated using the criteria described in the previous section. A summary of the evaluation results is presented in the following subsections.

3.3.1 Applicability

Figure 3 provides a quick overview on the applicability of the seven selected data bases to the various components of highway safety analysis. It should again be emphasized that the only criterion used in the assessment is whether the data base can be used for that particular analysis. No consideration is given to the utility of the data base, which is to be evaluated separately.

It is evident from figure 3 that State accident data bases, integrated with roadway inventory data, are the only data bases that are applicable to all components of highway safety analysis. The three national general purpose data bases (HPMS, FARS, and NASS) and the special purpose data bases are somewhat limited in their applications. Discussions on the individual data bases are presented as follows.

The HPMS data base is a continuing, integrated data base designed to serve FHWA's day-to-day planning and policy decision-

Highway Safety Analysis Characterization Scheme				General Purpose Data Base				Special Purpose Data Base[3]		
Type of Analysis	Unit of Analysis	Purpose	Specificity	NPMS	State[1] Accident Data Bases	FARS[2]	NASS CSS	FHWA RRR Data File	Calspan Study Data File	NASS LBSS
Problem Identification	Location	System Wide	Highway	●	●					
			Accident		●					
		Site Specific	Highway		●					
			Accident		●					
	Accident	System Wide	Highway		●	●	●		●	●
			Accident		●	●	●		●	●
Cross-Sectional Evaluation	Location	Comparative Evaluation	Highway	●	●					
			Accident		●					
		Relationship/ Predictive Modeling	Highway	●	●					
			Accident		●					
	Accident	Comparative Evaluation	Highway		●		●		●	●
			Accident		●		●		●	●
		Relationship/ Predictive Modeling	Highway		●		●		●	●
			Accident		●		●		●	●
Longitudinal Evaluation	Location	Evaluation	Highway	●	●			●		
			Accident		●			●		

Notes: (1) The evaluation is based on the assumption that the State accident and roadway inventory data are integrated in the data base.
(2) The evaluation is limited to fatal accidents only.
(3) The evaluation is limited to the specific purpose of the data base.

Blank - Not applicable ● - Applicable

Figure 3. Summary of Evaluation on Applicability of Selected Data Bases to Highway Safety Analysis.

making needs. The data base was designed to provide the FHWA with the capability to:

1. Monitor the performance of the Nation's highway systems on a continuing basis.

2. Determine the relationship between future highway investment levels and highway systems performance.

3. Determine the impacts of existing highway programs and policies.

4. Estimate the potential impacts of alternative future programs and policies.

5. Provide statistical and trend data on the extent, geometrics, condition, operating characteristics and usage of the highway plant.

The HPMS data base provides an inventory on such general information items as mileage classified by highway system, jurisdiction, and selected operational characteristics, and areawide data on totals for land area, population, mileage, vehicle miles of travel, and accidents. Extensive data are provided on the physical and operational characteristics of the sample panels. However, the data are summary in nature as they apply to the entire sample panel which can be several miles long and vary in length between sample panels. The specificity is thus limited to summary type of variables.

Accident data associated with the HPMS panels are provided in summary form only, i.e., the data are limited to counts of total, fatal, and nonfatal injury accidents and nothing else. The applicability of the data base is thus limited to only location-based analyses on system-wide problem identification, cross-sectional evaluation, and possibly longitudinal evaluation. The data base is not applicable for all analyses that are accident-based or site specific.

State accident data bases, when integrated with roadway inventory data, are applicable to all components of highway safety analysis. As pointed out previously, it is believed that most States have the capability to merge accident and roadway inventory data files, even though some of the States do not currently have their files integrated. Without roadway inventory data, the State accident data bases will be limited to only accident-based analyses.

It should be noted, however, that there are wide variations in the availability, definition, and format of data elements between the State accident data bases so that merging across States to form a national data base would be a very difficult and major undertaking. The problems associated with merging accident data bases across States are documented in a recently completed FHWA study entitled, "Adequacy of Existing Recordkeeping Systems for Evaluating Highway Safety Projects" (1,2).

The FARS and NASS CSS data bases are intended for use by the U.S. Department of Transportation to obtain detailed information on traffic accidents to estimate the size, scope, and nature of the Nation's motor vehicle traffic accident problem. Both data collection efforts are operated and maintained bt NHTSA's Center for Statistics and Analysis (NCSA). These data bases provide NHTSA with the needed information in its efforts to reduce the number of traffic accidents and the losses that result from them; to evaluate existing and proposed highway and motor vehicle safety standards; to identify traffic safety problems; and to establish better ways of dealing with those problems.

The FARS data base is applicable to only accident-based system-wide problem identification. The applicability of the data base is severely limited because only fatal accidents are included so that there is no basis of comparison in terms of severity. Also, there are no built-in exposure data to calculate fatal accident or fatality rates. Information from other sources will be necessary in order to use the FARS data for any type of safety analysis other than problem identification.

The NASS CSS data base is not applicable for all location-based analyses since the data base has no location information. Also, the data base does not currently have any exposure information for calculation of accident rates.

The FHWA RRR data file is created specifically to evaluate the safety impacts of RRR projects using a before-and-after design. Thus, the data base is applicable only for longitudinal evaluation. Also, since only summary accident data are available in the data base, the specificity is confined primarily to highway variables with very limited information on accident variables.

The Calspan Study data base is limited to single-vehicle, ran-off-road accidents while the NASS CSS data base is intended for longitudinal barrier accidents only and their applicability is evaluated accordingly. Both data bases are accident based with no location information so that all location-based analyses and accident-based, site-specific problem identification are not applicable.

3.3.2 Utility

A summary of the evaluation results on the utility of the seven selected data bases is shown in figure 4. It should be emphasized that the evaluation is based on available documentation and related publications gathered and reviewed in the study, and not on actual processing and application of the data bases. Some of the evaluation criteria are rated

Evaluation Criteria (1)	General Purpose Data Base				Special Purpose Data Base		
	HPMS (2)	State Accident Data	FARS	NASS CSS	FHWA [illegible] Data	Calspan Study Data	NASS LBSS Data
1. Breadth of Representation							
a. Geographical Representation	National	Individual State	National	National	11 States	6 States	National
b. Sampling Scheme	Statistical	Census	Statistical	Statistical	Convenient	Convenient	Convenient
2. Sample Size	~100,000 Sections	Varies by State	~40,000 Accidents/Year	~9,000 Accidents/Year	196 Sites (as of 5/83)	7,872 Accidents	~300 Accidents/Year
3. Level of Detail							
a. Highway	Fair/Good	Fair/Good	Poor	Fair	Fair	Fair/Good	Good
b. Accident	Poor (Summary Data)	Fair	Fair	Good	Poor (Summary Data)	Fair/Good	Good
4. Accuracy and Consistency	Fair	Poor/Fair	Fair/Good	Good	Fair	Fair/Good	Good
5. Flexibility							
a. Data Processing	Fair	Fair	Good	Poor/Fair	Good	Good	Poor/Fair
b. Integration	Yes	Yes	No	No	No	No	No

(1) Evaluation Criteria 3-5a were graded on a three point scale: Poor, Fair, Good.

(2) The evaluation is based on the assumption that the State accident and roadway inventory data are integrated in the data base.

Figure 4. Summary of Evaluation on Utility of Selected Data Bases for Highway Safety Analysis.

subjectively by the project staff on a simple three-point scale of poor, fair, and good. Brief descriptions of the evaluation results for each data base are presented as follows.

HPMS is a national data base with information on approximately 100,000 roadway sections sampled from all 50 States, the District of Columbia, and Puerto Rico. The roadway sections are sampled based on a statistical scheme so that national estimates can be made from the data. The large sample size should allow for very detailed analysis. The level of detail is fair to good on highway-related data elements with information available on general roadway and traffic characteristics. However, since the highway data elements are applicable to the entire section which may be several miles long, the specificity of the analyses will necessarily be general in nature. The level of detail on accident data elements is very poor since only summary accident data are available.

The data are submitted by the States and cooperating agencies and the extent of quality control is somewhat limited. Thus, the accuracy and consistency of the data base are judged to be only fair. Based on review of the available documentation on the data base, the data processing requirements for the data base appear to be fairly complicated and is, thus, rated as fair. The data base does have the capability of merging with other data bases using a location matching process.

State accident data bases are maintained by each State and are a census of all reported accidents. The sample size varies by State and is very large for analysis purposes. Assuming that the accident and roadway inventory data are integrated, information on general roadway and traffic characteristics is available, though the level of detail varies from State to State. For example, the Utah accident data base is a fully integrated system and contains much more information than the Texas accident data base which has only roadway inventory data merged with the accident data.

Police-level accident data are limited in detail and are subject to inaccuracies in such areas as location identification, definitions, and interpretation of data elements. Quality control of the data is generally from poor to fair. Data processing for State accident data bases requires large computer facilities due to the massive amounts of data, but is pretty straightforward. Merging with other data bases is achieved through a matching process based on location or other identifiers, such as vehicle or driver license numbers.

The FARS data base contains a census of all fatal traffic accidents in the United States with a sample size of approximately 45,000 accidents per year. The sample size is large enough for most analyses, but not for analyses involving rare events (e.g., crash cushion accidents) or great specificity (e.g., vehicles of certain year, make and model).

The level of detail for the FARS data base is similar to that available from police-level accident data. The major advantages of the FARS data over State accident data are the improved accuracy and consistency of the data and the use of standardized coding form so that data from different States can be merged into a single data base. The FARS data base is fairly simple to process and use. However, it is not possible to merge the FARS data base with any other data base since all identifiers are deleted from the data.

The NASS CSS data base contains a statistical sample of reported accidents, designed to provide national estimates of accident statistics. Accidents are selected by a method of disproportionate probabilities from 50 localities, known as Primary Sampling Units (PSUs), within the continental United States. Note that not all of the 48 States are included in the sample, but the PSUs are scattered across the country. Approximately 9,000 accidents were sampled each year in the Continuous Sampling Subsystem (CSS) during 1982-1984 and a larger sample size of 12,000-13,000 accidents is planned for future years.

The sample size is adequate for making general national estimates, but may become insufficient when greater specificity is needed. For example, in a study to estimate the severity of accidents involving roadside objects and features (4), the sample sizes for individual roadside objects and features become so small that the estimates are somewhat unstable despite the fact that four years (1979-1982) of NASS CSS data were used.

The level of detail available on accident data elements is very extensive, but fairly limited for highway-related data elements. The data are quality controlled exhaustively for good accuracy and consistency. The data base is somewhat difficult for users who are not familiar with the NASS program to learn and understand because of the complexity of the program and the voluminous documentation.

There is also a problem with incompatibility between data from the early years (1979-1981) for some of the data elements, requiring extensive recoding and reformatting to merge between years. This problem of incompatibility between years has been resolved for the years 1982-1984 although a major revision has been implemented in 1985. It is not possible to merge the NASS data base with any other data base since all identifiers have been eliminated from the data.

The FHWA RRR data file is intended specifically to address questions regarding the possible safety effect of RRR projects. Eleven States participated in the study and submitted data on RRR projects of their choice with no apparent sampling scheme. The sample size is very small and inadequate for any in-depth analysis. The level of detail is fair for highway-related data and poor for accident data elements since only summary accident data are included.

The data are submitted by the States and it is suspected that there is only limited quality control for the data. The accuracy and consistency of the data are fair at best. Data processing for the data file should be very straightforward due to its simplicity and small sample size. The data base does not have location identifiers and merging with other data bases is not possible.

The Calspan study data file is designed to study the hazards of single-vehicle ran-off-road accidents. Accident data were collected by State police from six States on mostly two-lane rural highways, supplemented by roadway and traffic information from State data files. The accidents were not selected using a statistical sampling scheme and thus are not necessarily representative of any known population. The sample size of 7,972 accidents is large considering that only single-vehicle, ran-off-road accidents on two-lane rural highways are studied.

The level of detail is fair to good for both highway and accident data elements. Additional information and photographic documentation were gathered by the investigating police officers to supplement data available from accident reports and State roadway inventory and traffic data files. The accuracy of the collected data should be better than those of regular accident reports since the police officers received special (though limited) training on accident investigation. The collected data were quality checked and the accuracy and consistency of the data should be reasonably good. Processing of the data file is fairly straightforward. However, it is not possible to merge this data base with other data bases since all location identification has been eliminated.

The NASS LBSS data collection effort is a special study under the NASS program, designed specifically to address the severity of longitudinal barrier accidents. The accident data are collected at the 50 PSUs though the number of accidents sampled at each PSU varies. The accidents are sampled on the basis of a stratification scheme, but not necessarily representative of the population. The original plan called for a total sample size of 3,000 to 4,000 accidents, but the current rate is only approximately 300 accidents per year The total sample size will be slightly over 1,000 cases assuming that the data collection effort will end by the end of 1985. The smaller than planned sample size may not be adequate for the analysis, depending on the specificity desired.

The level of detail for the collected data is very comprehensive on both highway and accident data elements. The investigators are highly trained in accident data collection and the data are rigorously quality controlled so that the accuracy and consistency of the collected data should be of high quality. Processing of the data base is fairly complicated with multiple data files as is the case with the NASS CSS data base. Again, it is not possible to merge the LBSS data base with any other data base due to the lack of identifiers for matching purposes.

3.4 Discussions

In evaluating the seven selected data bases, the most striking impression is the limited applicability of the data bases from the highway safety analysis as defined in this study. It is expectedfor the special purpose data bases to have limited applicability since they are intended and designed for specific purposes. However, the applicability of the three national, general purpose data bases, i.e., HPMS, FARS, and NASS, is not much better.

It should be emphasized that these three data bases, though categorized as general purpose data bases, are designed with objectives different from that of satisfying the information needs of highway safety analysis from the standpoint of FHWA. The evaluation results presented in this study should therefore be viewed only from the standpoint of highway safety analysis as specifically defined for the purpose of this study. They do not reflect the applicability or utility of these data bases in any other application.

Integrated State accident data files are the only type of data base that can be used for the entire spectrum of highway safety analysis. There are many drawbacks associated with State accident data, the most critical of which is the variation among the States on such key items as reporting format and data elements, reporting threshold,etc. Attempts to standardize the accident record-keeping systems among the States have met with little success. This has effectively eliminated any possibility of combining the State accident data files to create a national data base.

In terms of utility, the three general purpose national data bases are either a census, or a statistical sample designed to allow for national estimates. State accident data bases are also a census of all reported accidents in the individual States. The special purpose data bases are generally based on samples of convenience and therefore not necessarily representative of any population. Generalization of the results from samples of convenience may not be valid due to built-in biases.

The general purpose data bases have very large sample sizes that are adequate for many analyses. The only general purpose data base that may have a problem with sample size is the NASS data base when very detailed and specific analyses are needed. The sample sizes for special purpose data bases are generally rather small, but these data bases are intended for specific purposes and the sample size requirement should have been taken into consideration in the study design.

The level of detail available from the general purpose data bases is either too great or insufficient, depending on the analysis to be conducted. This is to be expected since a general purpose data base has a large number of users, each with differing data needs. Thus, the level of detail is a compromise between the data needs of the users and practical constraints. For special purpose data bases, this is less of a problem since the intended application of the data base is already well-defined and the data base is designed specifically for that application.

For highway-related data elements, State roadway inventory and traffic data files are a good starting point. Most accident-based data bases are lacking in highway-related data elements unless supplemented by either merging with roadway inventory and traffic data files or through on-site investigations. For accident-related data elements, the police accident report is the minimum requirement. Summary accident information is just not sufficiently detailed for most analyses except at a very gross level.

For most of the location-based analyses that are of interest to FHWA, accident rate (e.g., accidents per million vehicles or per 100 million vehicle miles of travel) and severity (e.g., percent injury and fatal accidents) are the key dependent variables. Police level accident data are generally adequate for such applications. For accident-based safety analyses, police-level accident data are often found wanting for lack of sufficient detail. Some analyses will require variables that can only be collected through in-depth accident investigation, such as the NASS program or special data collection efforts.

Police level accident data are subject to the problems of inaccuracy and inconsistency, as previously discussed. These problems could be minimized by enhancing the police level accident data with a more rigorous quality control process such as that for the FARS data base and the Calspan Study data base. The accuracy and consistency of in-depth accident data are tightly quality controlled at considerable expenses. It appears that the enhanced police level accident data are a good compromise between costs and desired levels of accuracy and consistency.

The data processing requirements for large national data bases are likely to be complicated due to the massive volume of data and the large number of data elements involved, especially when different levels are involved, e.g. accident level, vehicle level, and occupant level. However, it is also expected that the users of such large national data bases have the necessary resources to handle the data processing requirements. The key is the availability of appropriate documentation to aid the users in their understanding and use of the data bases. The documentation for some data bases reviewed during this study is not as good as it could be, thus rendering the data bases more difficult to use than they should be.

The ability to merge a data base with other data bases would greatly enhance the applicability and utility of the data base. Data elements not available from the data base itself can be incorporated from other data sources to satisfy the information needs of specific analyses. This in turn provides the flexibility to keep the number of data elements in the data base to a minimum without sacrificing the applicability and utility of the data base.

CHAPTER IV. CONCEPTUAL ALTERNATIVES

4.1 General Consideration

The desirable properties of an idealized national data base for highway safety analysis from FHWA's standpoint can be derived from the evaluations and discussions presented in Chapter III. Specifically, the data base should:

- Provide for both location- and accident-based analyses.
- Provide broad geographical representation and, preferably, be based on a statistical sampling scheme so that the results can be generalized to the entire nation.
- Have a large enough sample size to handle most of the highway safety analyses of interest.
- Have, as a minimum, the level of detail available from State roadway inventory data for highway-related data elements and from police accident reports for accident-related data elements.
- Be quality controlled for accuracy and consistency.
- Have the capability to be merged with other data bases.

In addition, there should be sufficient flexibility in the data collection system to allow for special studies designed to address very specific questions or topics that are beyond the scope of the data base itself.

None of the four existing general purpose data bases has all the desired characteristics, as previously discussed in Chapter III. Each data base has its own strengths and weaknesses. This chapter examines various conceptual alternatives that could improve and enhance the capabilities and utility of the existing general purpose data bases for highway safety analysis from the FHWA standpoint. No consideration is given to special purpose data bases since they are designed and used only for specific applications.

4.2 Conceptual Alternatives

Numerous conceptual alternatives to improve and enhance the capabilities and utilities of the existing general purpose data bases were considered. Many were rejected out-of-hand: some for being infeasible or impractical and others for not being cost-effective. Only a few alternatives were considered seriously. Brief discussions on some of the alternatives that were rejected and those that were included for consideration are presented in this section.

The ideal alternative is to have a single data collection system that has all the desirable characteristics described above that would satisfy all the information needs for highway safety analysis. By modifying and integrating the four existing general purpose data bases, i.e., HPMS, FARS, NASS and State accident data bases, a single data base could theoretically be created for this purpose. The individual components would serve different functions, but complement each other, so that data needs for various safety analyses might be satisfied by using one or more of the individual components.

This alternative would require major fundamental changes to the various data collection systems, both technically and administratively. Theoretically, this might be a feasible and even desirable concept. However, this is obviously not a practical alternative. Thus, no further consideration was given to this alternative in this study.

The FARS and NASS data bases are accident-based and lack the capability to be merged with other data bases. It is not possible to modify these two data bases to a location-based system without totally redesigning the data collection systems. Any improvements or enhancements short of major redesign and restructuring of the data collection systems would not extend the applicability of these two data bases beyond that of accident-based type of analysis. No alternative was therefore considered for the FARS or NASS data bases.

It is obvious that any alternative to enhance and improve existing data bases to meet the needs of FHWA would evolve around the HPMS and the State accident data bases. Detailed assessments on candidate alternatives to improve or enhance the HPMS or the State accident data bases are presented in the following subsections.

4.2.1 HPMS Data Bases

The HPMS data base is location-based and the panels or highway sections are sampled on a statistical basis to provide national representativeness. It has a sufficiently large sample size to handle most of the highway safety analyses of interest and the capability to be merged with other data bases, albeit indirectly. However, the HPMS data base also has some major shortcomings, as follows:

1. Only summary accident data are provided;
2. The roadway and operational data elements apply to the entire sample panel which varies in length. This results in a lack of specificity for some of the data elements.

The lack of detailed information on accident data could be remedied by merging the State accident data files with the HPMS data base through a location matching process. With an appropriate system design, the merged data base could provide for both location- and accident-based analyses.

One alternative is to keep the current HPMS data base unchanged. Accident records would be matched with the HPMS panels through a location matching process on an individual State basis. No modification would be made on the accident records. This alternative would be easy to implement with a minimum of effort provided that the States already have the capability to merge their accident files with the HPMS files. Unfortunately, this is not the case at the present time which means that the merging process would have to be developed for some of the States that do not currently have such capability.

Assuming that such merging capability is developed, the users would still have to extract the required data from the merged data base to create an analysis file suitable for use with the intended analysis. The burden of converting the merged data base into a usable analysis file would be borne by the users which would likely discourage its use. Also, the level of detail would be limited to that available from the HPMS data base and police-level accident data and any analysis requiring greater detail or specificity would have to resort to special studies created specifically for that purpose.

Another alternative is to create a safety analysis subsystem within the HPMS data base. Appropriate modifications would be made to the HPMS and State accident data collection systems to create a data base that would be suitable for safety analysis. This would involve changes to the HPMS data elements and the State accident data records. The users would be provided with a single safety analysis data base for analytical purposes with a minimum of data manipulation required. The level of detail is again limited to that available from the HPMS data base and police-level accident data so that special studies would have to be conducted for any analysis requiring greater details or specificity.

The major obstacle to setting up a single accident data base is the wide variation among the States in their accident report forms and reporting thresholds. The accident report forms vary among the States in terms of available data elements, format, definitions, and coding levels. The effort required to merge all the State accident data bases into a single standardized format is a monumental task. In some past and ongoing research studies, several State accident data bases are merged into a single data base for analysis purpose. The process is found to be very tedious and time consuming. Moreover, the level of detail on the data elements for the merged data base is usually reduced to the lowest level available from the individual States.

The use of varying reporting thresholds among the States is even more problematic. The reporting thresholds used in most States are based on certain levels of property damage, e.g., 250 dollars or above, towaway vehicles, or injury to one or more of the involved occupants. However, the reporting thresholds vary among the States, i.e., for a given accident, it may be reported in some States but not in others. It is evident that such differences in reporting thresholds would introduce unknown biases into the data base. The ideal solution is to have the States standardize their accident record systems, i.e., using a standardized accident reporting form and the same reporting threshold, thus eliminating the problem totally. A lot of effort has been devoted to this goal through the years with only limited success. There is no reason to believe that the situation will improve in the foreseeable future.

The problem with the lack of uniformity and compatibility in the accident reporting form could be alleviated by using an approach similar to that of the FARS system. A subsample of accidents, e.g., a total of 250,000 accidents, occurring within the HPMS panels would be selected based on a statistically representative scheme. These sample accidents would be recoded onto a standardized form and entered into a single data base. At the same time, supplemental information on accident, roadway, traffic and other data elements could be added to the data base. More rigorous quality control checks could be installed to improve on the accuracy and consistency of the data. In short, the data quality would be improved to that of an enhanced police level.

The extra manpower required could be provided through FHWA contracts with appropriate State agencies. State personnel, paid for by the contracts, would be used for the coordination, recoding, collection of supplemental data, quality control, and data entry functions. The data would then be compiled at a centralized location to create the data base. The number of accidents included in the data base would be a function of funding available.

The problem with differences in reporting thresholds among the States is much more difficult to resolve. Any changes in the reporting thresholds would probably require legislation at the State level. Also, there are variations even within a State, e.g., some major metropolitan areas have adapted the policy of reporting only injury and fatal accidents, leaving the reporting of property-damage-only accidents to driver self-reporting.

Another drawback is the lack of specificity for some roadway data elements since the data elements apply to the entire HPMS panel which varies in length up to several miles. This problem could possibly be alleviated by merging State roadway inventory files into the HPMS data base or by subdividing the HPMS panels into shorter sections of equal lengths. Either approach would require considerable effort.

4.2.2 State Accident Data Bases

Integrated State accident data bases can be used for both accident- and location-based analyses through a location matching process. A national data base could, theoretically, be created by merging across the States. This data base would be applicable to all components of highway safety analysis as discussed previously under the applicability for selected data bases. It is a census of all reported accidents in the nation and the sample size is enormous.

The problem, as pointed out previously, is the lack of uniformity and compatibility among the States in their accident and inventory record systems which makes the merging of State accident data files into a single data base a monumental task. Also, the data base would be too large for most applications. Extensive computer facilities would be required and associated data processing cost would be very high due to the large number of records. This would not be a viable alternative and thus is not considered any further.

One alternative is to select a sample of the accidents to create a data base. To be applicable for both location- and accident-based analyses, the initial sample must be on roadway sections. Then, the accidents or a subsample of accidents occurring within these roadway sections could be selected for inclusion in the data base. This alternative, in effect, is almost identical to the second alternative identified for the HPMS data base and shares the same advantages and drawbacks. No further consideration was given to this alternative.

Another alternative is select a small number of States with integrated accident data bases and merge them into a single data base. The States would be selected on the following criteria:

- Geographical representation.
- Existing capability of integrating the accident data files with the roadway inventory, traffic, and other pertinent data files.
- Compatibility among the States in their accident and roadway inventory record systems.

Geographical representation is approximated by dividing the nation into a number of regions and then selecting one State from each region. It should be emphasized that no two States are alike and the combined data base is not truly representative of the nation. In other words, the extrapolation of the analysis results to States other than those included in the data base is not statistical in nature.

Caution should be exercised in interpreting the analysis results, especially if the analysis of interest is susceptible to the influence of regional characteristics, such as weather and terrain conditions, design standards, age of the facilities, etc. More detailed discussion on how to account for such differences in the analysis and interpretation of the results will be presented in the next section.

Another consideration is the relative size of the individual State data bases. It is conceivable that the size of one State, in terms of number of highway miles and accidents, is so large relative to the other States in the data base that the analysis results are heavily biased toward that State. This problem could be minimized by selecting States with roughly equal proportions. On the other hand, it may be desirable to have each State in proportion to the relative size of the region it resides so that the data base would be more representative on a national basis.

A number of States have established , or are in the process of developing, integrated accident record systems, such as Michigan, Montana, New York, North Carolina, Ohio, Texas, Utah, and Washington. This list is by no means all inclusive and the degree of integration also varies among the States. Of course, it would be desirable to select systems with as high a degree of integration as possible.

The importance of compatibility among the selected States in terms of the reporting format and reporting threshold has already been discussed previously and will not be repeated here. Every effort should be made to select those States with the highest compatibility to minimize the effort required to merge the State data files into a single data base. Since only a small number of States, e.g., four to five States, are involved, there is a better chance of finding States that are relatively compatible. Also, it may be easier to work with these States to achieve an even higher degree of compatibility.

4.3 Discussions

A number of conceptual alternatives have been presented and discussed in the previous section. Some of the alternatives are considered impractical, infeasible, or not cost-effective, and are rejected outright. The more promising alternatives worthy of further consideration are as follows:

- Supplement the HPMS data base with accident data by merging the State accident data bases into the HPMS data base.
- Create a safety analysis subsystem within the HPMS data base.
- Merge selected integrated State accident data bases into a single data base.

The first alternative is perhaps the least attractive of the three alternatives. First, some of the States do not have existing capability to merge the accident data files into their HPMS data file. This would require considerable effort and expenditure to develop such capabilities initially and to maintain them on an annual basis. Second, even after merging with the HPMS data base, the merged accident data files are still on an individual State basis. The users would have to extract the required data from the individual State data files and combine them to create an analysis file suitable for use with the intended analysis. This would greatly complicate the data processing requirements and thus discourage its use.

The second alternative is the most desirable, but also the most expensive. There is the initial cost of setting up the data collection system, including design of the standardized accident reporting form, coding instructions, data entry and processing, and quality control. In addition, contracts would have to be established with the States and training provided for State personnel. Also, to provide better specificity on some of the data elements, it would be desirable to subdivide the HPMS panels into shorter sections of equal length. A rough estimate of the startup cost is in the range of one million dollars.

After the system is established, there would be annual operational expenses associated with the data collection effort, and the update and maintenance of the data base. The annual cost would vary depending on the number of accidents sampled. Assuming an annual sample of 250,000 accidents, the operational expense is estimated to be in the range of 3 to 5 million dollars per year.

The third alternative is the least expensive while providing a reasonably good data base for safety analyses. The startup cost consists of identifying and selecting the State integrated accident record systems for inclusion in the data base and acquiring the data bases from the selected States. Since the individual State accident data bases are already integrated, it is necessary to only develop the required software to merge the individual data files into a single data base. A startup cost of quarter of a million dollars should be sufficient for the purpose.

The annual operating cost is correspondingly low, which includes the acquisition of the State accident data bases and update of the software for merging the files. An annual budget of $200,000 should be sufficient, not including any reporting requirements or applications.

It is evident that the third alternative of merging several integrated States accident data files into a single data base is the most cost-effective approach and is therefore recommended. More detailed discussion on the pros and cons of the recommended approach are presented in the following subsection.

4.3.1 Recommended Alternative

Some of the major considerations associated with this recommended alternative are as follows:

- Geographical representation.
- Compatibility.
- Level of detail.
- Administrative considerations.
- Privacy of data.

The major concern with this approach is the possible lack of credibility since the data base does not provide true national or geographical representation. Even if the States are selected on a regional basis, there is no guarantee that the analysis results would be applicable to the individual States. Some of this concern could be alleviated through more rigorous validation procedures.

Results of any analysis derived from the data base should be validated internally and, if possible, externally. For instance, a predictive model is developed using the data base which includes combined data from four States. The model should be applied to each of the four States individually to check if the results are consistent across the States. It would also be desirable to apply the model to one or two States not included in the data base as an external check. If the results are consistent across the States, there is reason to believe that the results would be applicable to individual States. However, if there are wide variations in the results, it would be necessary to reanalyze the data to determine the cause(s) for such variations and to develop appropriate adjustment factors to account for differences among the States.

In other words, analysis results derived from the data base should be validated by applying the results to the individual States included in the data base and, if possible, to other States outside of the the data base. This would also reduce biases introduced in the results due to unequal size of the States in the data base. This validation process is relatively straightforward and inexpensive since it involves only the application, and not the development, of the analysis results.

Every effort should be made to select States that are compatible in terms of data elements and reporting threshold. It is recognized that true compatibility is not attainable at the current time. However, since the number of States involved is small, a high degree of compatibility could be achieved. Also, there is a better chance of improving the degree of compatibility by working closely with the States and possibly through such means as demonstration projects.

The level of detail on the accident data is limited to that of police reported level while the level of detail on the roadway and traffic data elements is restricted to what is available from the State roadway inventory files. Such levels of detail are usually adequate for analyses of a general nature, but not for specific applications.

It may be desirable to supplement the roadway inventory data with a limited number of data elements that are deemed essential, but are unavailable from the existing inventory files in one or more of the States. However, this should be kept to a minimum, and preferably on an ad hoc basis. There is always a tendency to try to satisfy the information needs of as many users as possible. This could result in the inclusion of too many data elements that are only used infrequently. By so doing, the cost for the data collection and processing could be increased substantially without a corresponding increase in the benefits.

It is probably more cost-effective to include in the data base on (a continuous basis) only those data elements that are most essential or those that are currently available from the State data files. Then, for applications requiring more details than are available from the continuous data base, special studies specifically designed for the application would be used.

As for the quality of the data, they would be subject to the same problems as those of the State data bases since no additional quality control checks are incorporated. One alternative is to improve the data quality to that of enhanced police-level data through recoding and additional quality control checks. The costs associated with this enhancement are fairly substantial and probably not cost-effective since only four or five States are involved.

Proper administration of the data base is essential to the success of the data base. The data base should be administered through a single agency, be it FHWA or a contractor to FHWA. The data base manager has to have intimate knowledge of the individual State data bases and constantly keep abreast of any new developments in the States. The manager should also have a good understanding of the requirements for highway safety analysis in order to assist the users in properly analyzing the data base. This user interface is critical to the acceptance of the data base by the users.

The final consideration concerns the privacy and accessibility of the data base. Tort liability has been a growing concern of the States in recent years. It may be difficult to enlist the cooperation and assistance of the States without consideration for the privacy and accessibility of the data. It would be ideal if the data base could be protected under some form of legislation and be restricted to only research and development applications. Otherwise, safeguards against requests by attorneys or non-governmental agencies through subpoenas or the Freedom of Information Act should be developed to maintain data privacy. The safeguards should also be extended to limit the accessibility of the data base to only authorized users.

4.3.2 Illustrative Examples

To illustrate the applicability and utility of the recommended alternative, it is instructive to examine how the hypothetical data base would fare in addressing the example questions posed previously in Chapter II under highway safety analysis. Details of the illustrative examples are provided in Appendix D. Only a summary of the highlights is provided in this subsection.

The need to merge with other data bases in addressing specific analysis is well-demonstrated with the examples. In order to identify bridge sites, the data base has to be merged with the computerized bridge inventory file through a location matching process. It is both impractical and undesirable to carry too many data elements in the data base on a continuous basis. It would be more cost-effective to maintain only the most essential data elements in the data base. More specific or detailed information would have to be obtained by merging with other data bases or through special studies.

To allow for both location- and accident-based analysis, it is necessary to maintain two separate files, one for the locations and the other for the corresponding accidents. These files could be used individually or in combination depending on the question being addressed. For location-based analyses, the accident data would be merged into the location file for determining accident frequency and rate. A computer program to merge these two files would have to be developed. For accident-based analyses, only the accident file would be required.

There are a number of situations in which the hypothetical data base would not be applicable or useful. Summaries of such situations are presented as follows:

1. The data base would not be applicable to site-specific analyses unless the population of interest is included in the data base. More importantly, it is inappropriate to use a national general purpose data base to address site-specific analyses. Such analyses are best addressed at the State and local levels, and not at the national level.

2. Longitudinal evaluation type of analysis is also site-specific and the number of locations at which a particular countermeasure is installed at any given time is usually rather small. While the hypothetical data base may be applicable to some of the questions, it is oftentimes just as easy to set up a special study for the specific question to be addressed than to try to glean the information from the hypothetical data base. Moreover, the required level of detail for the data is sometimes beyond that available from the data base (i.e., general roadway

inventory data and police-level accident data) so that supplemental data collection is already necessary.

3. The applicability of the data base is limited not only by the data elements available, but also by the level of detail available in the data elements. For example, the analysis on safety associated with double-bottom tractor-trailer trucks is greatly hampered by the inability to identify accidents involving these trucks. A minor change in the accident report form to include a separate code for double-bottom tractor-trailer trucks under vehicle type would greatly facilitate future studies on the safety of these trucks.

4. The specificity of the posed question is another factor affecting the applicability of the data base. Despite the large sample size of the data base, certain events, such as large trucks impacting crash cushions, are so rare that the number of applicable accidents may be too small for proper analysis.

5. There are questions that simply cannot be addressed with accident analysis. Accident measures are relatively gross indicators and they may not be sensitive enough to detect subtle changes or differences in some instances. It is important to recognize and understand the limitations of accident analysis so that appropriate alternatives could be used to properly address the question under study.

In summary, the recommended alternative of merging four or more integrated State traffic record systems into a single data base would provide the needed information for most highway safety analyses of a general nature from the standpoint of FHWA. However, it should be recognized that the data base also has its limitations. Some of the analyses are better addressed with special studies and there are others that are simply not answerable with accident analysis. Nevertheless, the recommended alternative appears to be a effective means of addressing much of FHWA 's data needs in highway safety analysis at a reasonable cost.

CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Findings and Conclusions

• Highway safety analysis, as defined in this study, can be categorized as either analysis or implementation. Analysis refers to the use of the data bases to address problems and questions from the standpoint of research and development, evaluation, and analysis. Implementation is related to the development of warranting criteria and project selection based upon the warrants. Assessment of the data bases is strictly from the analysis standpoint and excludes implementation.

Highway safety analysis can be characterized using a taxonomy based on four factors:

1. Type of Analysis

    Problem Identification
    Cross-Sectional Evaluation
    Longitudinal Evaluation

2. Unit of Analysis

    Location
    Analysis

3. Purpose

    Problem Identification - System Wide vs. Site Specific
    Cross-Sectional Evaluation - Comparative Evaluation vs. Relationship/Predictive Modeling
    Longitudinal Evaluation - Evaluation

4. Specificity

    Highway
    Accident

Sixteen components of highway safety analysis are identified with the characterization scheme based on which the applicability and utility of selected existing data bases are evaluated.

• Existing data bases are categorized using another taxonomy based on the following four criteria:

1. Application

    Primary
    Secondary

2. Purpose

   Primary - General Purpose vs. Special Purpose
   Secondary - Exposure vs. Inventory

3. Unit of Analysis

   Location
   Accident

4. Level of Detail

   Police Level
   Enhanced Police Level
   In-Depth

Only primary data bases that can be used directly for safety analysis are included in the study. The existing data bases are then grouped into seven categories according to this categorization scheme.

• Seven existing data bases are selected for study, one from each of the seven categories:

General Purpose Data Base:

1. Highway Performance Monitoring System (HPMS).
2. State Accident Data Bases.
3. Fatal Accident Reporting System (FARS).
4. National Accident Sampling System (NASS) Continuous Sampling Subsystem (CSS).

Special Purpose Data Base:

5. FHWA RRR Data File.
6. Calspan Study Data File.
7. NASS Longitudinal Barrier Special Study (LBSS).

The emphasis of the evaluation is on the four general purpose data bases for obvious reasons. The three special purpose data bases are included to illustrate the use of special studies to address specific questions that cannot be answered with the general purpose data bases.

• These seven selected data bases are evaluated for their applicability and utility in addressing the information needs of the 16 components of highway safety analysis. The evaluation criteria used are as follows:

1. Applicability - the types of highway safety analysis that the data base can be used for.

2. Utility - how good the data base is in satisfying the information needs of the applicable analyses:

   a. Breadth of representation
   b. Sample size
   c. Level of detail
   d. Accuracy and consistency
   e. Flexibility.

• The three national, general purpose data bases, i.e., HPMS, FARS, and NASS CSS, and the special purpose data bases are rather limited in their applications. It is understandable for the special purpose data bases to have limited applicability since they are designed for specific purposes. However, the applicability of the three national general purpose data bases is not much better. It is obvious that the emphasis for these data bases is to provide a census or estimates on a national scale and little consideration has been paid to the use of these data bases in highway safety analysis from the FHWA standpoint.

The HPMS data base has extensive roadway data, but only summary data on accidents. This eliminates the use of HPMS in any accident-based type of analysis. Also, the roadway data apply to entire roadway sections, or HPMS panels, which have varying lengths. The specificity of the roadway data is therefore also limited to summary type of variables.

The FARS and NASS CSS data bases are both accident-based and are thus not applicable for any location-based type of analysis. The applicability of the FARS data base is even more limited since only fatal accident are included so that there is no basis of comparison in terms of severity. Also, both data bases do not currently have any exposure information for calculation of accident rates.

State accident data files, when integrated with roadway inventory data, are the only data bases that are applicable to all components of highway safety analysis. Many of the States do not currently have their roadway inventory and accident data files integrated although it is believed that most of the States have the capability for doing so. With regard to accident data, there are wide variations among the States in the availability, definition, and format of data elements and in their reporting thresholds. This makes the merging of accident data bases across States a very difficult and major undertaking.

The utility of the data bases varies somewhat among the general purpose data bases, but none with any major problems. The emphasis in devising conceptual alternatives is on improving the applicability, and not on the utility, of the data bases.

• An idealized national data base for highway safety analysis from FHWA's standpoint should have the following desirable characteristics:

1. Handle both location- and accident-based analyses.

2. Have broad geographical representation or be based on a statistical sampling scheme.

3. Have a large sample size.

4. Have, as a minimum, general roadway inventory data and police level accident data.

5. Be quality controlled for accuracy and consistency.

6. Have the capability to be merged with other data bases.

None of the existing general purpose data bases has all the desired characteristics. Each data base has its own strengths and weaknesses.

• Various conceptual alternatives to improve and enhance the applicability and utility of the existing general purpose data bases were considered. Many alternatives were rejected for being infeasible, impractical, or not being cost-effective. For example, the ideal alternative of modifying and integrating the four existing general purpose data bases into a single data collection system which would have all the desirable characteristics and could satisfy all the information needs for highway safetyanalysis is obviously not a practical alternative.

The FARS and NASS CSS data bases are accident-based and cannot be modified to a location-based system without totally redesigning the data collection systems. Any improvement short of major redesign would not extend the applicability of these data bases to beyond that of accident-based type of analysis. No alternative was therefore considered for the FARS and NASS CSS data bases.

The more promising alternatives considered evolve around the HPMS and integrated State accident data bases, including:

1. Supplement the HPMS data base with accident data by merging State accident data bases into the HPMS data base,

2. Create a safety analysis subsystem within the HPMS data base, and

3. Merge selected integrated State accident data bases into a single data base.

The first alternative would keep the current HPMS data base unchanged. Accident records would be matched to the HPMS panels on an individual State basis. This alternative is the least attractive of the three alternatives. First, some of the States do not currently have established capability to merge their accident files into the HPMS file. This would require considerable effort and expenditure to develop and maintain such capabilities for all these States. Second, even after merging with the HPMS data base, the merged accident data files are still on an individual State basis. The users would have to extract the required data from the individual State data files and combine them to create an analysis file. This would greatly complicate the data processing requirements and thus discourage its use.

The second alternative involves selecting a subsample of accidents that occurred within the HPMS panels based on a statistically representative scheme. These sampled accidents would be recoded onto a standardized form and entered into a single data base. Supplemental data elements could be added to the data base at the same time if so desired. Also, more rigorous quality control could be installed to improve on the accuracy and consistency of the data. Another potential improvement is to merge State roadway inventory data into the HPMS data base or to subdivide the existing HPMS panels into shorter sections of equal length.

The second alternative is the most desirable, but also the most expensive. There is the initial cost of setting up the system. More importantly, after the system is established, there would be annual operational expenses associated with the data collection effort and the update and maintenance of the data base. The recoding of the accident data would require the use of State personnel, under contract to FHWA. A rough estimate of the startup cost is in the range of one million dollars with an annual operational expense of 3 to 5 million dollars, assuming an annual sample of 250,000 accidents.

The third alternative involves the selection of a small number of States with existing integrated accident data bases and merging them into a single data base. Since the individual State accident data bases are already integrated, it is necessary to only develop the required software to merge the individual files into a single data base. A startup cost of quarter of a million dollars is estimated. The annual operating cost is estimated at $200,000, which includes the acquisition of the State accident data bases and updates of the software for merging the files. This alternative is the least expensive while providing a reasonably good data base for highway safety analysis and is thus recommended for further consideration.

5.2 Recommendations

The recommended alternative is to merge several integrated State accident data files into a single data base. The major characteristics of the resulting data base are as follows:

1. The data base is applicable to all components of highway safety analysis,

2. Some geographical representation is provided by dividing the nation into a number of regions and selecting one State from each region,

3. The data base would have a very large sample size,

4. The level of detail is limited to State roadway inventory data and police level accident data,

5. The quality of data is the same as that of the individual State data files since no additional quality control checks are incorporated,

6. The data base could be merged with other data bases.

The data base would provide, at a reasonable cost, the needed information for most highway safety analyses of a general nature from the standpoint of FHWA. However, it should be recognized that the data base also has its limitations. Some of the analyses are better addressed with special studies and there are others that are simply not answerable with accident analysis.

Some major considerations associated with the recommended approach and resulting data base are summarized as follows.

- Selection of the States for inclusion into the data base is a critical ingredient to the success of this approach. The States would be selected on the following criteria:

1. Geographical representation - one State from each region with due consideration for the relative size of the individual State data bases.

2. Existing capability of integrating the accident data files with the roadway inventory, traffic, and other pertinent data files.

3. Compatibility among the selected States in terms of their accident reporting format and reporting thresholds, and their roadway inventory record systems.

- The major concern with this approach is the possible lack of credibility since the data base does not provide true national or geographical representation. Some of this concern could be alleviated through more rigorous validation procedures. Results of any analysis derived from the data base should be validated internally by applying the results to the individual States. If the results are consistent across the States, there is reason to believe that the results would be applicable to other States. However, if there are wide variations in the results, it would be necessary to reanalyze the data to determine the cause(s) for such inconsistency and to develop appropriate adjustment factors to account for the differences. Also, it would be desirable to further validate the results with one or two States not included in the data base as an external check.

- There is always the tendency to include as many data elements as possible to satisfy the information needs of various users. This could mean the inclusion of supplemental data elements not available from the existing data files. However, it is probably more cost-effective to include in the data base on a continuously basis only those data elements that are most essential and are currently available from the State data files. For analyses requiring more detailed information than is available from the data base, the data could be obtained with supplemental data collection or special studies.

- Proper administration of the data base is essential to the success of the data base. The data base should be centralized and administered by a designated data base manager within FHWA or a contractor to FHWA. The manager should have intimate knowledge of the individual State data bases and constantly keep abreast of any new developments in the States. The manager should also have a good understanding of the requirements for highway safety analysis to properly interface with the users.

- The privacy and accessibility of the data base is another key consideration gi[illegible] the current concern of the States on tort liability. It wo[illegible]e ideal if the data base could be protected through legisl[illegible]n to only research and development applications. Otherwise, some safeguards against unwanted or unauthorized use of the data base need to be developed.

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APPENDIX A

ILLUSTRATIVE EXAMPLES OF HIGHWAY SAFETY ANALYSIS

PROBLEM IDENTIFICATION

Question 1. What are the accident rates for bridge sites by highway type and bridge width?

Unit of analysis: Location (bridges)
Purpose: System wide
Specificity: Highway (highway type and bridge width)

Comments. This is the basic question on any location-based problem identification type of analysis. Implicit in the question is whether there is a safety problem associated with bridge sites. This may be answered by identifying those combinations of highway type and bridge width with the highest accident rates, or by comparing the various accident rates to some baseline, such as the average accident rate for non-bridge sites. The extent of the problem is provided by the magnitude of the accident rates.

Question 2. What are the accident rates for trucks with gross weight of over 10,000 pounds at bridge sites?

Unit of analysis: Location (bridges)
Purpose: System wide
Specificity: Accident (trucks with gross weight of over 10,000 pounds)

Comments. The question is similar to the first question except that the accidents are constrained to only trucks with gross weight of over 10,000 pounds.

Note that the specificity does not have to be exclusively highway or accident, but can be a combination of both. For example, the question can be changed to, "What are the accident rates for trucks with gross weight of over 10,000 pounds at bridge sites by highway type?" The specificity is now both accident (trucks with gross weight of over 10,000 pounds) and highway (highway types). These examples are purposely kept simple to illustrate the various categories of highway safety analysis.

Question 3. Which are the top 50 bridge sites with the highest accident frequency on two-lane rural highways in the State of Texas for the 3-year period of 1982 to 1984?

Unit of analysis: Location (bridges)
Purpose: Site specific
Specificity: Highway (two-lane rural highways)

Comments. In site-specific, problem identification type of analysis, the basic question is usually related to the identification of specific locations with certain safety problems, e.g., top 50 bridge sites with highest accident frequency. It will always be necessary to define the population in terms of domain and time period, e.g., State of Texas from 1982 to 1984.

Question 4. Which bridge sites in the State of Texas had at least two fatal accidents within the 3-year period of 1982 to 1984?

Unit of analysis: Location (bridges)
Purpose: Site specific
Specificity: Accident (fatal accidents only)

Comments. This question is similar to Question 3 except that only fatal accidents are considered.

Question 5. What are the accident severities for bridge accidents by highway type and bridge width?

Unit of analysis: Accident (bridge accidents)
Purpose: System wide
Specificity: Highway (highway type and bridge width)

Comments. This question is similar to Question 1 except for the dependent variable, which is accident severity instead of accident rate. This illustrates the basic distinction between location- and accident-based types of analysis.

Question 6. What is the severity of bridge accidents involving large trucks (i.e., tractor semi-trailer and double bottom tractor-trailer trucks)?

Unit of analysis: Accident (bridge accidents)
Purpose: System wide
Specificity: Accident (large trucks)

Comments. Safety of large trucks has been a controversial topic in recent years due to legislations allowing for heavier trucks and the designation of a nationwide truck network. Implicit in this question is whether the severity of accidents at bridge sites involving large trucks is higher than some baseline, e.g., non-bridge sites, and/or other vehicle types.

CROSS-SECTIONAL EVALUATION

Question 7. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24-feet wide on two-lane rural highways?

Unit of analysis: Location (bridges)
Purpose: Comparative evaluation (bridge width narrower than 24 feet versus 24 feet and wider)
Specificity: Highway (two-lane rural highways)

Comments. In cross-sectional evaluation, the data are taken at a given point in time for the analysis, e.g., latest three years of accident data and current condition at bridge sites provided that no major improvement has taken place during the 3-year period. The specific comparison is the accident rate at narrow bridges with widths of less than 24 feet and wider bridges with widths of at least 24 feet.

Question 8. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24-feet wide for double bottom tractor-trailer trucks?

Unit of analysis: Location (bridges)
Purpose: Comparative evaluation (bridge width narrower than 24 feet versus 24 feet and wider)
Specificity: Accident (double-bottom tractor-trailer)

Comments. This question is similar to Question 7 except for the specificity which limits the data to only double bottom tractor-trailer trucks.

Question 9. What is the relationship between accident rate and bridge width for various highway types?

Unit of analysis: Location (bridges)
Purpose: Relationship (accident rate vs. bridge width)
Specificity: Highway (highway type)

Comments. This question and Question 7 illustrate the basic difference between comparative evaluation and relationship/predictive modeling. Both questions ask for the relationship between accident rate and bridge width. Question 7 specifies two discrete categories of bridge width, i.e., less than 24 feet and at least 24 feet in width, while this question has bridge width as a continuous variable. The statistical techniques used to address these two types of analysis are very different, thus necessitating the distinction between comparative evaluation and relationship/predictive modeling.

Question 10. What is the relationship between fatal accident rate and relative bridge width?

Unit of analysis: Location (bridges)
Purpose: Relationship (accident rate vs. relative bridge width)
Specificity: Accident (fatal accidents only)

Comments. This question is similar to Question 9, but constrained to fatal accidents only. Also, the independent variable is changed from absolute bridge width to relative bridge width, i.e., the difference between bridge and approach roadway widths.

Question 11. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?

Unit of analysis: Accident (bridge rail accidents)
Purpose: Comparative evaluation (bridge rails with vs. without approach transition treatment)
Specificity: Highway (bridge rail transition)

Comments. The comparison in this question is on the severity of bridge rail accidents between bridges with approach guardrail transition treatment and those without. This same question can be addressed in two totally different approaches, as further discussed under Question 16.

Question 12. Is the severity of bridge accidents higher for double bottom tractor-trailers as compared to tractor semi-trailers?

Unit of analysis: Accident (bridge accidents)
Purpose: Comparative evaluation (double bottom tractor-trailer vs. tractor semi-trailer)
Specificity: Accident (double bottom tractor-trailer and tractor semi-trailer accidents only)

Comments: In Question 6, the severity of bridge accidents for large trucks is determined. This question goes one step further to compare the severity of bridge accidents between double bottom tractor-trailer trucks and tractor semi-trailers.

Question 13. Do the impact conditions (i.e., impact speed and angle) for bridge rail accidents vary as a function of bridge shoulder width on two-lane rural highways?

Unit of analysis: Accident (bridge rail accidents)
Purpose: Relationship (impact conditions vs. bridge shoulder width)
Specificity: Highway (two-lane rural highways)

Comments: This question differs from the other questions in that the dependent variable is not accident frequency, rate, or severity, but impact conditions, i.e., impact speed and angle. Otherwise, the question is similar to the others. The unit of analysis is bridge rail accidents constrained to two-lane rural highways. The relationship of interest is that between impact conditions and bridge shoulder width.

Question 14. What is the relationship between the vehicle curb weight and injury severity for bridge rail accidents involving passenger cars?

Unit of analysis:	Accident (bridge rail accidents)
Purpose:	Relationship (vehicle curb weight vs. injury severity)
Specificity:	Accident (passenger cars only)

Comments: The effect of vehicle downsizing on highway safety has been a topic of interest in recent years. This question applies specifically to bridge rail impacts and the effect of vehicle curb weight on injury severity.

LONGITUDINAL EVALUATION

Question 15. Does widening the approach roadway to a bridge without corresponding widening of the bridge itself create a hazardous condition for various highway types?

Unit of analysis:	Location (bridges)
Purpose:	Evaluation (widening approach roadway with vs. without widening of bridge itself)
Specificity:	Highway (highway type)

Comments: This is a question commonly asked in RRR type of projects as to whether certain narrow bridges can remain in place while the approach roadway is being reconstructed to a higher standard.

The question can be answered using a before-and-after with control type of design in which the bridges are widened to the same width as the approach roadways in some projects and not widened in other projects. The accident rates and severity in the before and after periods can be compared for both the treatment and control bridges to determine if the widening of the approach roadway, without corresponding widening of the bridge itself, creates a hazardous condition.

A different approach can also be used to address this question. Since widening of approach roadway without widening of the bridge results in the change of the relative bridge width (i.e., difference between bridge and approach roadway widths), one can estimate its effect by using the relationship between accident rate and relative bridge width. Such a relationship can be established using cross-sectional evaluation type of analysis.

Longitudinal evaluation is a much more powerful technique than cross-sectional evaluation since it provides a direct answer to the question posed. The comparison is between the before and after periods on the same bridges. This allows for better control against other factors that may also affect the accident rates at bridges, e.g., traffic volume, approach alignment, etc., as compared to cross-sectional evaluation in which different bridges are used. The major problem with longitudinal evaluation is the lack of sufficient sample size. Since the number of accidents on bridges is fairly small, it would require either a large number of bridges or a long before-and-after period in order to have a large enough sample size for proper analysis.

Question 16. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?

Unit of analysis:	Location (bridges with changes in approach guardrail transition treatment)
Purpose:	Evaluation (bridge rails with and without approach transition treatment)
Specificity:	Accident (bridge rail accidents only)

Comments: This question is purposely selected to be identical to Question 11 under cross-sectional evaluation to again illustrate how the same question can be answered using two totally different approaches.

With cross-sectional evaluation, the severity of bridge rail accidents on bridges with approach guardrail transition treatment is compared to that on bridges without the treatment. This means that the comparison is between different bridges and the result is subject to the effect of other influencing factors, such as bridge and approach roadway characteristics.

In longitudinal evaluation, the severity of bridge rail accidents before (without) approach guardrail transition treatment is compared to that after (with) the treatment is implemented for specific bridges. Since the same bridges are involved, it is generally easier to control for the other influencing factors. The analysis is therefore more powerful than that of cross-sectional evaluation, provided a sufficient sample size is available.

APPENDIX B

LIST OF CANDIDATE DATA BASES

A number of data bases have been identified as candidates for further consideration in the study. This list is by no means all inclusive, but believed to have included the major data bases that are of interest to the study. The candidate data bases are grouped according to the categorization scheme described in the main body of the report. For each candidate data base, the following information is provided:

1. Short title of the data base.

2. Source of information - sponsoring agency, contract or project number, study title, and performing agency, whichever is applicable.

3. Status of data base - completed or ongoing.

PRIMARY, GENERAL PURPOSE DATA BASES

Location-Based, Police-Level Accident Data

1. Highway Performance Monitoring System (HPMS) - Federal Highway Administration (FHWA), ongoing. (Recommended for further study.)

Accident-Based, Police-Level Accident Data

1. State Accident Data Files - State highway and law enforcement agencies, ongoing. (Recommended for further study.)

Accident-Based, Enhanced Police-Level Accident Data

1. Fatal Accident Reporting System (FARS) - National Highway Traffic Safety Administration (NHTSA), ongoing. (Recommended for further study.)

Accident-Based, In-Depth Accident Data

1. National Accident Sampling System (NASS) - NHTSA, ongoing. (Recommended for further study.)

PRIMARY, SPECIAL PURPOSE DATA BASES

Location-Based, Police-Level Accident Data

1. FHWA RRR Study - FHWA, in-house, inactive. (Recommended for further study.)

2. Urban Arterial Study - FHWA, "Analysis of Urban Arterial Road and Street Accident Experience," Goodell-Grivas, Inc., completed.

3. Narrow Bridge Study - FHWA, "Accident Analysis of Highway Narrow Bridge Sites," Southwest Research Institute, completed.

4. Utility Pole Study - FHWA, "Evaluation of Utility Pole Accident Countermeasures," Goodell-Grivas, Inc., completed.

5. Truck Accident Study - FHWA, "The Effect of Truck Size and Weight on Accident Experience and Traffic Operations," Biotechnology, Inc., completed.

6. Clear Recovery Zone Study - National Cooperative Highway Research Program (NCHRP), "Effectiveness of Clear Recovery Zone," Midwest Research Institute, completed.

7. Interstate Accident Study - FHWA, completed.

8. Delineation Study - FHWA, "Cost-Effectiveness and Safety of Alternative Roadway Delineation Treatments for Rural Two-Lane Highways," Science Applications, Inc., completed.

9. Skid Study - FHWA, "Effectiveness of Alternative Skid Reduction Measures," Midwest Research Institute, completed.

Accident-Based, Enhanced Police level Accident Data

1. Calspan Study - FHWA, "Hazardous Effects of Highway Features and Roadside Objects," Calspan Field Services, Inc., completed. (Recommended for further study.)

2. Utility Pole Accident Study - FHWA, "An Analysis of the Urban Utility Pole Accident Problem," Calspan Field Services, Inc., completed.

3. Motor Carrier Accident Reports - Bureau of Motor Carrier Safety (BMCS), FHWA, ongoing.

4. Hazardous Materials Incident Report - FHWA, ongoing.

5. Grade Crossing Accident Reports - Federal Railroad Administration (FRA), ongoing.

Accident-Based, In-Depth Accident Data

1. NASS Longitudinal Barrier Special Study (LBSS) - NHTSA/FHWA, ongoing. (Recommended for further study.)

2. National Crash Severity Study (NCSS) - NHTSA, completed.

3. Pole Study - NHTSA/FHWA, "Accident Analysis - Breakaway and Nonbreakaway Poles Including Sign and Light Standards Along Highways," Southwest Research Institute, ongoing.

4. Pedestrian Injury Causation Study (PICS) - NHTSA, completed.

5. BMCS Accident Investigation Reports - BMCS, ongoing.

SECONDARY DATA BASES

Exposure

1. National Personal Transportation Survey (NPTS) - Bureau of Census, periodic.
2. National Travel Survey - Bureau of Census, periodic.
3. Truck Inventory and Use Survey - Bureau of Census, periodic.
4. Speed Monitoring Report - FHWA, ongoing.
5. National Driver Register - NHTSA, ongoing.
6. National Electronic Injury Surveillance Study (NEISS) - NHTSA, ongoing.
7. State traffic counts - State highway agencies, ongoing.

Inventory

1. National Bridge Inventory - FHWA, ongoing.
2. National Railroad-Highway Grade Crossing Inventory - FRA, ongoing.
3. State inventory data files, e.g. roadlog, alignment, sign and signal inventory, intersections, etc. - State highway agencies, ongoing.

APPENDIX C

LIST OF DATA FILES AND DOCUMENTATIONS REVIEWED

A summary of data files, documentation, and related publications collected and reviewed in the study is listed as follows.

I. HIGHWAY PERFORMANCE MONITORING SYSTEM (HPMS).

Data File:

None. (Due to the massive volume of data associated with the HPMS data file and the limited budget allocated to data processing in the study, any actual processing of the HPMS data file will be requested through FHWA.)

Documentation:

"Highway Performance Monitoring System Analytical Process," Volume I - Executive Summary and Volume II - Technical Manual, Office of Highway Planning, Federal Highway Administration, U.S. Department of Transportation, Washington, D. C., March 1983.

"Highway Performance Monitoring System - Field Manual for the Continuing Analytical and Statistical Data Base," Office of Highway Planning, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., January 1984. (Also earlier editions of January 1979, and September 1980.)

Related Publications:

"Highway Performance Monitoring System - Vehicle Classification Case Study," Office of Highway Planning, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., August 1982.

"The Status of the Nation's Highways: Conditions and Performance," Report of the Secretary of Transportation to the U.S. Congress, July 1983.

"Highway Safety Performance - 1982: Fatal and Injury Accident Rates on Public Roads in the United States," Report of the Secretary of Transportation to the U. S. Congress, December 1983.

"Highway Statistics, 1983," Federal Highway Administration, U. S. Department of Transportation, Washington, D. C.

"Traffic Monitoring Guide," Draft Report, Office of Highway Planning, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., June 1984.

II. STATE ACCIDENT DATA BASES

TEXAS

Data Files:

Texas Accident and Roadway Inventory SAS Data Files, 1981-1983.

Documentation:

"Accident and Roadway Inventory SAS Data Files - User Manual," Accident Analysis Division, Texas Transportation Institute, Texas A&M University System, College Station, Texas, August 1984.

UTAH

Data Files:

None. (Processing of the data files will be provided by Utah DOT.)

Documentation:

"Utah Department of Transportation Highway Information System, 1984," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, 1984.

"State Highway Information System, Task A - Detailed Work Plan Report," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, March 1983.

"Systems Development Methodology (SDM/70) Overview," Katch & Associates, Atherton, California, and Atlantic Software, Inc., Philadelphia, Pennsylvania, March 1983.

"System Requirements Definition (SRD) Report," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, March 1983.

"System Design Objectives (SDO) Report," Transportation Planning Division, Utah Department of Transportation, Utah Department of Transportation, Salt Lake City, Utah, April 1983.

"System External Specifications (SES) Report," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, October 1983.

"System Internal Specifications (SIS) Report," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, March 1984.

"Safety File Linkage System User Manual," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, September 1984.

"Safety File Linkage Demonstration Project - Final Report," Transportation Planning Division, Utah Department of Transportation, Salt Lake City, Utah, September 1984.

"Highway Information System - Displays and Outputs," Utah Department of Transportation, Salt Lake City, Utah, October 1984.

Related Publications:

Conley, C.G., Abbott, F.P., Brinkman, C.P., and Tom, J., "Model System for Evaluating Safety Projects Using State Record Systems," Report No. FHWA/RD-81/186, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., January 1982.

Verve Research Corp., "Feasibility Analysis of Producing Accident Tables, Volume I: Final Report," Prepared under Contract No. DOT-FH-11-9484 for Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., July 1981.

III. FATAL ACCIDENT REPORTING SYSTEM (FARS)

Data File:

None. (Processing of the FARS data file will be requested through FHWA.)

Documentation:

"Fatal Accident Reporting System - 1982: An Overview of U. S. Traffic Fatal Accident and Fatality Data Collected in FARS for the Year 1982," National Center for Statistics and Analysis, National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C.

IV. NATIONAL ACCIDENT SAMPLING SYSTEM (NASS)

Data Files:

NASS Continuous Sampling Subsystem (CSS) data files, 1979-1983.

Documentations:

Partyka, S.C., "The Analyst's Primer: Getting Started with National Accident Sampling System Data," National Center for Statistics and Analysis, National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C., December 1983.

"National Accident Sampling System (NASS) - Analytical User's Manual," National Center for Statistics and Analysis, National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C. (one manual for each year's data file from 1979 to 1983.)

"National Accident Sampling System - Data Collection, Coding and Editing Manual - 1984 Continuous Sampling System, Version Number 7," National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C., December 1983. (Also manual for 1983 CSS, Version No. 6., December 1982.)

Related Publications:

"Report on Traffic Accidents and Injuries for 1979-1980," National Center for Statistics and Analysis, National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C., February 1982.

"National Accident Sampling System 1981: A Report on Traffic Accidents and Injuries in the U. S. Collected in NASS in the Year 1981," National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C.

"National Accident Sampling System 1982: A Report on Traffic Accidents and Injuries in the U. S. Collected in NASS in the Year 1982," National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C.

Memorandum from Director of National Center for Statistics and Analysis on Mathematical Analysis Division Analytical Studies in FY 1984, December 17, 1984.

V. FHWA RRR DATA FILE

Data File:

FHWA RRR Data File.

Documentation:

"RRR Evaluation Procedure Manual," Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., Revised March 1982.

Related Publication:

"Evaluation of the Safety and Operational Impact of Resurfacing, Restoration and Rehabilitation (RRR) Type Projects," Interim Report, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., May 1983.

VI. CALSPAN STUDY DATA FILE

Data File:

Calspan Study Data File.

Documentation:

Coding manual and field forms.

Related Publications:

"Hazardous Effects of Highway Features and Roadside Objects, ol. 1. Literature Review and Methodology," Report No. FHWA-RD-78-201, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., September 1978.

"Hazardous Effects of Highway Features and Roadside Objects, Vol. 2. Findings," Report No. FHWA-RD-78-202, Federal Highway Administration, U. S. Department of Transportation, Washington, D. C., September 1978.

VII. NASS LONGITUDINAL BARRIER SPECIAL STUDY (LBSS)

Data File:

NASS LBSS data files - 1982 and 1983.

Documentation:

Mak, K.K., and Magaro, A., "National Accident Sampling System (NASS) Longitudinal Barrier Special Study - Coding/Editing and Field Procedures Manual," National Highway Traffic Safety Administration, U. S. Department of Transportation, Washington, D. C., Revised October 1982.

APPENDIX D

ILLUSTRATIVE EXAMPLES FOR RECOMMENDED ALTERNATIVE

The applicability, utility, and limitations of the recommended alternative are examined in this Appendix through illustrative examples. The hypothetical data base is assumed to include general roadway inventory and accident data from four States, merged into a single data base. Example questions posed under highway safety analysis (see Chapter II and Appendix A for more details) are addressed using the hypothetical data base.

PROBLEM IDENTIFICATION

Question 1. What are the accident rates for bridge sites by highway type and bridge width?

Comments. The data base does not contain information pertaining to bridge sites. This requires the merging of the hypothetical data base with the computerized bridge inventory file through a location matching process. The importance of the ability to merge the data base with other data files is clearly demonstrated.

An analysis file would be created to address not only this question, but the other posed questions as well. In order to allow for both location-based and accident-based analyses, two separate files, one with bridge site as the unit of analysis and the other containing the accidents at these bridge sites, would be created. Depending on the question to be addressed, these two separate files could be used individually or together. A computer program would have to be developed to merge the bridge and the accident files.

The accident rate, e.g., number of accidents per million vehicles crossing the bridge, would be calculated for each bridge site. This would require the merging of the accident file into the bridge file for calculation of the accident rate. The bridge sites would be categorized by highway type, e.g., functional class, and bridge width. The average accident rate for each category would then be determined for use with the problem identification analysis.

Question 2. What are the accident rates for trucks with gross weight of over 10,000 pounds at bridge sites?

Comments. The analysis file created under Question 1 would also be applicable to address this question. In calculating the accident rate for the individual bridges, only accidents involving trucks with gross weight over 10,000 pounds would be included. However, the gross weights of trucks are generally not available from police-level accident data and it is not possible to identify trucks with gross weight over 10,000 pounds. The only alternative is to use the variable "vehicle type" as a surrogate measure and select the accidents accordingly.

Question 3. Which are the top 50 bridge sites with the highest accident frequency on two-lane rural highways in the State of Texas for the 3-year period of 1982 to 1984?

Comments. The data base would not be applicable to address this question unless Texas is one of the four States included in the data base. Moreover, it is inappropriate to use a general purpose data base to address site-specific analyses. Such analyses are best addressed at the State and local levels, and not at the national level.

If Texas is one of the four States in the data base, it is a simple matter to subset the data to include only bridge sites on two-lane rural highways in Texas and the corresponding accidents for the 3-year period of 1982 to 1984. The bridges would then be sorted in descending order of accident rate and the top 50 bridges listed.

Question 4. Which bridge sites in the State of Texas had at least two fatal accidents within the 3-year period of 1982 to 1984?

Comments. The same comments for Question 3 also apply to this question. Otherwise, it is a simple matter to list all bridge sites with at least two fatal accidents within the 3-year period.

Question 5. What are the accident severities for bridge accidents by highway type and bridge width?

Comments. Since accident is now the unit of analysis, only the accident file is needed for the analysis. The accidents would be categorized by highway type and bridge width and accident severity, e.g., percent fatal plus incapacitating injury accidents, computed for each of the categories.

Question 6. What is the severity of bridge accidents involving large trucks (i.e., tractor semi-trailer and double-bottom tractor-trailer trucks)?

Comments. Again, accident is the unit of analysis and only the accident file would be used for the analysis. Accidents involving large trucks would be subsetted and the accident severity computed accordingly.

CROSS-SECTIONAL EVALUATION

Question 7. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24-feet wide on two-lane rural highways?

Comments. The analysis file would first be subsetted to included only bridges on two-lane rural highways. The accident rates for individual bridges would be calculated, again by merging the accident file into the bridge file. The bridges would then be categorized according to their widths, i.e., less than 24 feet and 24 feet or wider. The average accident rate for each category would be computed and compared for significant difference.

Question 8. Are there differences in accident rates between bridges with width narrower than 24 feet and those that are at least 24-feet wide for double-bottom tractor-trailer trucks?

Comments. The analysis for this question would be similar to that for Question 7 except that only accidents involving double-bottom tractor-trailer trucks would be included.

There is likely a problem with identifying double-bottom tractor-trailer trucks since most State accident reporting forms do not have this as a separate code. Without this code, the hypothetical data base would not be able to address this question. Even if such a code is available, the number of accidents involving such trucks is very small for any individual bridge. This poses a problem with insufficient sample size and the analysis results would be questionable. In short, this question may not be answerable at this time, even with a special study.

Question 9. What is the relationship between accident rate and bridge width for various highway types?

Comments. The accident rates for individual bridges would first be calculated and the bridges categorized by highway type. The relationship between accident rate and bridge width would then be developed for each of the highway types, using such techniques as regression analysis.

Question 10. What is the relationship between fatal accident rate and relative bridge width?

Comments. An approach similar to that for Question 9 would be used. Only fatal accidents would be included in the calculation of the accident rates for the individual bridges. Also, the relative bridge widths would have to be computed for the bridges by subtracting the approach roadway width from the bridge width.

Question 11. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?

Comments. Only bridge rail accidents would be included in the analysis. The problem for this question is the lack of information on approach guardrail transition treatments. Such records are rarely available from roadway inventory data and it would require supplemental data collection, either from photologs or actual site visits to the bridges, to gather such data. In other words, this question is probably not answerable with the hypothetical data base without supplemental data collection.

Caution should be exercised in analyzing the data and interpreting the results. Since different bridges are involved, it is important to control for other factors that may influence the severity of accidents involving transitions to bridge rails. This is one of the major weaknesses associated with cross-sectional evaluation.

For questions on the performance of roadside safety appurtenances such as this, a special study is probably a better approach. First, supplemental data collection is already required to gather specific information not available from the roadway inventory data file. Second, police-level accident data do not provide sufficient detail to properly analyze the performance of roadside appurtenances. For example, there is no information on such items as the in-service condition of the appurtenance, the impact conditions, post-impact trajectory of the impacting vehicle, malfunctioning of the appurtenance (e.g., snagging, overriding, vaulting, etc.), subsequent impact(s) if applicable, damage to the vehicle and appurtenance, etc.

Police-level accident data are useful for gross problem identification and evaluation. However, for detailed performance evaluation, in-depth accident data would be necessary. Also, more detailed information would be required on the characteristics of the appurtenance and roadside conditions. This would require the use of special studies.

It is important to recognize that, even with the detailed site and accident data available from special studies, there are many questions that cannot be addressed with accident data. For example, the effect of using or not using a washer with the bolt that attaches the W-beam to the post can never be answered with accident analysis, regardless of the level of detail available for the data. Such questions would have to be addressed with computer simulation studies or full-scale crash testing programs.

Question 12. Is the severity of bridge accidents higher for double-bottom tractor-trailers as compared to tractor semi-trailers?

Comments. As previously discussed under Question 8, there is likely no separate code for double-bottom tractor-trailers so that this question cannot be addressed by the hypothetical data base. However, if this code is available, sample size is less of a problem than with Question 8 since the unit of analysis is now accident instead of location.

Question 13. Do the impact conditions (i.e., impact speed and angle) for bridge rail accidents vary as a function of bridge shoulder width on two-lane rural highways?

Comments. This question can only be addressed with the use of in-depth accident data through a special study. Information on impact conditions is not available with police-level accident data.

Question 14. What is the relationship between the vehicle curb weight and injury severity for bridge rail accidents involving passenger cars?

Comments. The accident file would first be subsetted to include only single vehicle bridge rail accidents involving passenger cars. The vehicle curb weight is not available from the accident reporting form, but can be derived from the vehicle make and model codes. A computer program for this purpose is already in existence and can be incorporated into the data base on a routine basis. The relationship between vehicle curb weight and injury severity, e.g., percent (probability) of fatal plus incapacitating injury accidents, could then be developed using such statistical techniques as logistic regression.

LONGITUDINAL EVALUATION

Question 15. Does widening the approach roadway to a bridge without corresponding widening of the bridge itself create a hazardous condition for various highway types?

Comments. For longitudinal evaluation type of analysis, it is probably better to use a special study than to extract the data from the hypothetical data base. First, the number of bridges included in the study is likely to be relatively small due to the costs associated with such reconstruction projects. Secondly, it is far simpler to conduct a special study than to manipulate the data base to extract the needed information.

In order to extract the information from the hypothetical data base, the bridges selected for study would first have to be identified from the data base. The dates of the widening improvements and the construction periods, which vary by bridge, would have to be identified as well as the before and after periods for the accident data. The conditions of the bridges and corresponding accidents in the before and after period would have to be identified and input to the analysis file. It would be easier and less prone to error to create the analysis file from scratch as in the case of a special study.

Question 16. Is there any difference in severity between accidents involving bridge rails with and without approach guardrail transition treatments?

Comments. The comments made under Questions 11 and 15 also apply to this question. In short, longitudinal evaluation type of analysis can be better addressed with a special study. Also, for questions on performance evaluation of roadside safety appurtenances, police-level accident data are limited to only gross problem identification and evaluation. In-depth accident data would be necessary for the more detailed evaluations.

FEDERALLY COORDINATED PROGRAM (FCP) OF HIGHWAY RESEARCH, DEVELOPMENT, AND TECHNOLOGY

The Offices of Research, Development, and Technology (RD&T) of the Federal Highway Administration (FHWA) are responsible for a broad research, development, and technology transfer program. This program is accomplished using numerous methods of funding and management. The efforts include work done in-house by RD&T staff, contracts using administrative funds, and a Federal-aid program conducted by or through State highway or transportation agencies, which include the Highway Planning and Research (HP&R) program, the National Cooperative Highway Research Program (NCHRP) managed by the Transportation Research Board, and the one-half of one percent training program conducted by the National Highway Institute.

The FCP is a carefully selected group of projects, separated into broad categories, formulated to use research, development, and technology transfer resources to obtain solutions to urgent national highway problems.

The diagonal double stripe on the cover of this report represents a highway. It is color-coded to identify the FCP category to which the report's subject pertains. A red stripe indicates category 1, dark blue for category 2, light blue for category 3, brown for category 4, gray for category 5, and green for category 9.

FCP Category Descriptions

1. Highway Design and Operation for Safety
Safety RD&T addresses problems associated with the responsibilities of the FHWA under the Highway Safety Act. It includes investigation of appropriate design standards, roadside hardware, traffic control devices, and collection or analysis of physical and scientific data for the formulation of improved safety regulations to better protect all motorists, bicycles, and pedestrians.

2. Traffic Control and Management
Traffic RD&T is concerned with increasing the operational efficiency of existing highways by advancing technology and balancing the demand-capacity relationship through traffic management techniques such as bus and carpool preferential treatment, coordinated signal timing, motorist information, and rerouting of traffic.

3. Highway Operations
This category addresses preserving the Nation's highways, natural resources, and community attributes. It includes activities in physical maintenance, traffic services for maintenance zoning, management of human resources and equipment, and identification of highway elements that affect the quality of the human environment. The goals of projects within this category are to maximize operational efficiency and safety to the traveling public while conserving resources and reducing adverse highway and traffic impacts through protections and enhancement of environmental features.

4. Pavement Design, Construction, and Management
Pavement RD&T is concerned with pavement design and rehabilititation methods and procedures, construction technology, recycled highway materials, improved pavement binders, and improved pavement management. The goals will emphasize improvements to highway performance over the network's life cycle, thus extending maintenance-free operation and maximizing benefits. Specific areas of effort will include material characterizations, pavement damage predictions, methods to minimize local pavement defects, quality control specifications, long-term pavement monitoring, and life cycle cost analyses.

5. Structural Design and Hydraulics
Structural RD&T is concerned with furthering the latest technological advances in structural and hydraulic designs, fabrication processes, and construction techniques to provide safe, efficient highway structures at reasonable costs. This category deals with bridge superstructures, earth structures, foundations, culverts, river mechanics, and hydraulics. In addition, it includes material aspects of structures (metal and concrete) along with their protection from corrosive or degrading environments.

9. RD&T Management and Coordination
Activities in this category include fundamental work for new concepts and system characterization before the investigation reaches a point where it is incorporated within other categories of the FCP. Concepts on the feasibility of new technology for highway safety are included in this category. RD&T reports not within other FCP projects will be published as Category 9 projects.