RESEARCH AND DEVELOPMENT

"Implementing research findings"

STUDY OF WIDTH STANDARDS FOR STATE AID STREETS AND HIGHWAYS

Volume I: Executive Summary

Technical Report Documentation Page

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16. Abstract

The objectives of this study were to assure that through critical reassessment of elements affecting width standards that the standards are indeed an up-to-date reflection of the best of available technical knowledge past and present; and to furnish the engineer facing the public a documentaion of sound reasons for the standards he is called upon to observe and defend.

The study involved a multi-dimensional approach including a study of present professional practice, a historical review, and an evaluation of the safety, operational environmental and cost aspects of width elements. Variables considered include human factors responses, basic driver-vehicle-road relationships, system or network considerations, costs of construction and maintenance, and environmental impacts.

The project included the collection and synthesis of data, studies, information, unit values, etc. which describe each of the important variables and where necessary reflect the sensitivities of Minnesota conditions. This synthesis process enabled formal evaluation of all pertinent width elements resulting in a series of statements and recommendations concerning optimal values for input to Minnesota state aid design standards. A rational process for considering exceptional cases is suggested.

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STUDY OF WIDTH STANDARDS FOR
STATE AID STREETS AND HIGHWAYS

Volume I Executive Summary

Prepared For:
Local Road Research Board
State of Minnesota

By
Jack E. Leisch & Associates
June 1979

Foreword

This final report was prepared for the Local Road Research Board (LRRB) of the State of Minnesota. It documents the results of research conducted for the LRRB on width standards[1] for state-aid streets and highways. The objective of the research was the collection, analysis and documentation of recent research concerning the safety, operational and cost aspects of roadway width elements. This was accomplished using the resources of Jack E. Leisch and Associates. Project direction was provided by Jack E. Leisch. The principal investigator for the research was Timothy R. Neuman.

Valuable input to the research was provided by the Minnesota Department of Transportation and the LRRB. Ronald M. Canner, Jr. served as Research Coordination Engineer and Gabriel S. Bodoczy as Research Services Engineer from MnDOT. The efforts of the following individuals who composed the LRRB Project Panel are acknowledged:

Herb Klossner
Project Panel Chairman
Hennepin County Public Works Director

Robert Witty
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Golden Valley City Engineer

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North Mankato and St. Peter City Engineer

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Engineering Concepts, Inc.
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The researchers also wish to acknowledge the contributions of Gordon Fay and F.W. Thorstenson of the Minnesota Department of Transportation, William J. Wiedelman, who was principal investigator for the initial part of the research, and John Glennon who served as a special consultant.

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[1]Mn/DOT Standards and Mn State Aid Standards for the purposes of this report are used interchangeably and mean Minnesota State Aid Standards.

Table of Contents

List of Figures

List of Tables

RESEARCH OBJECTIVES AND APPROACH

One of the most important tools the highway engineer has is the set of design standards which he applies to construction and/or rehabilitation of highway facilities. Limited construction and maintenance budgets and increased public pressure on the engineer to justify the expenditure of public highway funds demand these standards be cost-effective.

Because of these concerns, the Local Road Research Board of the State of Minnesota has considered the need to undertake a study of all items pertaining to street and roadway widths, shoulder widths and related cross-sectional elements. To this end, the objectives included:

1. An analysis of Minnesota's present state-aid width standards, including reviews of both format and content.
2. A review and documentation of the operational and safety aspects relating to width standards.
3. A cost-effective evaluation of width standards in their present form and variations thereof to insure results toward optimal expenditure of highway funds.
4. A documentation of all analysis procedures so that a basis for verification, changes in, and adaptation of width standards, including local considerations and special situations, is made available.

The accompanying research report documents the results of that study. The material presented is intended to enable the LRRB to review Minnesota's standards and confirm or make adjustments to them; and at the same time provide Minnesota's county and municipal engineers with the basis for applying those standards in a cost-effective manner.

The research conceptually involved a multi-dimensional "attack" on the problem, utilizing all data, documentation, etc. which could aid in justification of width elements. The dimensions requiring investigation included: (1) a study of present professional practice in design of streets and highways, (2) a historical review of the evolution of width standards, and (3) an evaluation of the safety, operational, environmental and cost aspects of width elements.

The application of the research approach required consideration of the many traffic operational and cost variables which may have an impact on highway width elements. Such variables included human factors responses, basic driver-vehicle-road relationships, and system or network considerations. Other important inputs to the analysis were costs of building and maintenance and environmental impacts.

In summary, the scope of research included the collection and synthesis of data, studies, information, unit values, etc. which describe each of the important variables and, where necessary, reflect the sensitivities of Minnesota's conditions. This synthesis process enabled formal evaluation of all pertinent width elements, with the ultimate goal being a series of statements and recommendations concerning optimal values of width elements for input to Minnesota design standards.

RESEARCH TASKS

The research involved a 4-step process:

1. Collection of data, study findings, etc. pertaining to roadway width elements
2. Development of evaluation methodologies
3. Documentation of research findings and results of analyses
4. Recommendations concerning adjustments to the format and values within MnDOT design standards

Collection of Data Pertaining to Roadway Width Elements

The first step consisted of three separate tasks. First, a literature search and review was conducted to identify studies describing safety, operational and cost impacts of variable width dimensions. The second task involved a nationwide survey of state, county and municipal engineers to determine what design standards are presently in use, what problems are typically encountered in their application, and what recommendations or opinions highway design professionals might have with respect to design standards. The third task consisted of a study of the historical progression of AASHTO and Minnesota design standards to obtain insights into the highway profession's response to changes in operating characteristics and gains in knowledge.

Development of Evaluation Methodologies

Based on the results of the literature search, methodologies for evaluating width elements were developed. Because of the basic operational differences between urban and rural traffic flow, two separate procedures were developed.

Evaluation of Rural Width Elements

Data and study results were synthesized to develop width-sensitive accident relationships for the following elements:

- Traveled Way and Shoulder Width
- Structure Width
- Side Slopes

These accident relationships were translated to annual dollar accident costs per mile of roadways with variable widths. These accident costs were compared with annualized construction costs in a traditional benefit/cost analysis format:

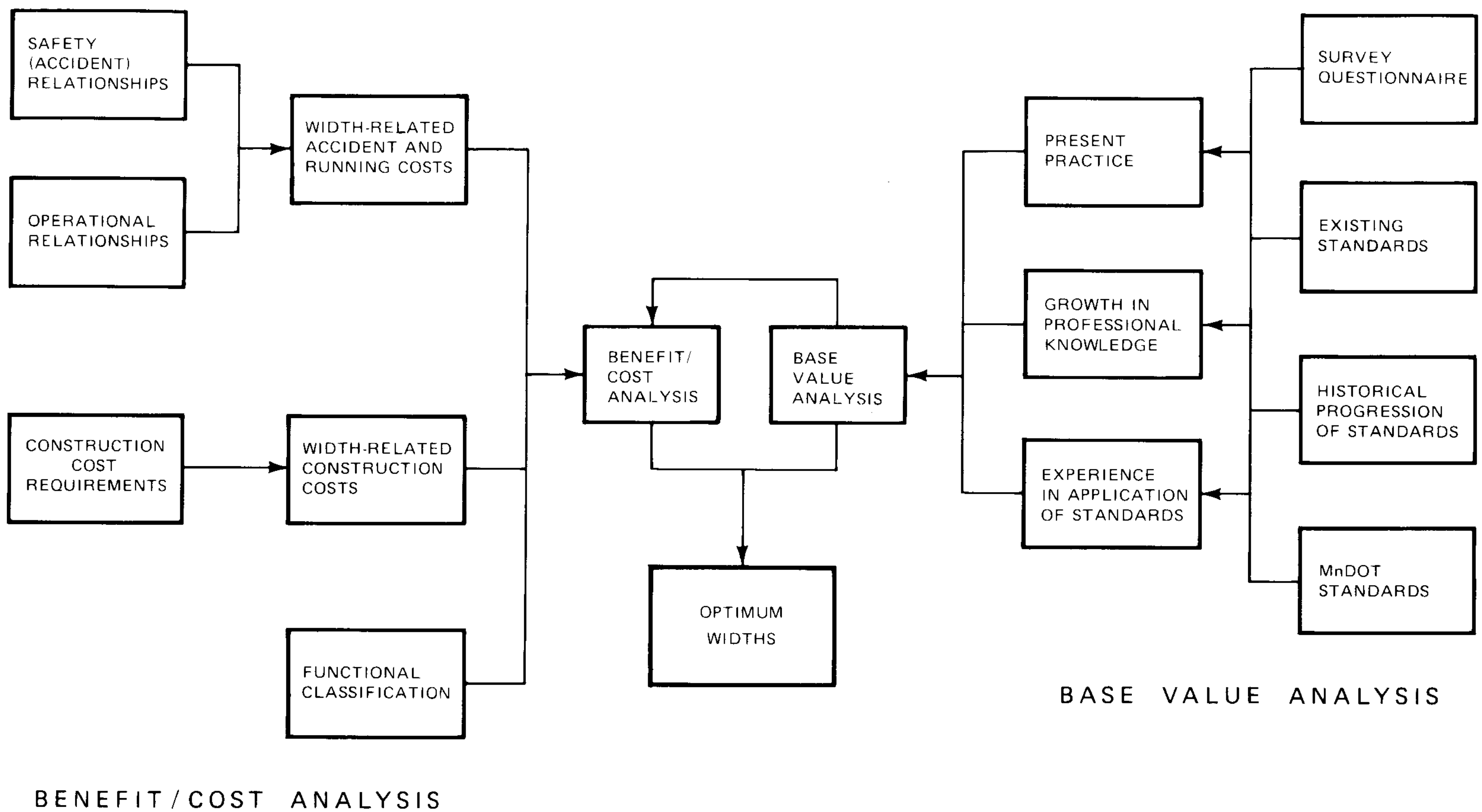
$$B/C = \frac{-(A_A - A_B)}{C_A - C_B}$$

where
A_A = Annual accident cost of the alternative dimension
A_B = Annual accident cost of the base dimension
C_A = Annual construction cost of the alternative dimension
C_B = Annual construction cost of the base dimension

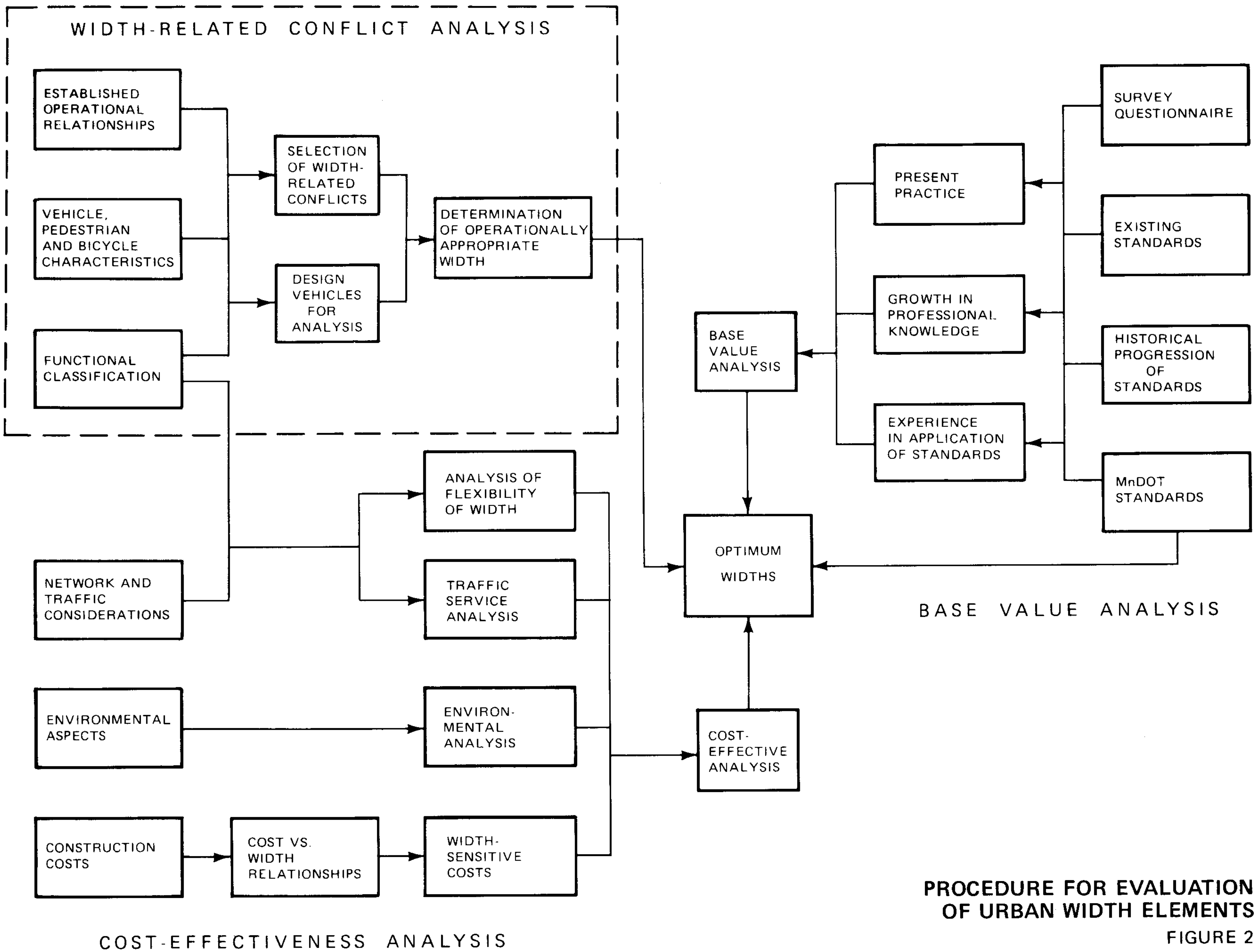
The benefit/cost analyses were only a part of the total rural evaluation process, detailed in Figure 1.

Evaluation of Urban Width Elements

Figure 2 outlines the more complex procedure utilized in the evaluation of urban width elements. A procedure by which the dynamic aspects of urban traffic flow as related to width was developed (Width-related Conflict Analysis).



PROCEDURE FOR EVALUATION OF RURAL WIDTH ELEMENTS
FIGURE 1



PROCEDURE FOR EVALUATION OF URBAN WIDTH ELEMENTS
FIGURE 2

Other aspects of urban streets and highways were investigated, including network considerations, operational flexibility requirements, and cost and environmental considerations. Individual evaluations of each of these aspects were combined into an overall cost-effectiveness model. This model, shown below and explained fully in the report, described optimal ranges of width values for all combinations of urban roadway as described by functional classification, number of lanes and presence/prohibition of parallel parking.

$$I_w = \frac{i_o + i_f + i_t + i_e}{C_w \times w}$$

Where

I_w is an index expressing the cost-effectiveness of a width, and

i_o is an operational index

i_f is a flexibility index

i_t is a traffic service index

i_e is an environmental index

C_w is a unit cost factor

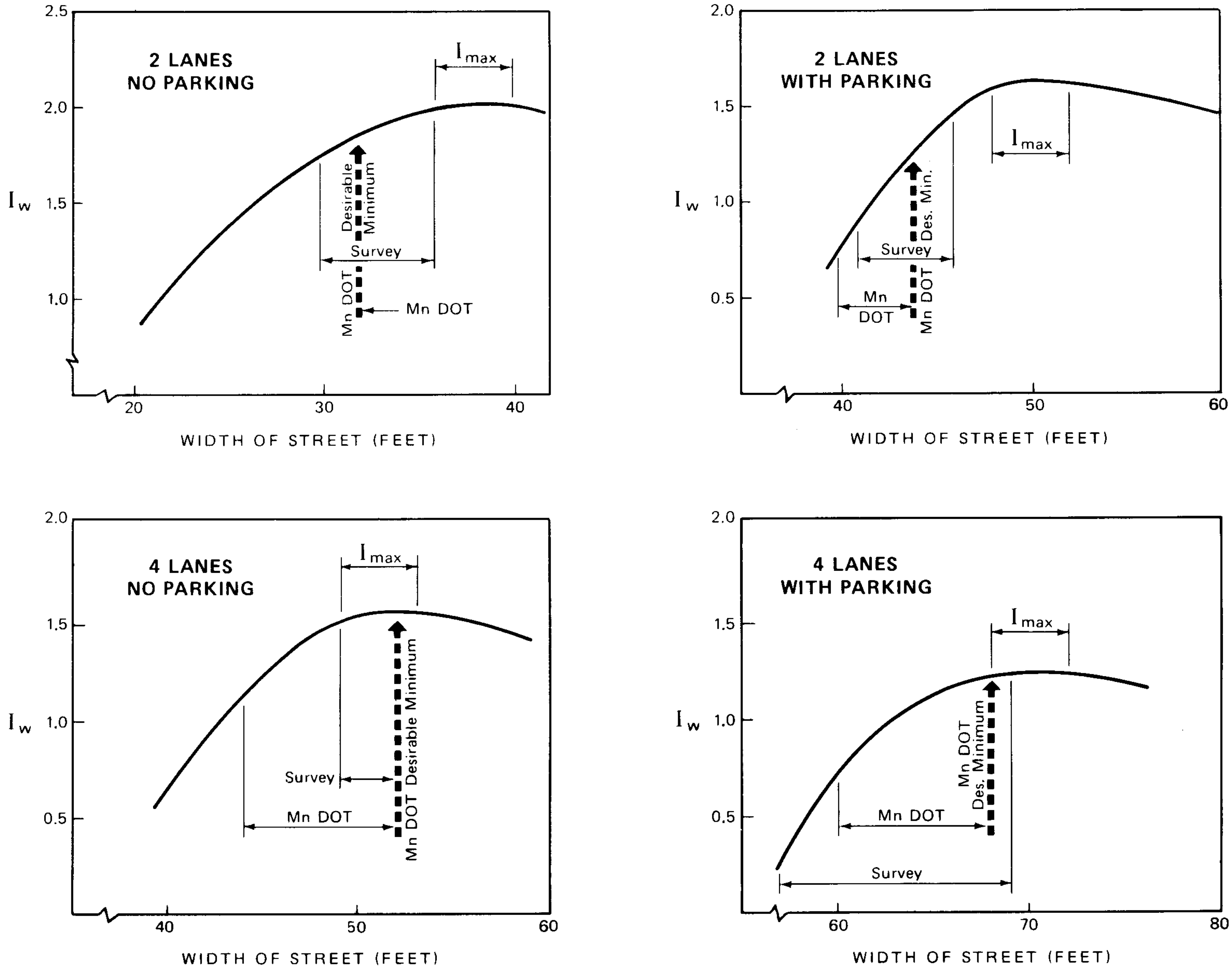
w is the width being evaluated

Note: See Part 3 for a complete derivation and description of the model

For each condition evaluated, values of I_w were plotted against their respective width values (w). Figure 3 illustrates the results, in which a range of widths with maximum I_w values indicates optimal widths for the condition being studied. Also shown in each set of curves is the present Minnesota standard as well as widths identified by the survey responses. A total of ten such curves **was** developed and used as input to the selection of widths appropriate for consideration as standards.

Documentation of Research Findings

The research effort resulted in a number of important findings which should prove useful in a further evaluation of Minnesota's state-aid design standards.



EXAMPLE SET OF COST-EFFECTIVENESS CURVES FOR URBAN ROADWAY WIDTHS
FIGURE 3

Functional Classification

An important concept developed and applied to the evaluation of width elements was that of functional classification. This concept recognizes the traffic demand and network differences among facilities, and the fact that these differences are translated into variable operating characteristics. By including a functional classification scheme within design standards formats, greater assurance is given that designs will reflect these variations.

The three basic characteristics suggested for use in the development of a functional classification scheme are:

- Traffic Volume
- Route Continuity or Connectivity
- Average Trip Length

These characteristics were used to describe the wide range of facility types on roadway networks. In urban areas, this includes streets providing local access and/or circulation facilities for residential areas; or high-volume regional arterials carrying through traffic. In rural areas, the range of facilities includes low-volume access roads serving individual farms and high-speed regional 2- or 4-lane highways.

Summary of Significant Width-Related Items Investigated

To assure a thorough analysis of all pertinent width elements, a wide range of width-related items was investigated. This included safety, traffic operational, cost and environmental aspects of highways and streets. A summary of the research findings with respect to many of these items is given in Figure 4 (rural) and Figure 5 (urban).

Summary of Width Values Justified by Evaluations

Results of the literature search and survey questionnaire, safety and operational analyses, and selected evaluation methodologies led to a set of width values considered to be justified by the researchers. These values, listed in Tables 1-3, provided the basis for further recommendations concerning Minnesota's state-aid design standards.

ITEM	RESEARCH FINDINGS	REPORT REFERENCE
ACCIDENTS AND SAFETY	• Accidents on rural highways are related to many of the basic elements.	pp 2.1 - 2.3
	• Increases in traveled way widths result in reduced accidents.	p 2.1; pp 2.35 - 2.36
	• Greater shoulder widths have a lesser impact on accident experience.	p 2.2; pp 2.35 - 2.36
	• The design of the roadside also has an effect on single vehicle accidents; wider, flatter configurations provide more favorable conditions.	pp 2.2 - 2.3; pp 2.35 - 2.38
TRAFFIC FLOW CONSIDERATIONS	• Restricted roadway widths have adverse impacts on the uniformity of operating speeds.	pp 2.43 - 2.45
	• The presence of wide shoulders provides storage space for disabled vehicles, aiding traffic flow.	p 2.2; p 4.11
TRAFFIC VOLUMES AND PATTERNS	• As traffic volumes increase, the expected annual number of accidents per mile also increases. Similarly, very low volume roadways would on average experience very few accidents per mile regardless of their design quality.	pp 2.35 - 2.40; p 4.9
TRAFFIC SPEED AND LATERAL PLACEMENT	• Restricted widths affect uniformity of speeds on low volume facilities.	pp 2.43 - 2.45
TRAFFIC COMPOSITION	• The percentages of trucks and presence of farm machinery may have an impact on selection of minimum roadway widths on low volume, local roads.	p 2.2
STREET CLASSIFICATION AND SYSTEM FUNCTION	• Classification of rural highways should be based on traffic volumes, trip purpose and system function.	pp 2.29 - 2.34
	• The format of roadway design standards should include functional classification as a basic input.	p 4.9; p 4.13
LAND USE CONSIDERATIONS	• The functional classification of a rural highway, based on trip purpose and system function, is affected by local land use.	pp 2.29 - 2.30
MAINTENANCE OF HIGHWAY AND UTILITIES	• Wider roadway widths (traveled way and shoulders) facilitate routine maintenance.	p 2.3 - 2.4; p 4.11
	• Flatter side slopes facilitate maintenance of the roadside.	p 2.4
NEW CONSTRUCTION VS. EXISTING IMPROVEMENTS	• Right-of-way or cost constraints may be such that consideration should be given to reconstructing or rehabilitating rural highways to less than full width. Selection of reduced width values under such special situations should be predicated on the operational characteristics of the facility (traffic volume, functional classification) and an understanding of the operational and safety "costs" of such restricted widths.	pp 2.9 - 2.10
PHYSICAL AND ENVIRONMENTAL CONSTRAINTS	• Occasional right-of-way constraints may influence the design of the roadside (selection of side slope) or border treatment.	pp 2.9 - 2.10

SUMMARY OF RURAL WIDTH-RELATED CONSIDERATIONS

FIGURE 4

ITEM	RESEARCH FINDINGS	REPORT REFERENCE
ACCIDENTS AND SAFETY	• Accidents on urban streets have not been shown to be related to width. The presence of intersections, driveways, parked cars and poor sight distance are prime causal factors.	p 3.1
TRAFFIC FLOW CONSIDERATIONS	• The capacity of urban roadways is directly related to their width.	p 3.2
	• The smoothness of flow in constrained situations (side friction from parked cars, bicycles, pedestrians, other vehicles) is dependent on available clearances, a direct function of street and vehicle widths.	pp 3.22 - 3.27
TRAFFIC VOLUMES AND PATTERNS	• Variations in traffic volumes throughout the day may require changes in a facility's operating conditions. Certain widths are more adaptable to such changes.	pp 3.58 - 3.59; pp 3.63 - 3.64
	• Gradual land-use or network changes may alter the function and operating character of a facility. Again, certain widths are more adaptable to such changes.	pp 3.58 - 3.63
	• Higher volume facilities have more conflicts and greater capacity needs, both of which are width-related.	pp 3.37 - 3.41
TRAFFIC SPEED AND LATERAL PLACEMENT	• Arterial streets operate at higher speeds, requiring greater clearances between conflicting vehicles.	pp 3.37 - 3.41
	• Analysis of width-related conflicts is based on the observed lateral placement of vehicles under a variety of constrained situations.	pp 3.36 - 3.51
TRAFFIC COMPOSITION	• The types and numbers of vehicles (trucks, buses, bicycles) and the presence of pedestrians determine the width-related conflicts to be analyzed for a particular facility's classification.	pp 3.41 - 3.43
INTERSECTION REQUIREMENTS AND RELATED SIGHT DISTANCE	• Higher volume arterial and collector-type streets require width at intersections for capacity reasons.	p 3.2
	• Median widths are partially a function of requirements for left-turn lanes.	p 3.2; p 3.78
LAND USE CONSIDERATIONS	• The nature of land use adjacent to a facility may help define the types of width-related conflicts which should be analyzed and their relative importance. (Example: Presence of large pedestrian and bicycle volumes or high turnover parking may be based on the type of adjacent land use.)	p 3.41 - 3.43; Appendices A-4, A-5
MAINTENANCE OF HIGHWAY AND UTILITIES	• Border area considerations include placement of all utilities, storage of snow, etc.	p 3.2; pp 3.26 - 3.28
	• Minimal disruption to traffic is achieved if routine maintenance can be handled within the border area.	pp 3.2 - 3.3
WEATHER CONDITIONS	• Winter weather conditions may result in significant snowfalls being stored in border areas and along curbs. This snow storage can reduce the effective width of the street.	pp 3.27 - 3.28
NEW CONSTRUCTION VS. EXISTING IMPROVEMENTS	• New construction should reflect all important width-related aspects (flexibility, systems considerations).	p 3.53
	• Rehabilitation may involve severe right-of-way or cost constraints, necessitating less than desirable widths.	pp 3.10 - 3.11
	• Selection of such widths should reflect a knowledge of their deficiencies.	p 3.11
PHYSICAL AND ENVIRONMENTAL CONSTRAINTS	• Physical and environmental constraints, while difficult to a quantify, are of sufficient importance in selection of optimal widths to be included in the basic analyses.	pp 3.28 - 3.30; pp 3.69 - 3.70

SUMMARY OF URBAN WIDTH-RELATED CONSIDERATIONS

FIGURE 5

Table 1

JUSTIFICATION OF RURAL ROADWAY WIDTH ELEMENTS
Traveled Way and Shoulder Widths ø

FACILITY	OPTIMUM WIDTHS (in feet) IDENTIFIED BY			
	Benefit/Cost Analysis *		Existing Standards and Practices	MnDOT Standards
	A	B		
LOW				
0-100 ADT	18 (2)≠	20 (2)	20 (4)	24 (2)
INTERMEDIATE				
100-250 ADT	20 (3)≠	22 (3)	20 (4)	24 (4)
250-400 ADT	22 (3)	24 (3)	22 (6)	24 (4)
HIGH				
250-750 ADT	22 (4)	24 (4)	22 (6)	24 (6)
750-1000 ADT	24 (4)	24 (4)	24 (8)	24 (8)
GREATER THAN 1000 ADT	24 (6-8)	24 (6-8)	24 (8-10)	24 (10)

ø Traveled way and shoulder width combinations are shown as in the following example: 22 (4) represents 22-foot traveled way with 4-foot shoulders

≠ Base Value (Minimum)

* Column A represents optimum widths identified by benefit/cost analysis with accident benefits only; Column B represents benefit/cost analysis including operational benefits (speed reduction costs).

Table 2

JUSTIFICATION OF RURAL ROADWAY WIDTH ELEMENTS

Structure Widths and Inslopes

FACILITY	OPTIMUM INSLOPES IDENTIFIED BY		
	Benefit/Cost Analysis	Existing Standards and Practices	MnDOT Standards
LOW			
0-100 ADT	2:1≠	2.5:1	3:1
INTERMEDIATE			
100-250 ADT	2:1-3:1	2.5:1	4:1
250-400 ADT	2:1-4:1	3:1	4:1
HIGH			
250-750 ADT	3:1-6:1	3:1	4:1
Greater than 750 ADT	4:1-6:1	3:1	5:1-6:1
	OPTIMUM STRUCTURE WIDTHS (in feet) IDENTIFIED BY		
	Benefit/Cost Analysis	Existing Standards and Practices	MnDOT Standards
LOW			
0-100 ADT	20≠	26-28	28
INTERMEDIATE			
100-400 ADT	30-32		32
HIGH			
250-750 ADT	34-36	36-39	32-36
Greater than 750 ADT	34-40		40-44

NOTE: Optimum widths shown for "Low" type facilities under Existing Standards and Practices are based on an average of minimum structure widths from survey; for "High" type facilities widths shown are based on an average of maximum structure widths from survey.

≠ Base Value (Minimum)

Table 3

JUSTIFICATION OF URBAN ROADWAY WIDTHS

FACILITY	OPTIMUM WIDTHS (in feet) IDENTIFIED BY			
	Width-related Conflict Analysis	Cost Effectiveness Analysis	Existing Standards and Practices	MnDOT Standards
LOCAL				
2 Lanes With No Parking	28	27-32	26-28	32
2 Lanes With Parking	40	44-48	32-40	42-44
COLLECTOR				
2 Lanes With No Parking	32	32-36	27-32	32
2 Lanes With Parking	44	46-48	38-42	42-44
4 Lanes With No Parking	44	48-50	45-50	48-52
4 Lanes With Parking	64	66-70	57-65	64-68
ARTERIAL				
2 Lanes With No Parking	32	36-40	30-36	32
2 Lanes With Parking	46	48-52	41-46	42-44
4 Lanes With No Parking	48	49-53	49-52	48-52
4 Lanes With Parking	60	68-72	57-69	64-68

Note: Optimum widths identified by Width-related Conflict Analysis are those widths at which all width-related conflicts are performed with at least minimum clearances.

Recommendations Concerning Adjustments to MnDOT Design Standards

Following completion of all analyses of width elements, Minnesota's rural and urban design standards were evaluated. Format, consistency, and the design values themselves were studied. A series of recommendations was made based on all previous research.

Suggested Values for Consideration as Rural Design Standards

Minnesota's rural state-aid standards at present provide for a high quality of design for all state-aid facilities. The minimum standard 12-foot lane, full shoulders at volumes of 1000 ADT, and very safety-conservative roadside standards all contribute to this high design quality. However, as has been demonstrated in the research, such standards may not be justified for the lowest volume state-aid highways in terms of overall safety benefits. By adjusting the standards to reflect the differences in safety benefits derived at various volume levels, greater total safety benefits should be obtained from the Minnesota highway dollar.

Specific recommendations, shown in Figure 6, include an alteration in the present functional classification scheme to more closely reflect the actual Minnesota rural network; revisions to the pavement, shoulder and structure width standards; and alterations in the side slope and recovery area standards.

Suggested Values for Consideration as Urban Design Standards

The researchers have three basic recommendations concerning Minnesota's urban state-aid standards.

1. The concept of functional classification should be employed within the basic structure of the standards. This can be achieved by adopting a simple "local," "collector" and "arterial" designation for all state-aid streets and highways, and by including such designations within the format of the standards.
2. Widths considered to be "low minimums" or less than desirable minimum should not be explicitly shown as values within the standards tables. These values, intended for use only under special, extreme conditions should be handled with footnotes to the basic standards.

Functional Classification	Projected ADT	Lane Width	Shoulder Width	Inslope (1)	Recovery Area (2)	Design Speed (3)	New Bridges (4)	Bridges to Remain (5)	
							Width Curb-Curb	Width Curb-Curb	Structural Capacity
LOCAL	0 - 100	10'	2'	2:1	10'	30 - 50	24'	18'	H - 15
COLLECTOR	100 - 250	11'	3'	3:1	15'	40 - 50	28'	22'	H - 15
	250 - 400	11'	4'	3:1	15'	40 - 50	30'	24'	H - 15
ARTERIAL	250 - 750	12'	4' - 6'	4:1	20'	50 - 60	32' - 36'	26'	H - 15
	750 - 1000	12'	6' - 8'	4:1 - 6:1	25'	50 - 60	36' - 40'	28'	H - 15
	1000 & Over	12'	8' - 10'	4:1 - 6:1	30'	50 - 60	40' - 44'	30'	H - 15

(1) Applies to Slope Within Recovery Area Only

(2) Obstacle Free (Measured from Edge of Traveled Way)

(3) Subject to Terrain

(4) Minimum Widths Listed shall Apply, Except that Lesser Widths may be Approved upon Sufficient Justification Where the Bridge Length Exceeds 100'

(5) When the Bridge Width is Less than the Traveled Way, Suitable Transition and Protective Devices shall be Provided

SUGGESTED STANDARDS FOR DESIGN OF MINNESOTA RURAL STATE-AID HIGHWAYS

FIGURE 6

3. A definite procedure for application of standards under constrained situations should be adopted. An example of such a procedure, which utilizes data and evaluation methodologies developed in the research, is presented within the report. This procedure provides guidance to the engineer in applying engineering judgment to selection of restricted widths, while helping him maintain the proper perspective with respect to the potential operational and safety effects of utilizing such widths.

These basic recommendations are reflected in the suggested urban design standards shown in Figures 7 and 7a. The width values shown were selected based on cost-effectiveness and consistency within the standards themselves.

LOCAL

Number of Lanes	Basic Lane Width	Undivided; No Parking Lanes			Undivided; With Parking Lanes One Side	Both Sides	
2	A 11	28			--	44[1]	
	B 12	32			34	44	

COLLECTOR

Number of Lanes	Basic Lane Width	Undivided: No Parking Lanes	With Median No Parking Lanes 4' Med.	14' Med.	Undivided; With Parking Lanes One Side	Both Sides	With 4' Median and Two Parking Lanes
2	A 11	32	--	--	--	44[1]	--
	B 12	32	--	--	36	46	--
4	A 11	46[1]	50[1]	60[1]	56[1]	64[1]	70[1]
	B 12	50	54	64	60	68	74

ARTERIAL

Number of Lanes	Basic lane Width	Undivided; No Parking Lanes	No Parking Lanes 6' Med.	16' Med.	Undivided; With Parking Lanes One Side	Both Sides	With 6' Median and Two Parking Lanes
2	A 11	34[1]	--	--	--	46[1]	--
	B 12	36	--	--	38	48	--
4	A 11	48[1]	54[2]	64[2]	58[1]	68[1]	76[2]
	B 12	52	58	68[3]	62	72	80
6	A 11	70[1]	76[2]	86[2]	80[1]	90[1]	98[2]
	B 12	76	82	92[3]	86	96	104

A Acceptable Minimum
B Desirable Minimum
1 Under extreme conditions a 2-foot reduction in width may be considered
2 Under extreme conditions a 2-foot reduction in roadway and/or a 2-foot reduction in median width may be considered; total reduction in width may not exceed 4 feet.
3 18-foot median may be considered, resulting in a 2-foot increase in total width

SUGGESTED STANDARDS FOR DESIGN OF MINNESOTA URBAN STATE-AID HIGHWAYS

FIGURE 7

PROCEDURE FOR CONSIDERATION OF SPECIAL SITUATIONS OR UNDUE CONSTRAINTS

(Examples: Existing right-of-way is already utilized to its "maximum"; potential for extreme environmental damage such as would result from removal of a long row of large trees exists, etc.)

1. If feasible, the low minimum standard indicated for use under extreme conditions (Notes[1] and [2]) should be utilized.
2. Where even the low minimum standard is not feasible, a special study should be directed toward a review of the particular cross sectional feature in question. A review of the recommended standard and its derivation should enable the determination of the operational effects of any incremental reductions in width beyond the low minimum. Such modifications in the low minimum overall width may take the form of a reduction of 2 feet but in no case exceed 4 feet, without considering the alternatives below.
3. If an acceptable dimension cannot be obtained from the above study, a special analysis of the street or highway in question and the surrounding network should be made. Possible solutions may include
   - conversion of the street to one-way
   - system adjustments (upgrading of a nearby, parallel facility and/or downgrading of the facility under study)
   - implementation of special parking restrictions (removal of on-street parking and development of nearby off-street parking facilities).

SUGGESTED PROCEDURE FOR APPLICATION OF URBAN DESIGN STANDARDS

FIGURE 7a