

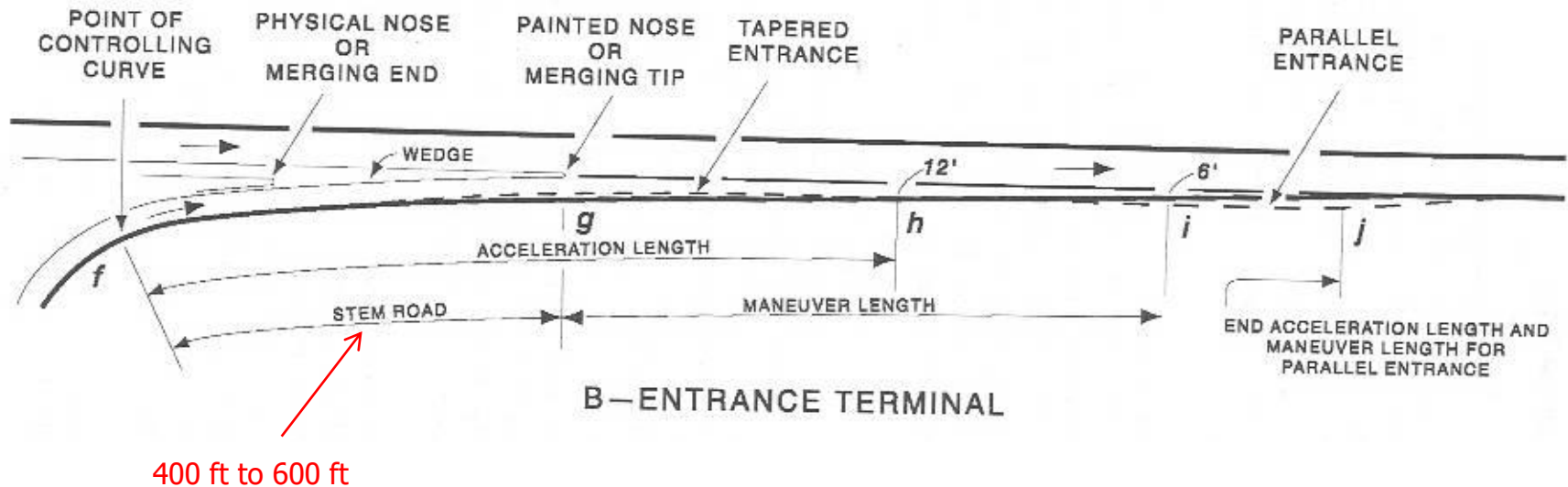
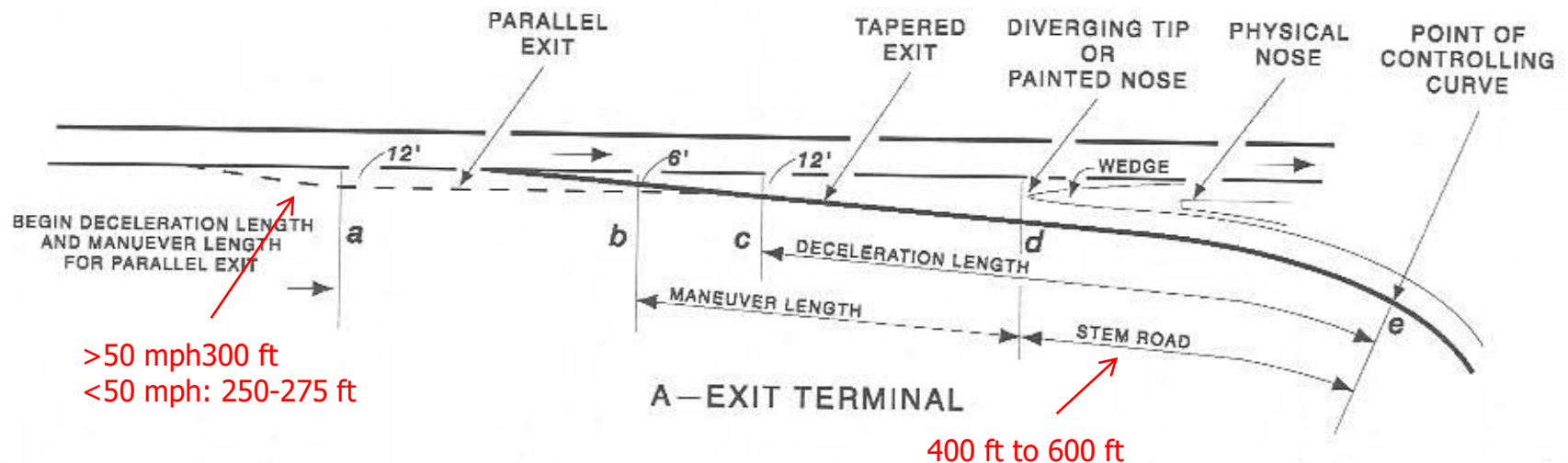
INTERCHANGE DESIGN

Part 2

Spring 2008

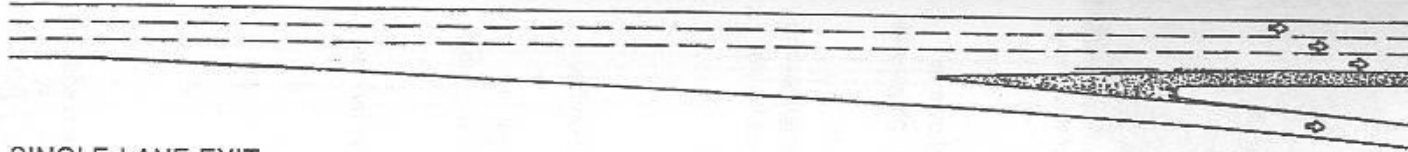
Note: all information taken from Freeway & Interchange: Geometric Design Handbook (2005) by J.P. Leisch et al. (ITE Publication)

Exit and Entrance Ramps

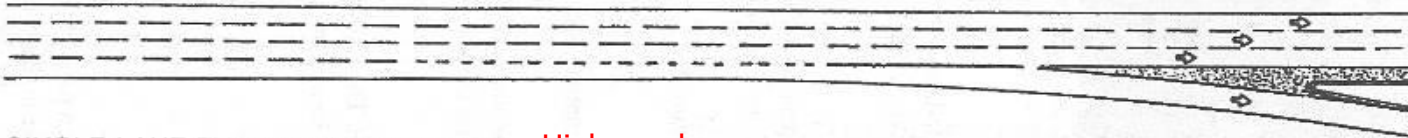


Designs for Exit Ramps

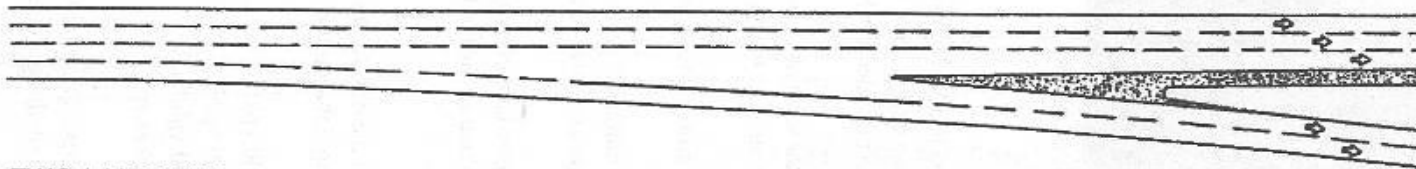
-A- SINGLE-LANE EXIT



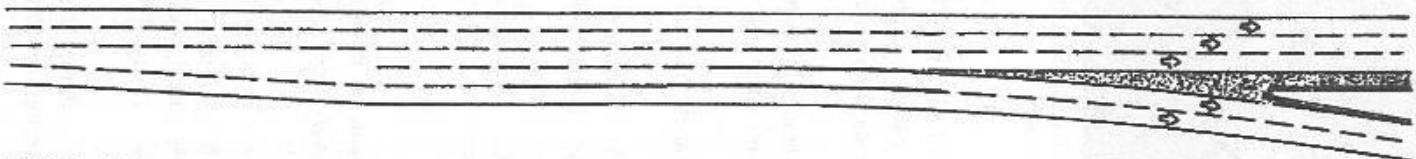
-B- SINGLE-LANE EXIT WITH LANE DROP Higher volumes



-C- TWO-LANE EXIT



-D- TWO-LANE, PARALLEL EXIT Best capacity



Designs for Exit Ramps



Figure 3-25. Two-Lane Exit—Undesirable Location.

Source: Joel P. Leisch.



Figure 3-26. Two-Lane Exit—Preferable Design.

Source: Joel P. Leisch.

- Taper angle too large
- Reduces capacity because drivers need to decelerate significantly at the gore area

$$V_d = \geq 60 \text{ mph}$$

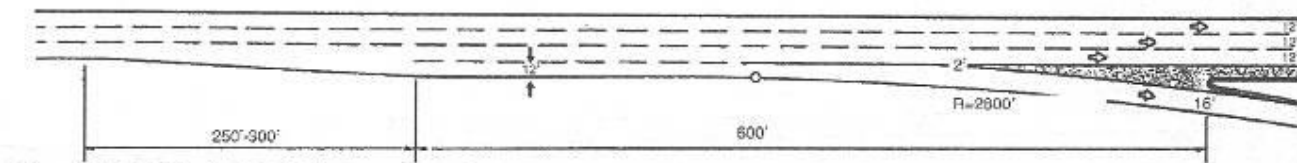
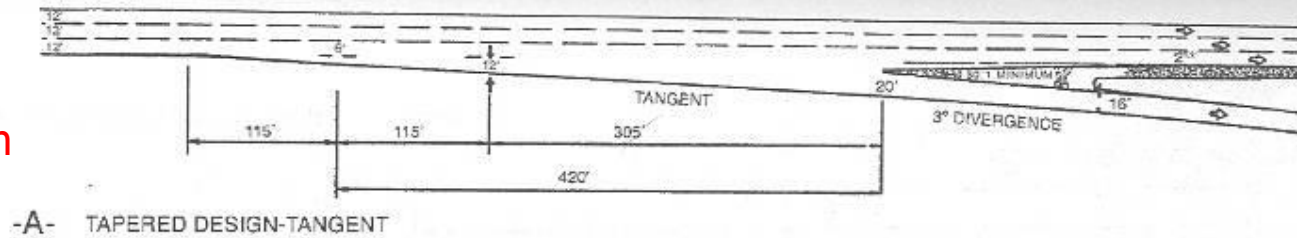


Figure 3-28. Typical Exit Ramps—One Lane.
Source: Jack E. Leisch.

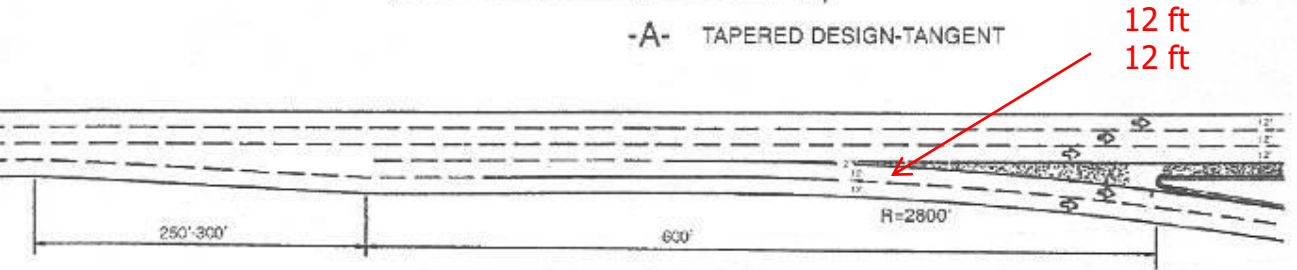
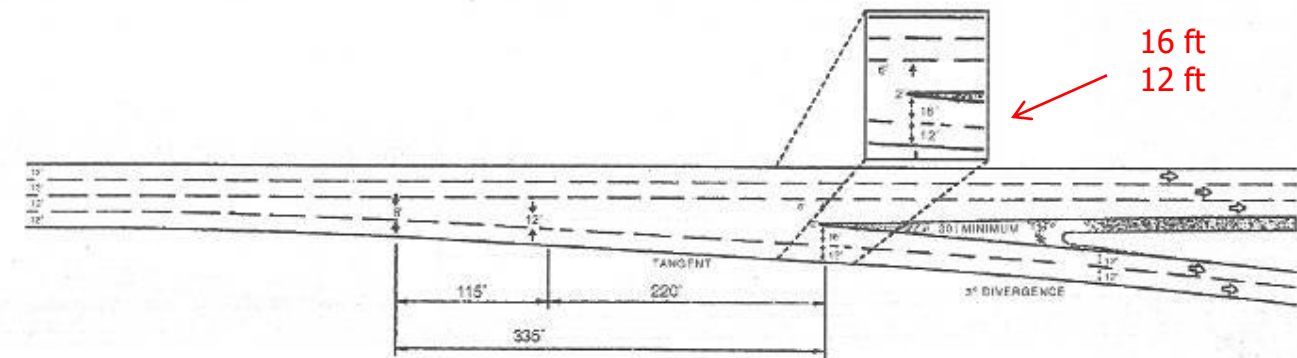


Figure 3-29. Typical Exit Ramps—Two Lane.
Source: Jack E. Leisch.

Designs for Entrance Ramps

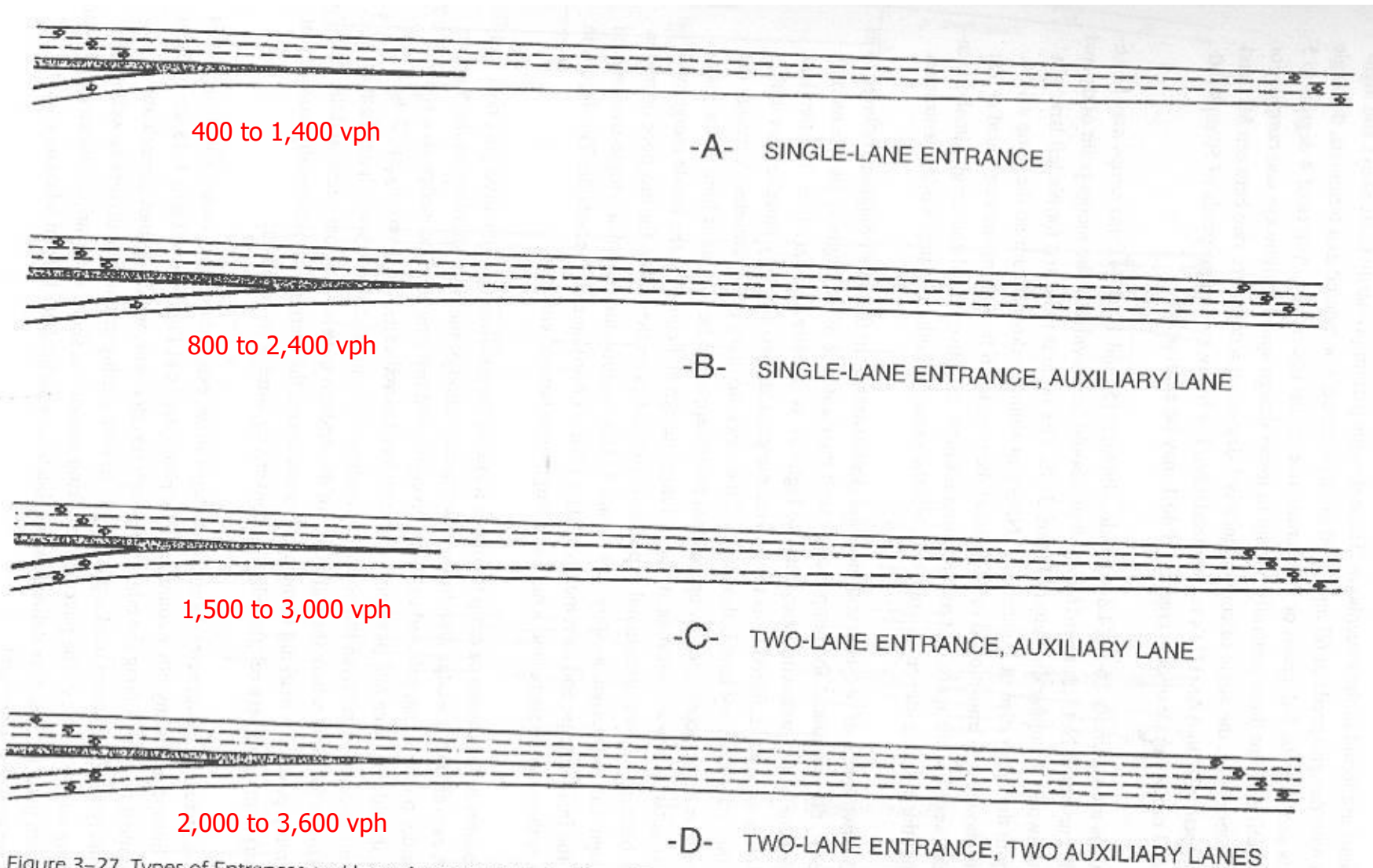
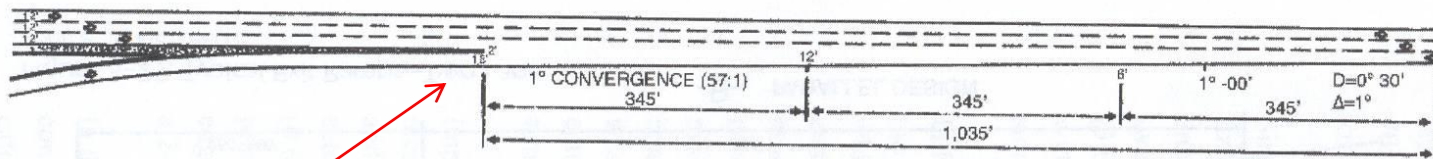


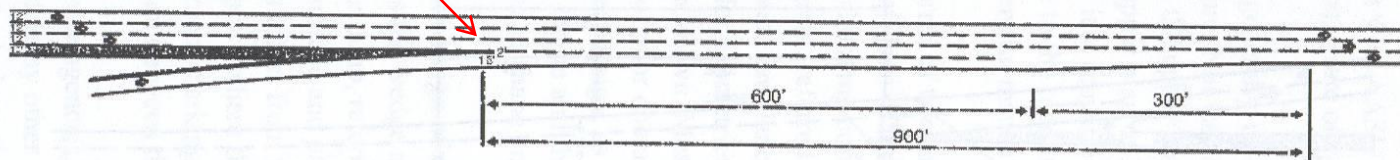
Figure 3-27. Types of Entrances and Lane Arrangements for Ramps

$V_d = \geq 60$ mph

16 ft



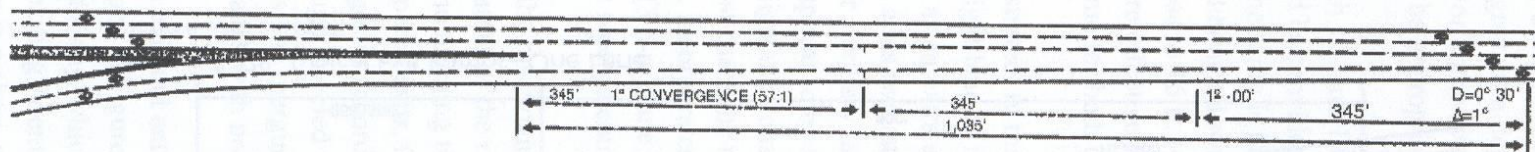
-A- TAPERED DESIGN



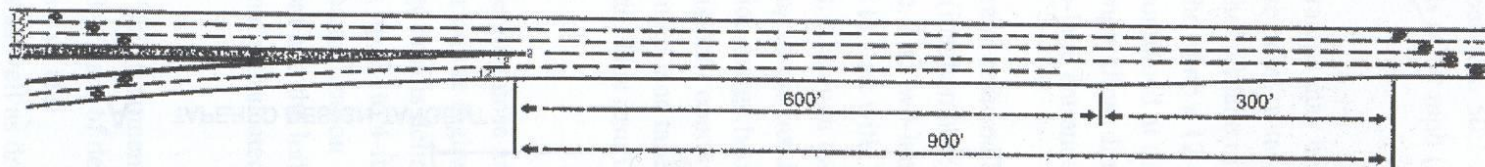
-B- PARALLEL DESIGN

Figure 3-30. Typical Entrance Ramps—One Lane.

Source: Jack E. Leisch.



-A- TAPERED DESIGN



-B- PARALLEL DESIGN

Figure 3-31. Typical Entrance Ramps—Two Lane.

Source: Jack E. Leisch.

Exits and Entrances on Curved Highways

Prevents through vehicles
to enter the ramp

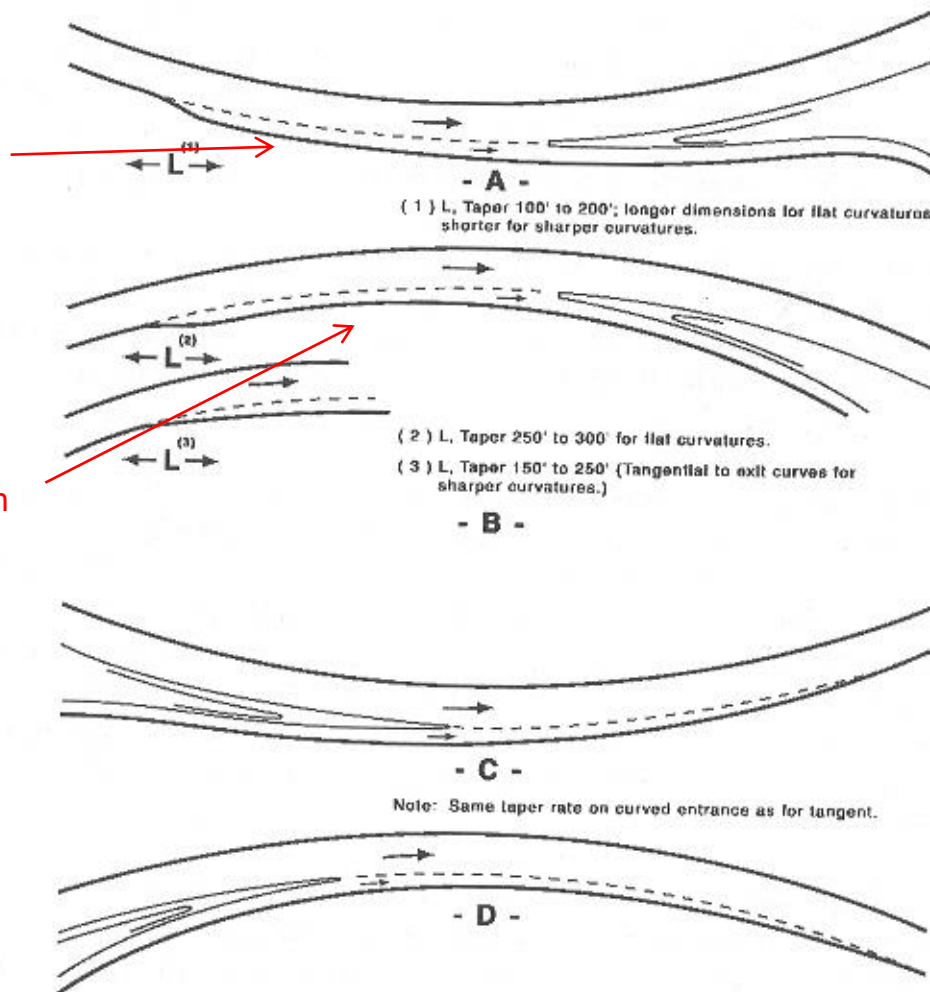
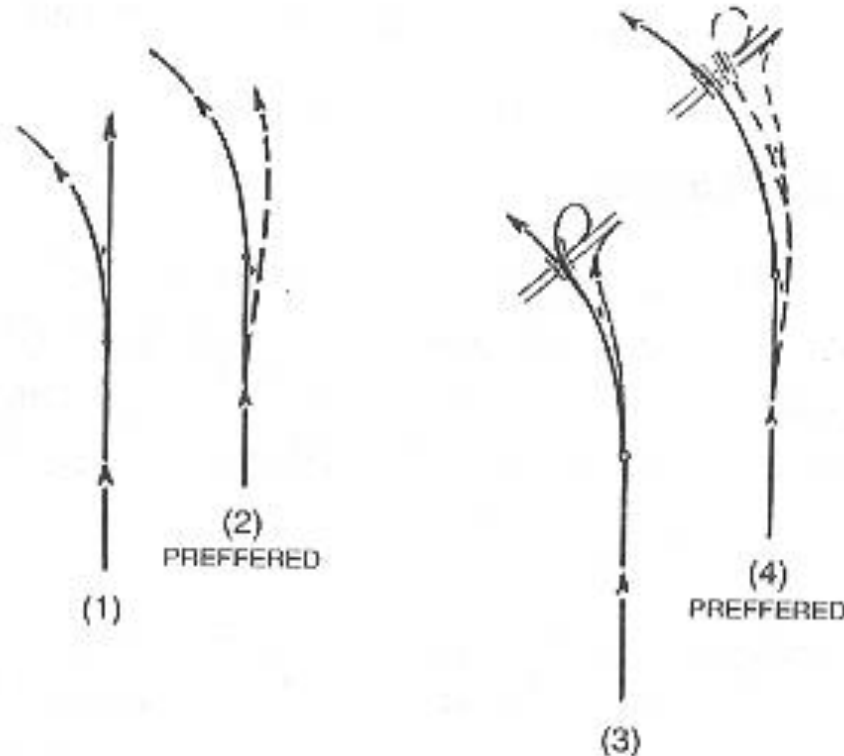


Figure 3-34. Exits and Entrances on Curved Highways.

Source: Jack E. Leisch.

Exits and Entrances on Curved Highways



Better to design exits on the tangent rather than on a curve

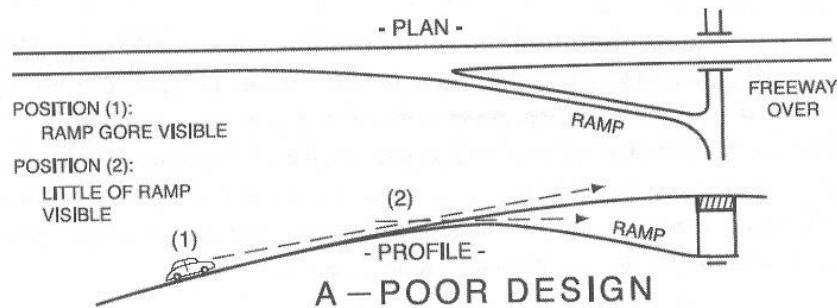
-A- RAMP EXIT ON TANGENT
PROLONGATION

-B- RAMP EXIT ON CURVED
ALIGNMENT
(Curve Preceded by Tangent)

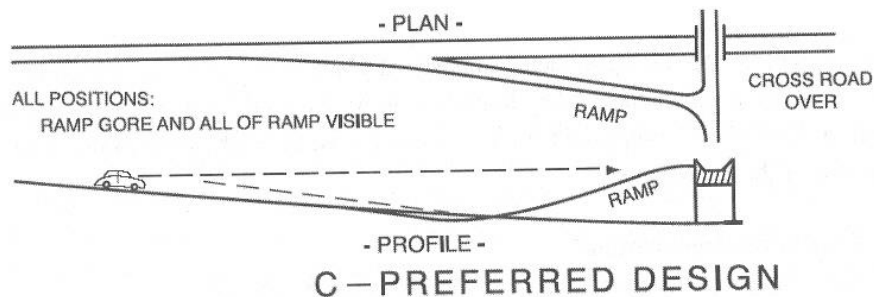
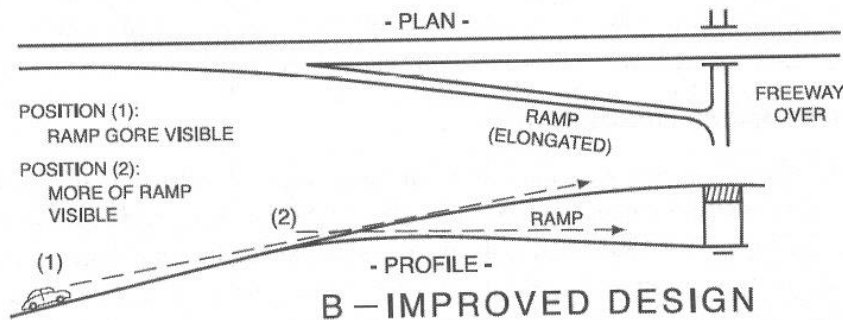
3-35. Treatment of Exits from Curved Highway.

Jack E. Leisch.

Interchange Design Overview



Should use Decision Sight Distance



Interchange Design Overview



Figure 6-15. Decision Sight Distance—Undesirable Design.

Source: Joel P. Leisch.

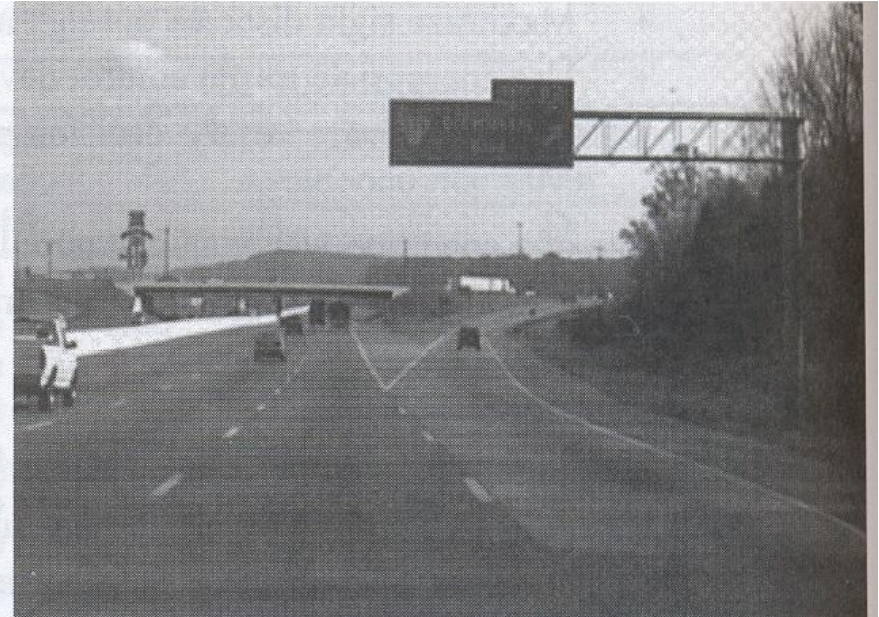
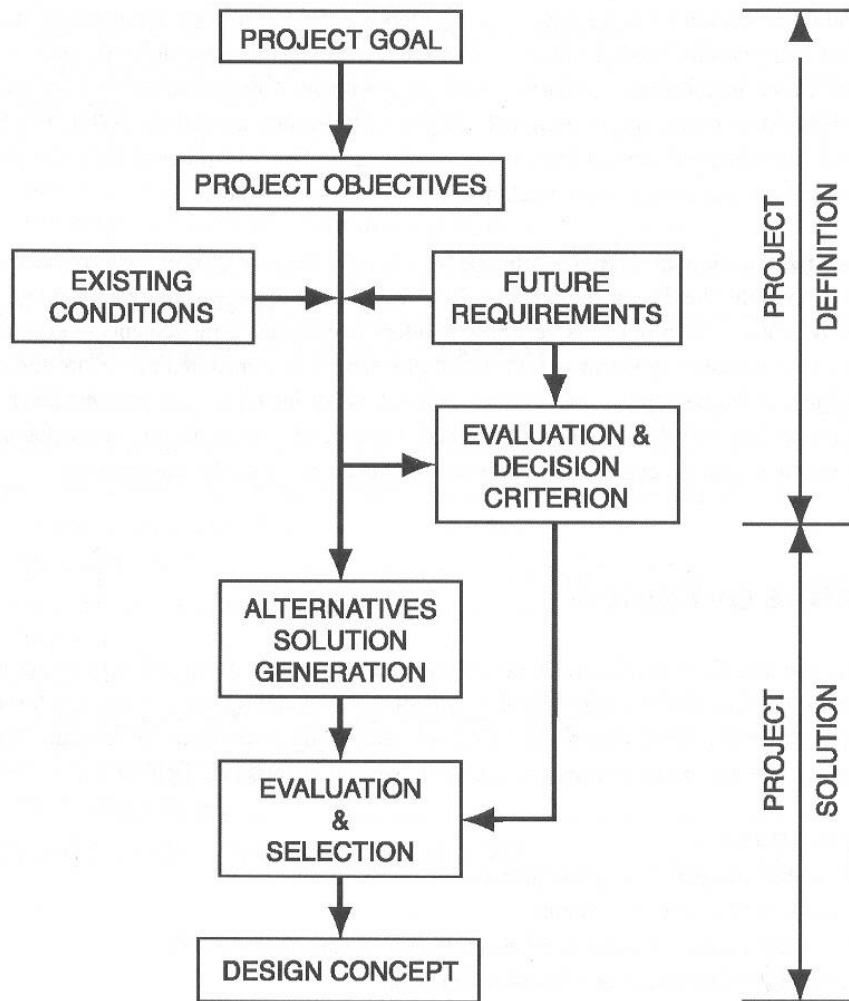


Figure 6-16. Decision Sight Distance—Desirable Design.

Source: Joel P. Leisch.

Interchange Design Overview



- A. Establish Objectives
 - B. Document Existing Conditions
 - C. Establish Future Design Requirements
 - D. Determine Evaluation and Decision Criteria
-
- A. Alternatives' Solution Generation
 - B. Alternatives' Analysis and Evaluation
 - C. Plan Selection

Figure 4-1. Interchange Design Study Methodology.
Source: Jack E. Leisch/Joel P. Leisch.

Interchange Design Overview

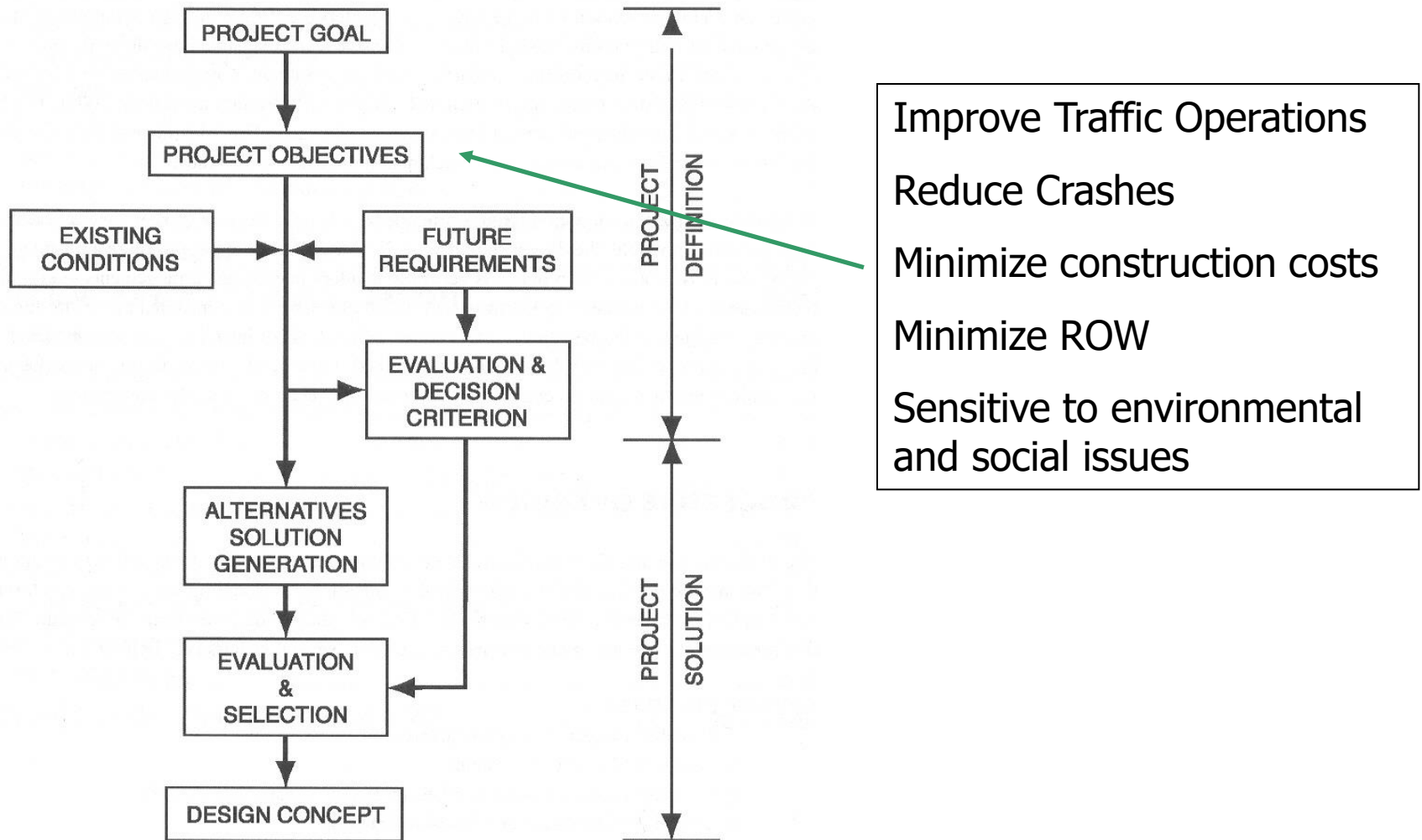
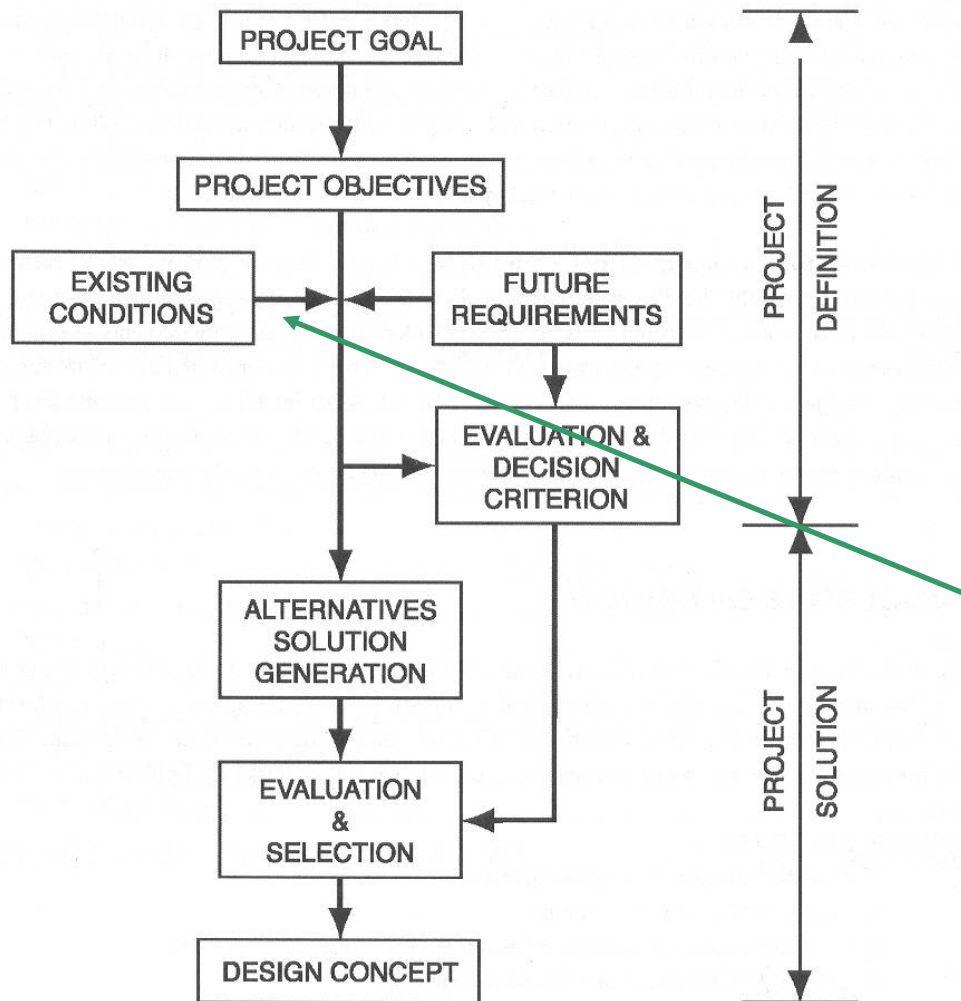


Figure 4-1. Interchange Design Study Methodology.
Source: Jack E. Leisch/Joel P. Leisch.

Interchange Design Overview



Existing ROW

Geometrics of the two intersecting roadways

Existing traffic on freeway and adjacent interchanges

Existing turning movements at intersections

Location and type of access on the crossroad

Location and type of development

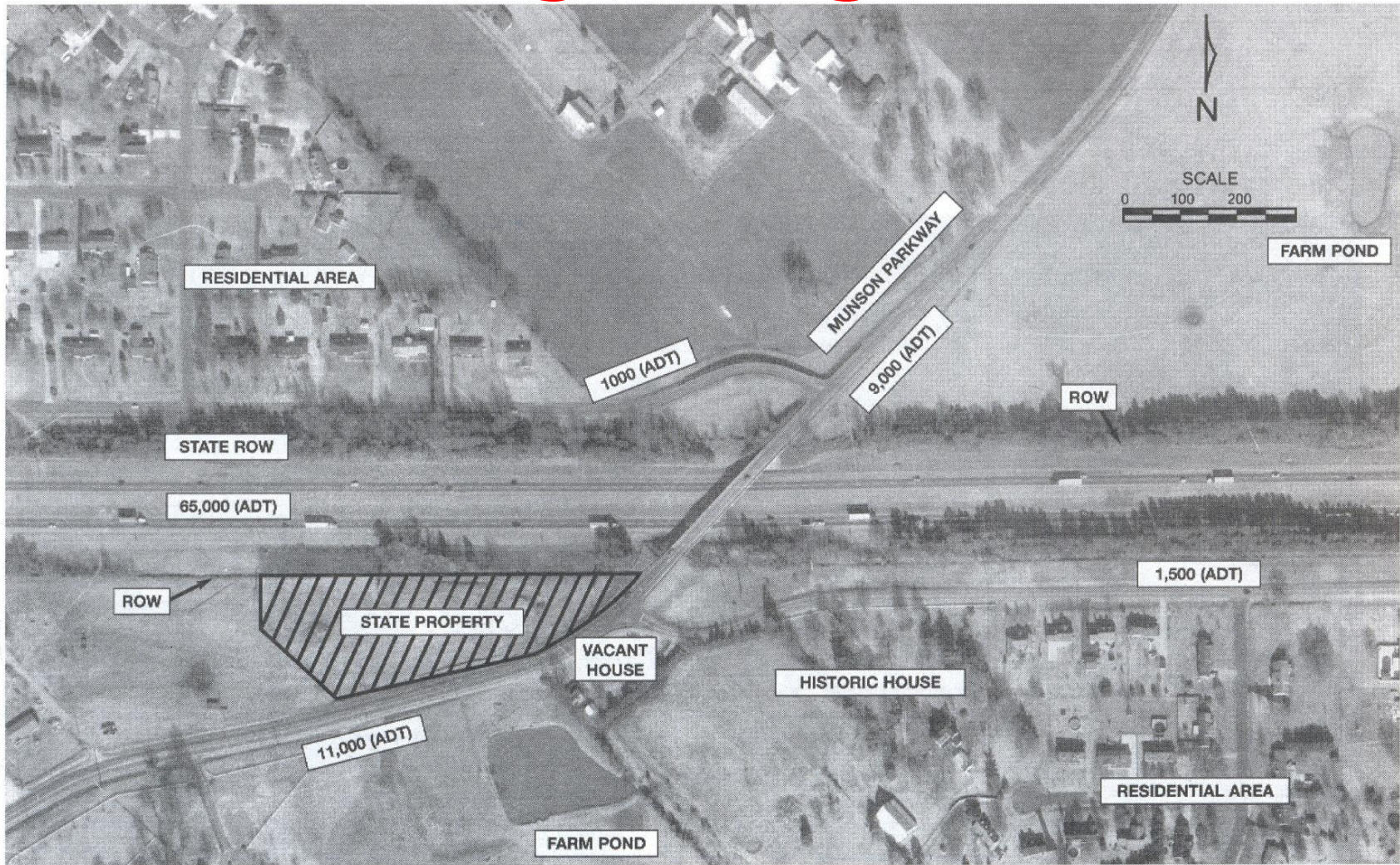
Transit operations

Pedestrians and cyclists

Environmental and sensitive areas

Figure 4–1. Interchange Design Study Methodology.
Source: Jack E. Leisch/Joel P. Leisch.

Interchange Design Overview



Interchange Design Overview

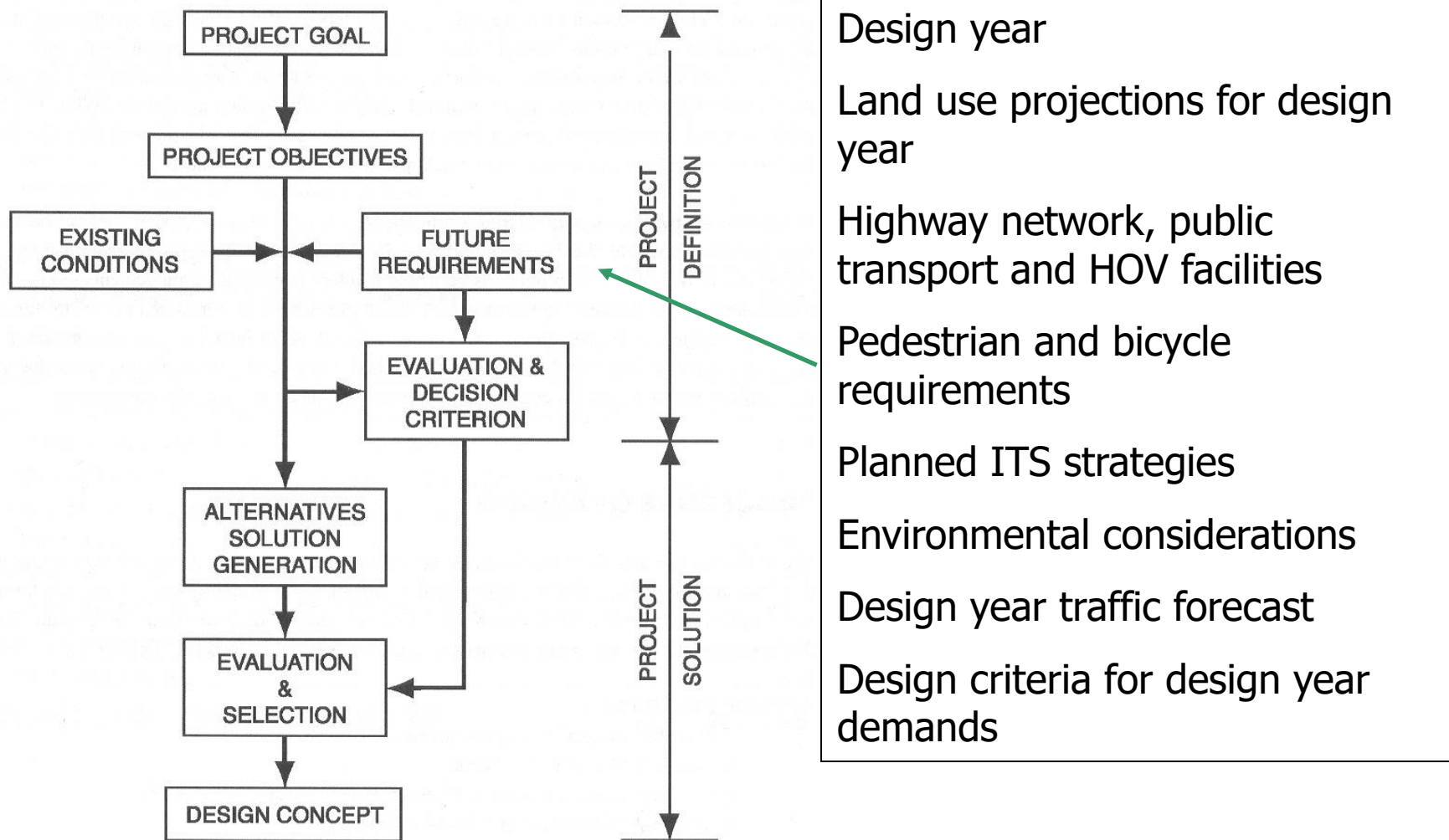
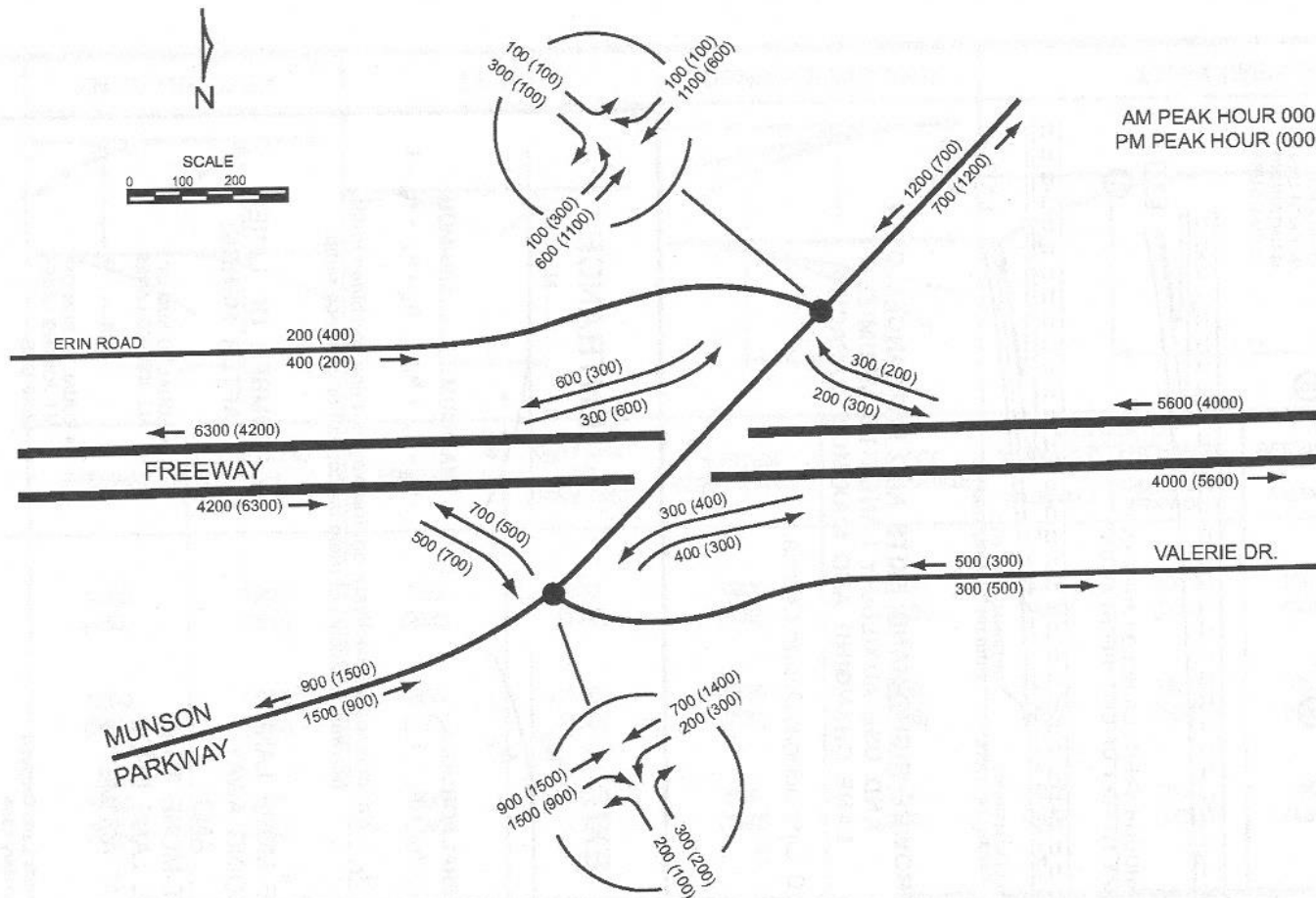


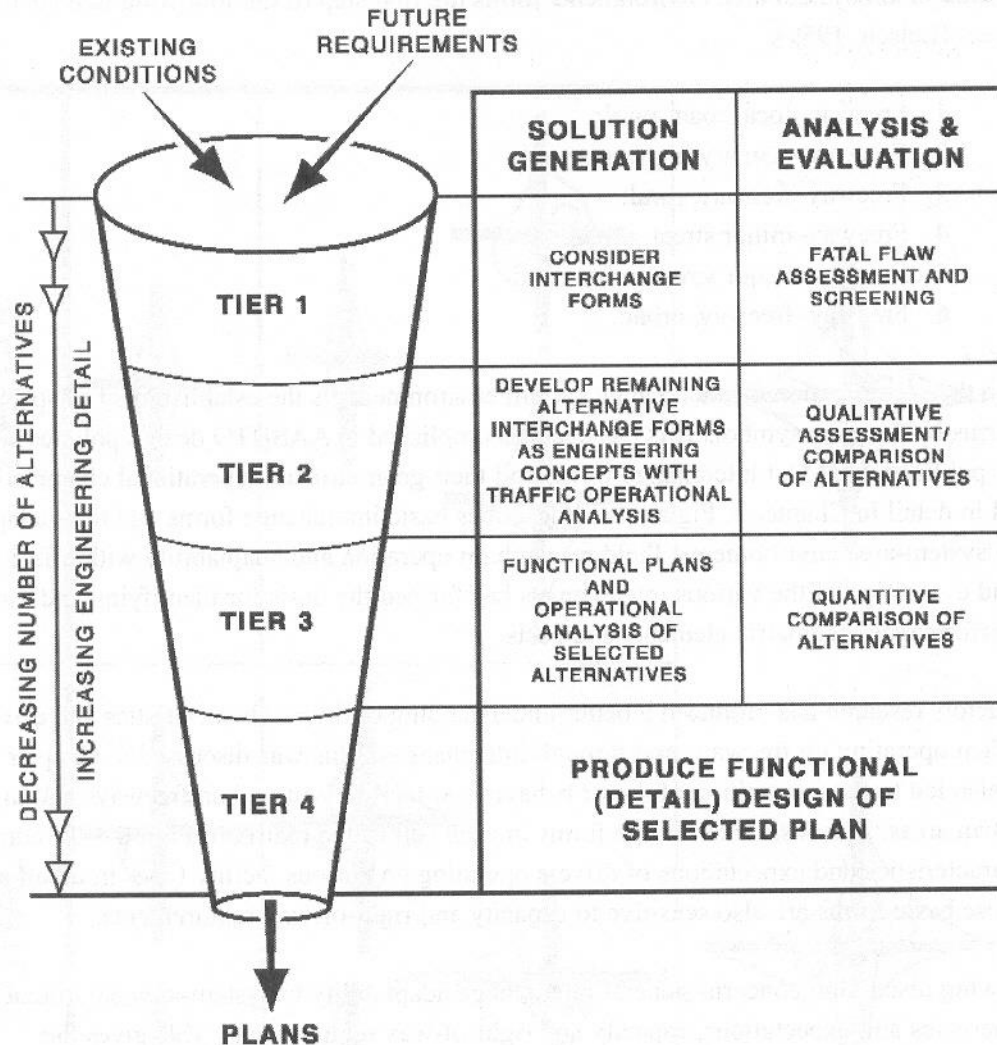
Figure 4–1. Interchange Design Study Methodology.
Source: Jack E. Leisch/Joel P. Leisch.

Interchange Design Overview



Forecasted design year hour volumes

Interchange Design Overview



Project Solution Process

Interchange Design Overview

- Tier 1
 - All interchange forms are considered and screened for fatal flaws
 - System-area environments (e.g., freeway-local road, freeway-freeway, freeway-major street, etc.) (see next overhead)
 - Screening consideration based on project definitions and scope
 - Can use a matrix as detailed below

Interchange Design Overview

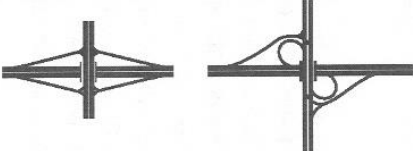
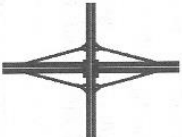
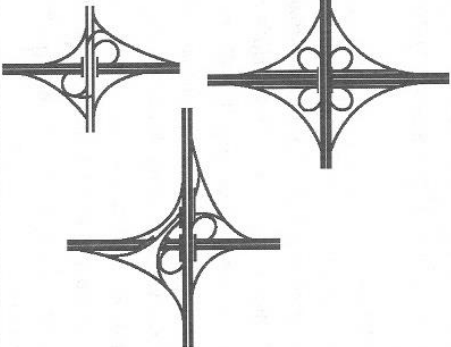
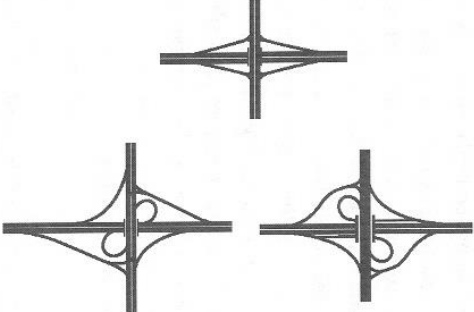
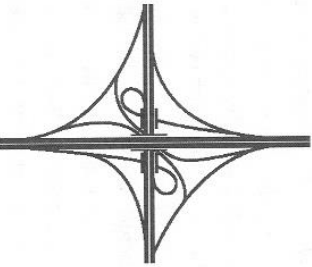
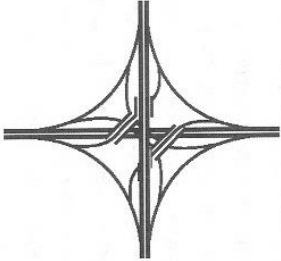
INTERSECTING FACILITY	RURAL	URBAN
LOCAL ROAD OR MINOR STREET		
MAJOR STREET OR HIGHWAY		
FREEWAY		

Figure 4-14. Adaptability of Interchanges.

Source: Jack E. Leisch.

Interchange Design Overview

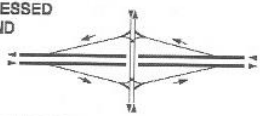
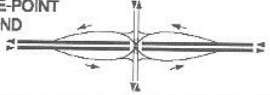
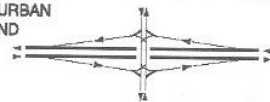
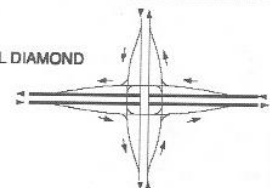
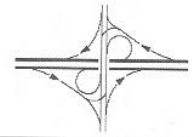
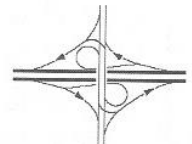
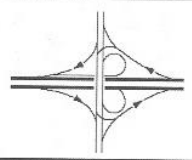
INTERCHANGE FORM	TRAFFIC OPERATIONS	RIGHT-OF-WAY	ENVIRONMENTAL/ SOCIAL IMPACTS	COSTS	CONSIDERATION TIER 2
COMPRESSED DIAMOND 	• Adequate Capacity • Not as efficient as other Diamonds	• Small Amount of ROW– More than other Diamonds	• Environmental – None • Some Access Modification	• Low Cost	NO
SINGLE-POINT DIAMOND 	• Adequate Capacity	• Minimal ROW	• None	• Moderate Cost	YES
TIGHT URBAN DIAMOND 	• Adequate Capacity	• Minimal (+) ROW	• None	• Low Cost	YES
3-LEVEL DIAMOND 	• High Capacity	• Moderate ROW	• Environmental – None • Significant Access Impacts along Arterial	• High Cost	NO
PAR CLO A 	• High Capacity	• Significant ROW	• Environmental – None • Some Access Modification	• Moderate Cost	YES
PAR CLO B 	• High Capacity	• Significant ROW	• Loop in NE Quadrant – Historic Site • Some Access Modification	• Moderate Cost	NO
PAR CLO AB 	• Adequate Capacity	• Significant ROW	• Loop in NE Quadrant – Historic Site • Some Access Modification	• Moderate-High Cost	NO

Figure 4– 15. Tier 1—Alternatives Screening.

Source: Joel P. Leisch.

Interchange Design Overview

- Tier 2
 - Initial engineering development and analysis of alternative interchange forms
 - Designs mapped to scale on maps/aerial photographs
 - Can use “single-line” drawings/sketches or in CADD software showing each ramp and direction of traveled-way
 - Involve public at this stage
 - Compare qualitative to reduce the alternatives to be carried out in Tier 3

Interchange Design Overview

- Tier 2
 - Major inputs:
 - Future traffic and lane requirements
 - Public transport plan, pedestrians and bicycle requirements
 - Future highway network
 - Analysis and evaluation of existing facility
 - Land use, environmental and ROW considerations
 - ITS strategies and HOV facilities
 - Design guidelines and criteria

Interchange Design Overview

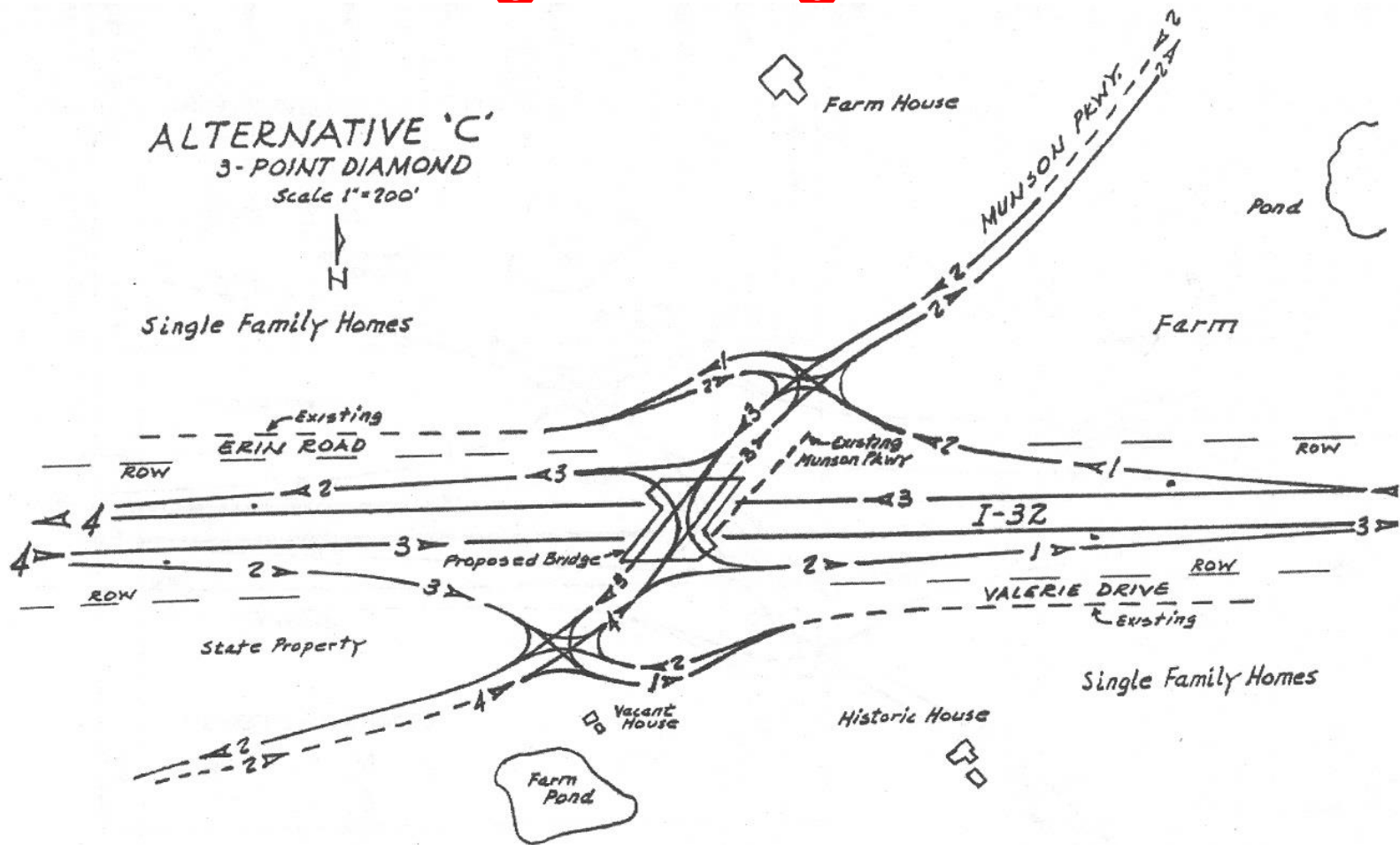


Figure 4-17. Single-Line Sketch Interchange.

Source: Joel P. Leisch.

Interchange Design Overview

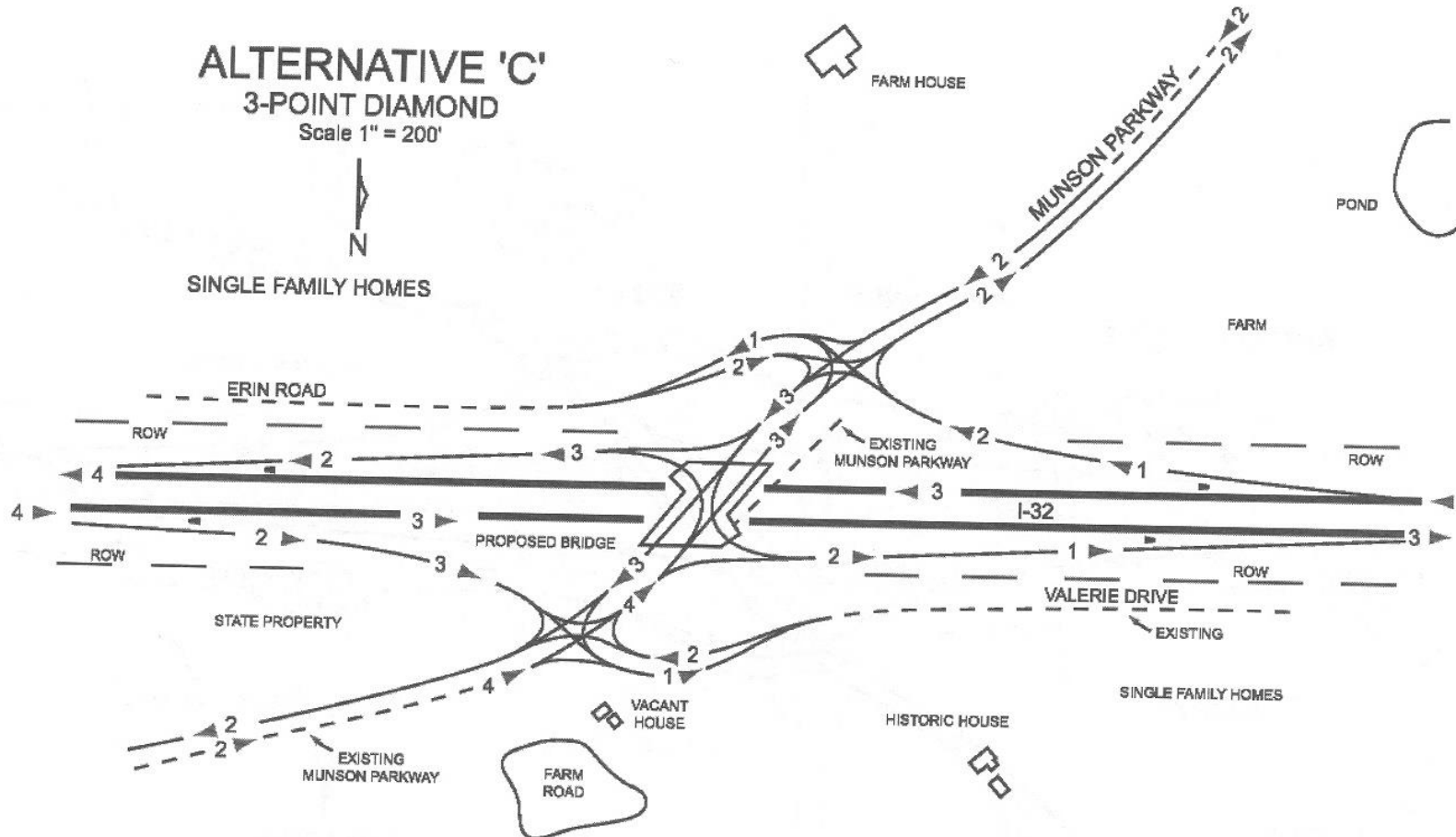


Figure 4-18. Single-Line CADD Interchange Concept.
Source: PBS&J.

Interchange Design Overview

BASIS: BALANCED
RATING SCALE: 5-10

PLAN ALTERNATIVE		I		II		III	
ITEM	SCALE VALUE	RATING	WEIGHTED VALUE	RATING	WEIGHTED VALUE	RATING	WEIGHTED VALUE
OPERATIONAL (25)							
CAPACITY/LOS	(10)	8	80	8	80	10	100
FLEXIBILITY	(10)	6	60	10	100	10	100
GEOMETRIC ALIGNMENT	(5)	8	40	8	40	10	50
SAFETY (20)							
OPERATIONAL	(15)	7	105	8	120	10	150
ROADSIDE	(5)	9	45	9	45	10	50
COSTS (25)							
CONSTRUCTION	(15)	8	120	10	150	8	120
R-O-W	(10)	10	100	9	90	7	70
IMPLEMENTATION (15)							
STAGING - CONSTRUCTION	(10)	6	60	10	100	9	90
MAINTENANCE OF TRAFFIC	(5)	7	35	9	35	10	50
ENVIRONMENTAL (15)							
TRAFFIC ACCESSIBILITY	(5)	10	50	10	50	8	40
IMPACT ON DEVELOPMENT	(10)	10	100	10	100	7	70
	(100)						
(POSSIBLE: 1000)	TOTAL		795		910		890

Figure 4-19. Alternatives Ranking (Example).

Source: Jack E. Leisch.

Eliminated from further study

Interchange Design Overview

- Tier 3
 - The selected alternatives are developed in geometric design form
 - Full design superimposed on single-line design
 - Functional profiles and cross sections developed
 - Prepare signing plan, drainage, structures, sequence of construction, phased implementation plan, ROW and construction costs, and operational analysis
 - Compare alternatives quantitatively (costs) (should include a benefit-cost analysis)
 - May need to involve public at this stage

Interchange Design Overview

- Tier 4
 - Finalize plan for the selected design
 - Prepare letting documents
 - Prepare design study report

Interchange Design Overview

Design Study Report

I. SUMMARY

II. INTRODUCTION

- Study Area and Problem Definition
- Study Goal and Objectives
- Project Approach and Schedule

III. PUBLIC INVOLVEMENT PROGRAM

- Overview of Process
- Public Participants
- Mission Statement
- Communication "Tools"

IV. EXISTING CONDITIONS

- Transportation System
- Traffic Volumes, Patterns, and Level of Service
- Accident Experience
- Existing Development and Right-of-Way Constraints
- Environmental Considerations
- Summary and Evaluation of Existing Conditions
- Traffic Model Calibration

V. FORECASTS OF FUTURE TRAVEL

- Growth Projections (Land Use and Development)
- General Projected Travel Growth (ADT)
- AM and PM Design Traffic Projections
- Other Peak Projections

VI. FUTURE SYSTEM DESIGN AND OPERATIONAL CONSIDERATIONS

- Design and Operational Criteria
- HOV and Public Transport Considerations
- ITS Elements
- Basic Lane Requirements

VII. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

- Tier 1 - Alternatives Considered and Screening
- Tier 2 - Alternatives Development and Ranking
- Tier 3 - Alternatives Concept Design and Evaluation

VIII. PREFERRED ALTERNATIVE

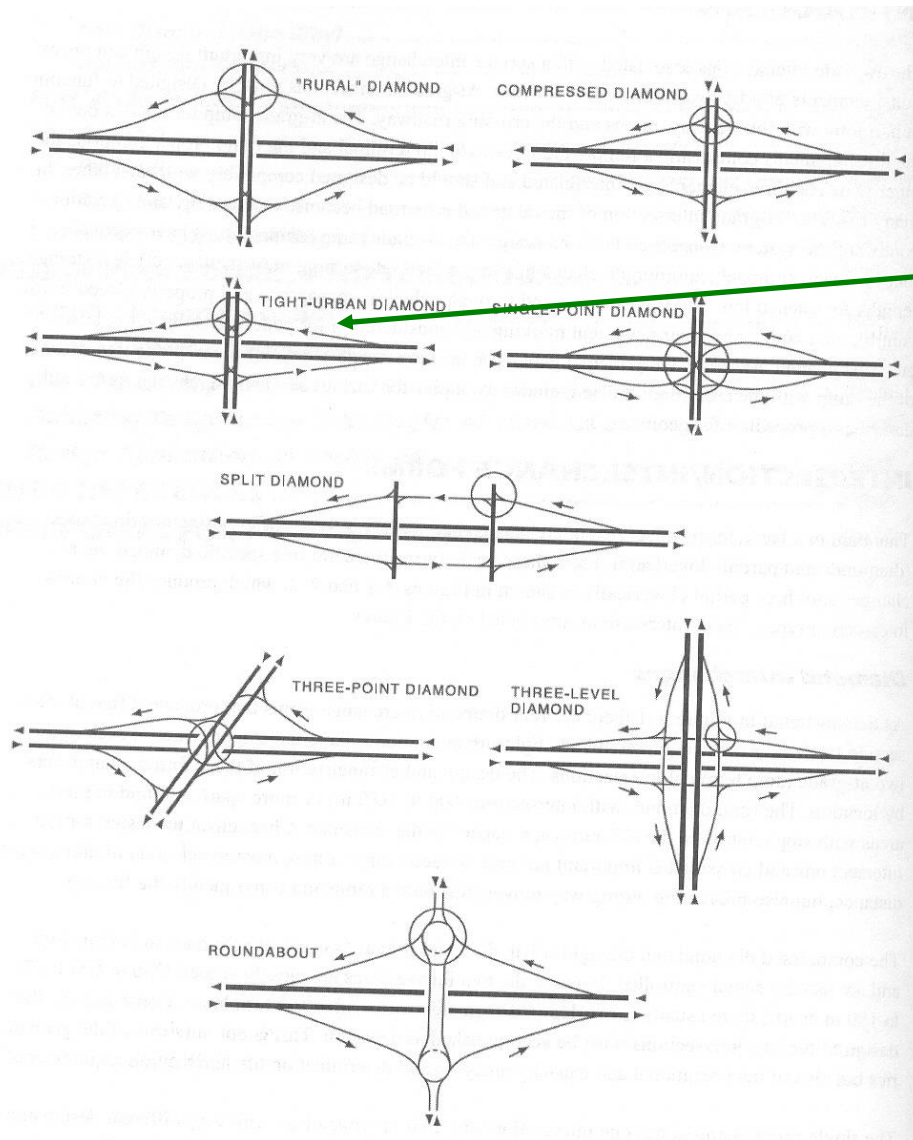
- Description of Preferred Alternative
- Estimated Costs
- Phased Implementation Concept
- Final Operational Analysis - Simulation

IX. SUMMARY AND RECOMMENDATIONS

Figure 4-27. Interchange Design Study Report—Example Contents.

Source: PRSS, I.

Ramp Terminal

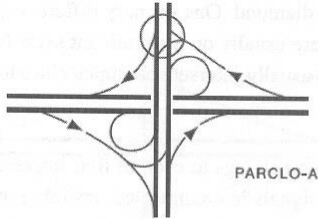


Four types for Diamond interchanges

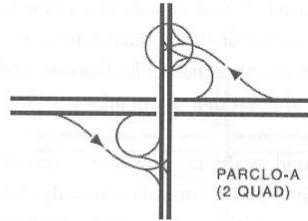
Design overlaps (left-turn lanes)

Ramp Terminal

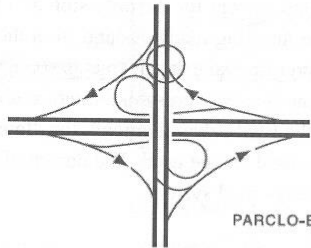
Several partial cloverleaf designs



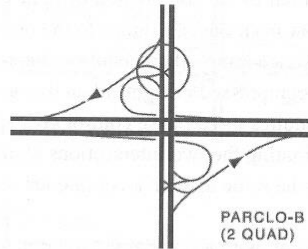
PARCLO-A



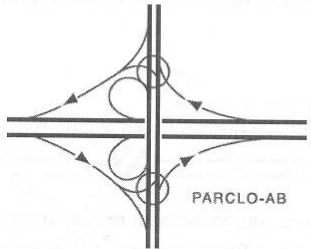
PARCLO-A
(2 QUAD)



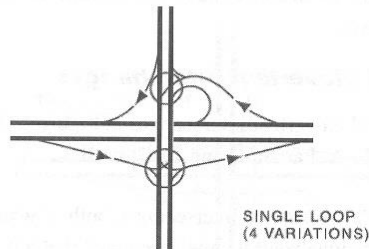
PARCLO-B



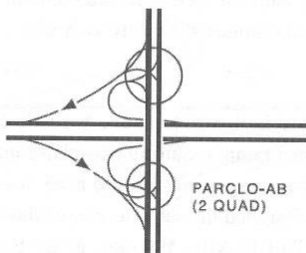
PARCLO-B
(2 QUAD)



PARCLO-AB



SINGLE LOOP
(4 VARIATIONS)



PARCLO-AB
(2 QUAD)

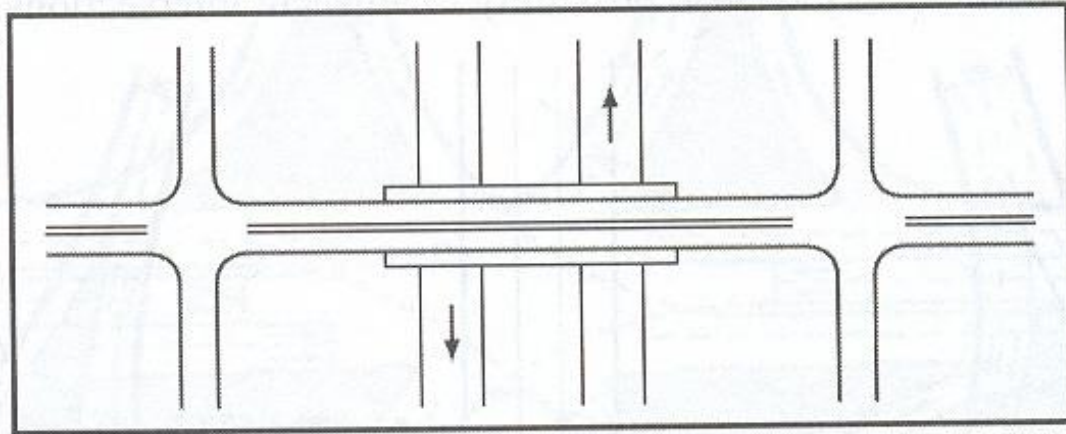
Ramp Terminal

- Design Principles
 - Design and traffic control scheme should optimize the operation quality of traffic flow
 - Designed to minimize crashes and their adverse effects
 - General guidelines
 - Discourage undesirable wrong-way movements
 - Desirable vehicle path should be clearly defined
 - Encourage safe vehicle speed
 - Traffic streams should cross at near-right angles and merge at flat angles
 - Provide accelerating and decelerating lanes (as well as turning bays)

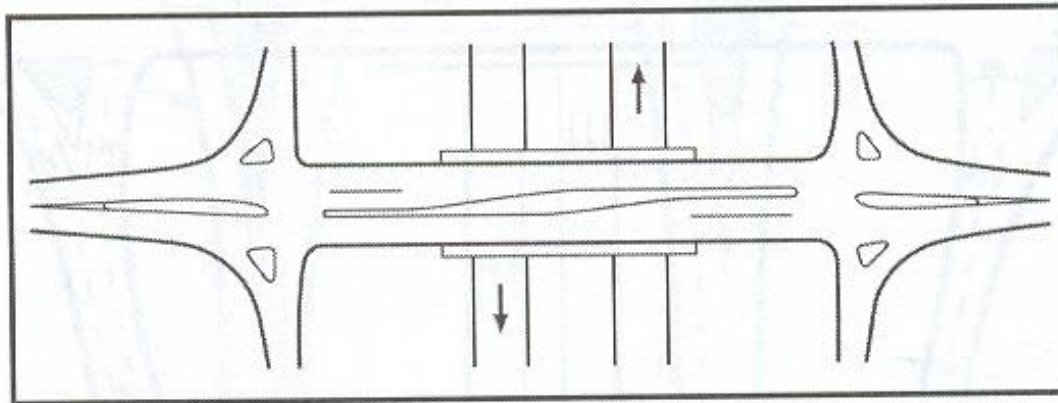
Ramp Terminal

- Design Criteria
 - Design speed should be between 25 and 40 mph (gore area should be between 50 and 60 mph)
 - Ramp approach should meet at 90°
 - Left-turning radii between 50 to 75 ft
 - Left-Turning Radii between 120 to 200 ft (single-point)
 - Grades should be less than 3%

Ramp Terminal



POOR DESIGN



GOOD DESIGN

Rural Design

Ramp Terminal

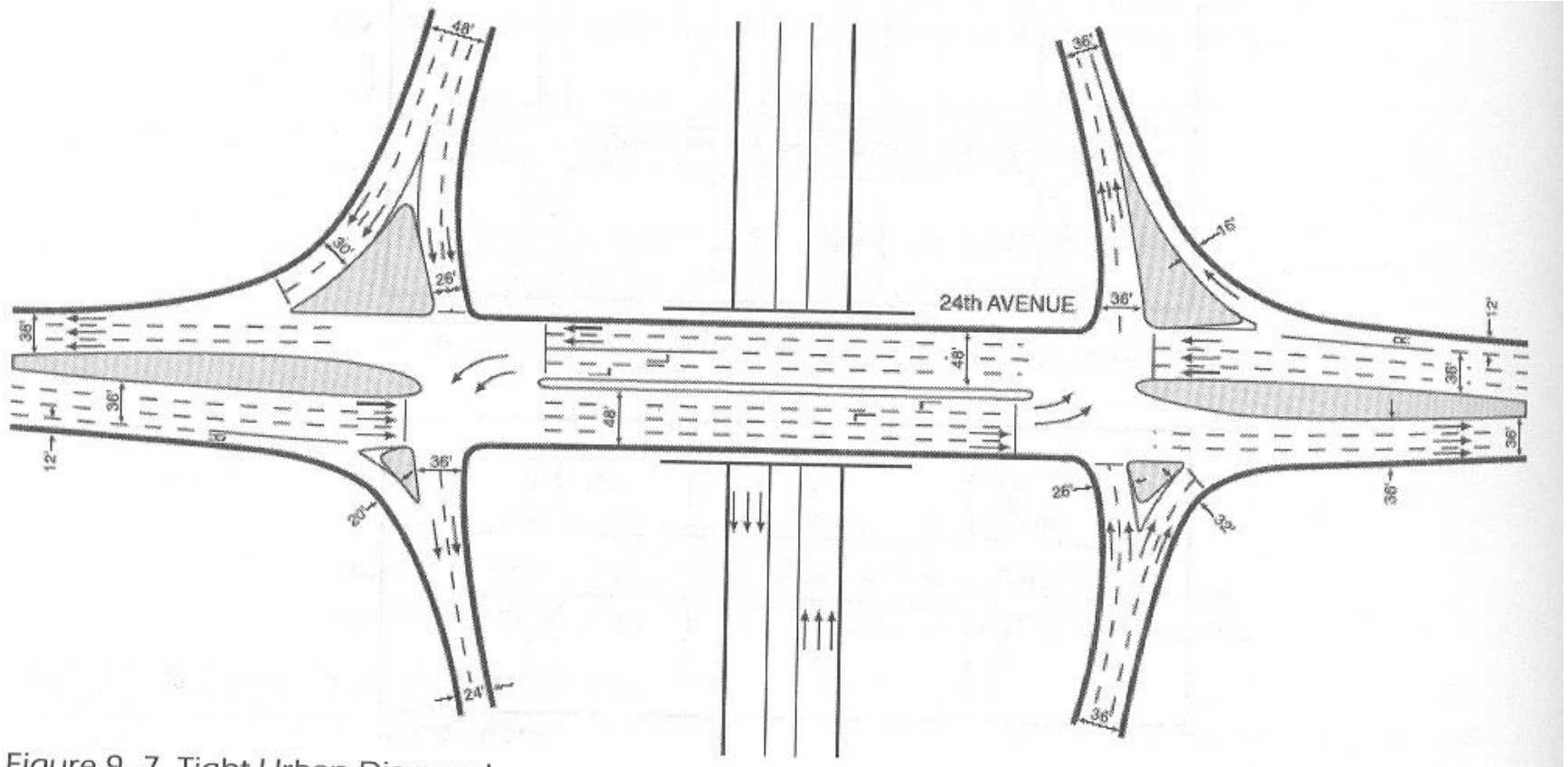
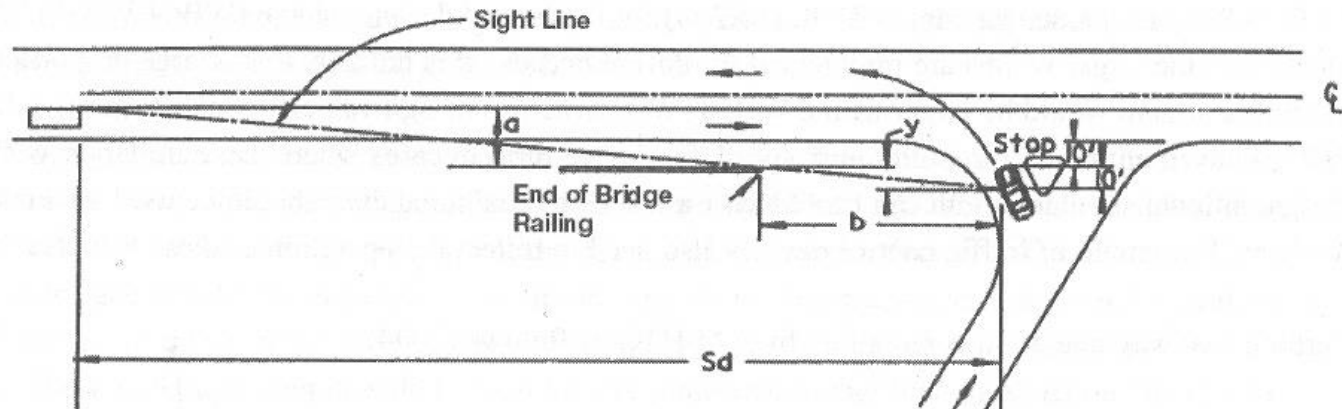


Figure 9_7 Tight Urban Diagram

Tight-Urban Diamond

Ramp Terminal

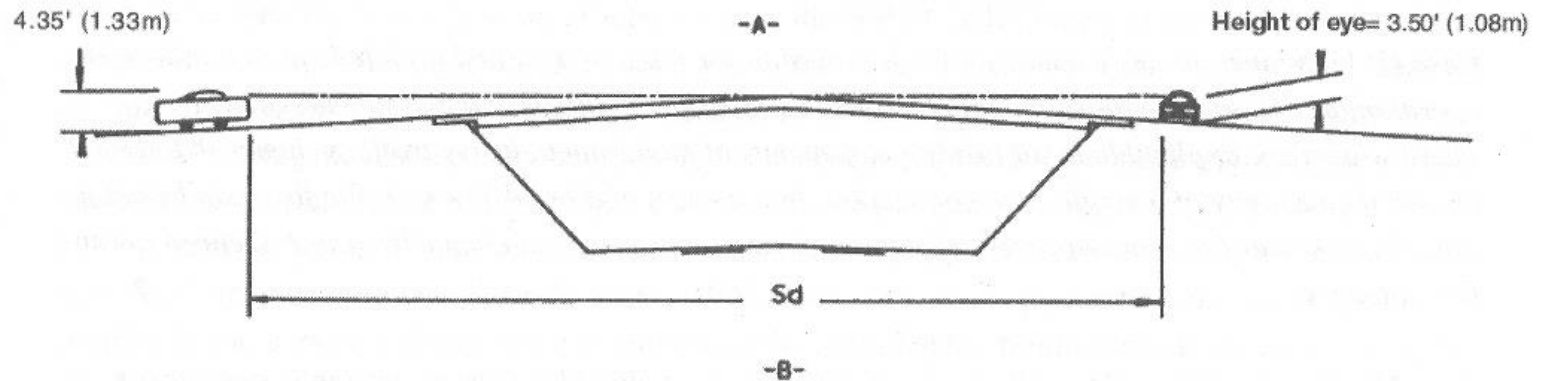


a = offset from driver's edge of through vehicle to edge of bridge railing.

y = offset from driver's eye to edge of bridge railing.

b = distance from driver's eye to edge of bridge railing.

$$S_d = \text{Sight Distance} = \frac{b(a+y)}{y}$$



Ramp Terminal

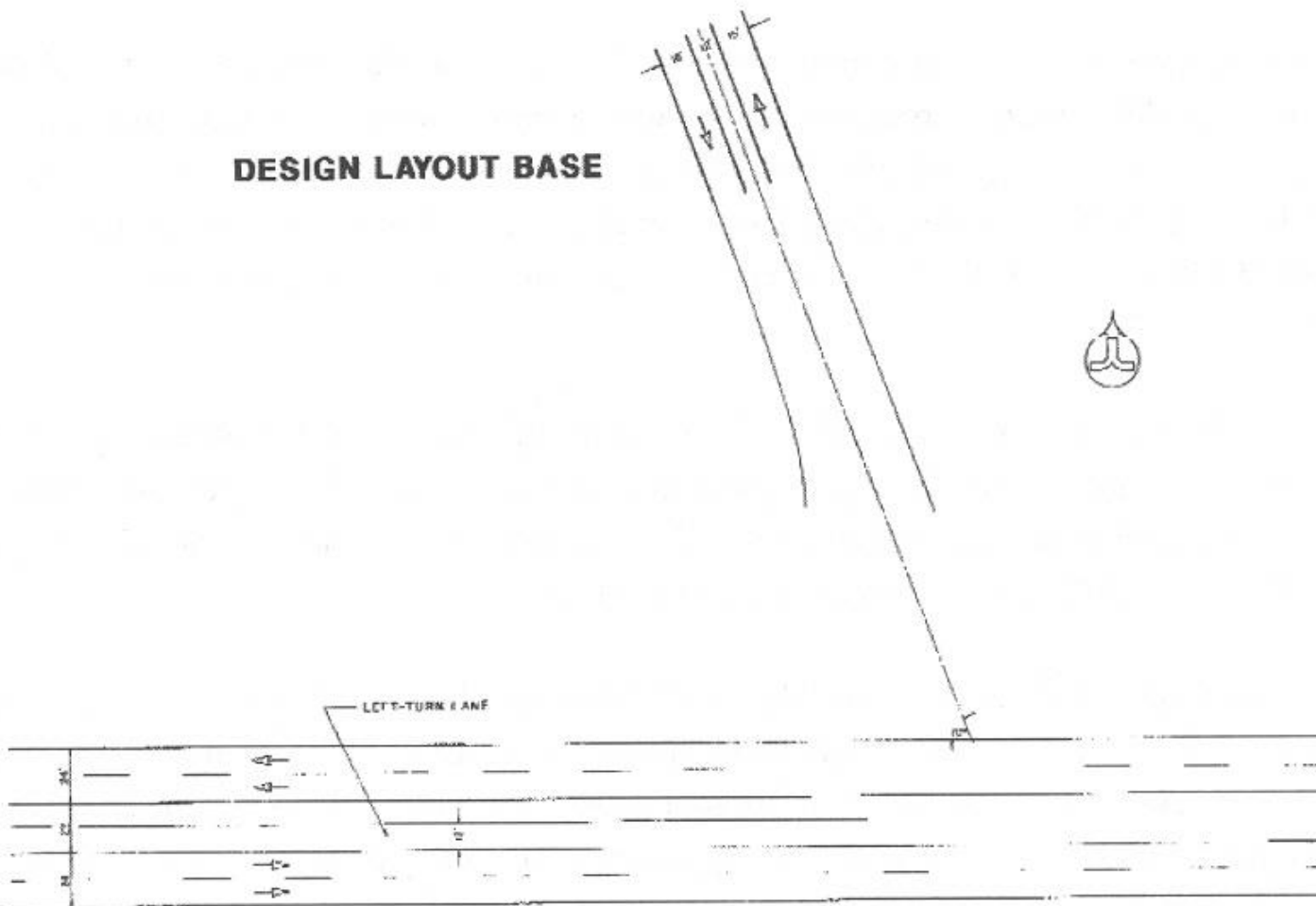


Figure 9–20. Base Map: Intersection Channelization Design.

Source: Joel P. Leisch.

Ramp Terminal

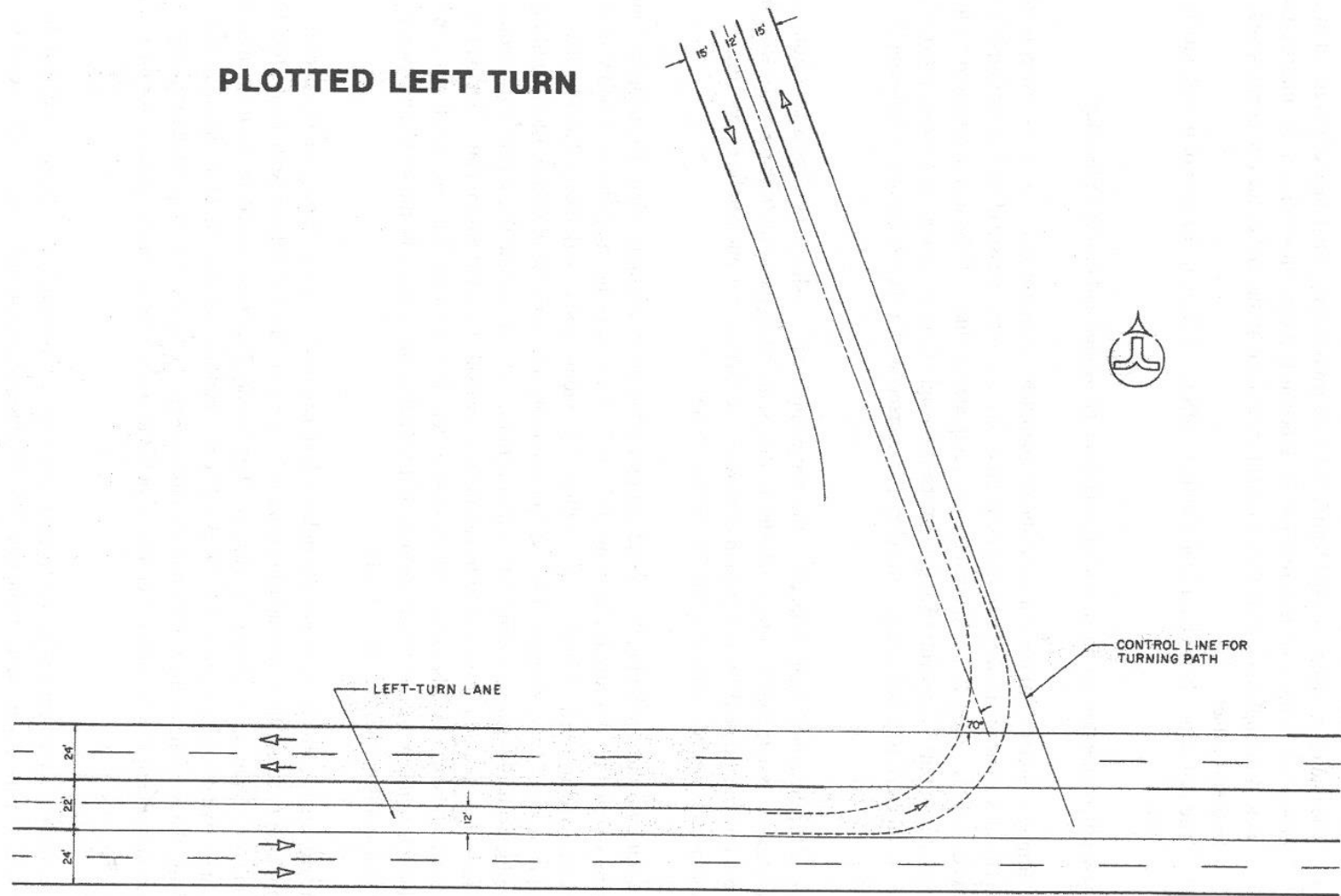


Figure 9-22. First Left Turn Plotted.

Source: Joel P. Leisch.

Ramp Terminal

DIVISIONAL ISLAND SKETCHED



Figure 9-23. Channelization Developed From First Left-Turn Plot.

Source: Joel P. Leisch.

Ramp Terminal

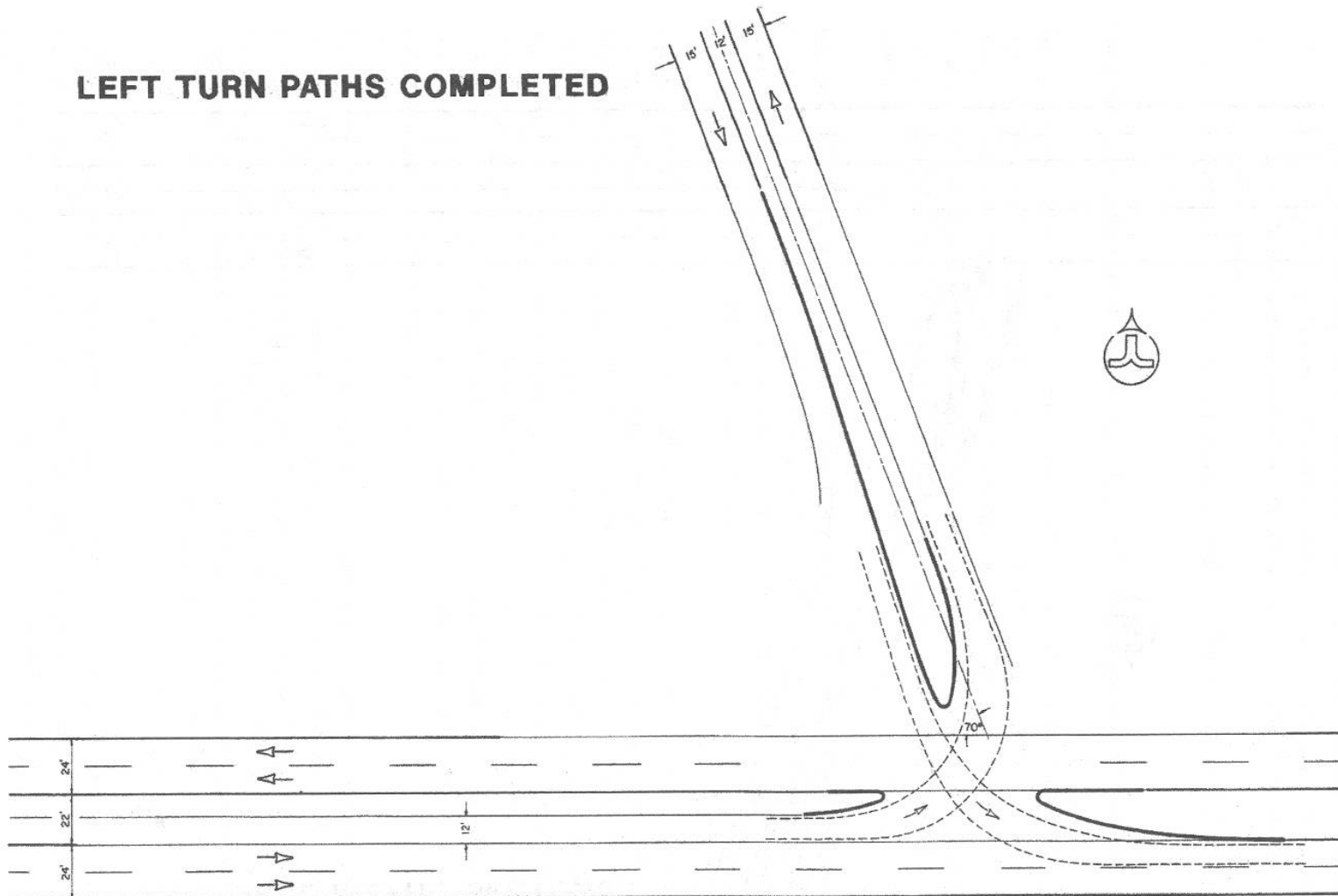


Figure 9-24. Second Left Turn Plotted (Median Design Completed).

Source: Joel P. Leisch.

Ramp Terminal

COMPLETED INTERSECTION LAYOUT

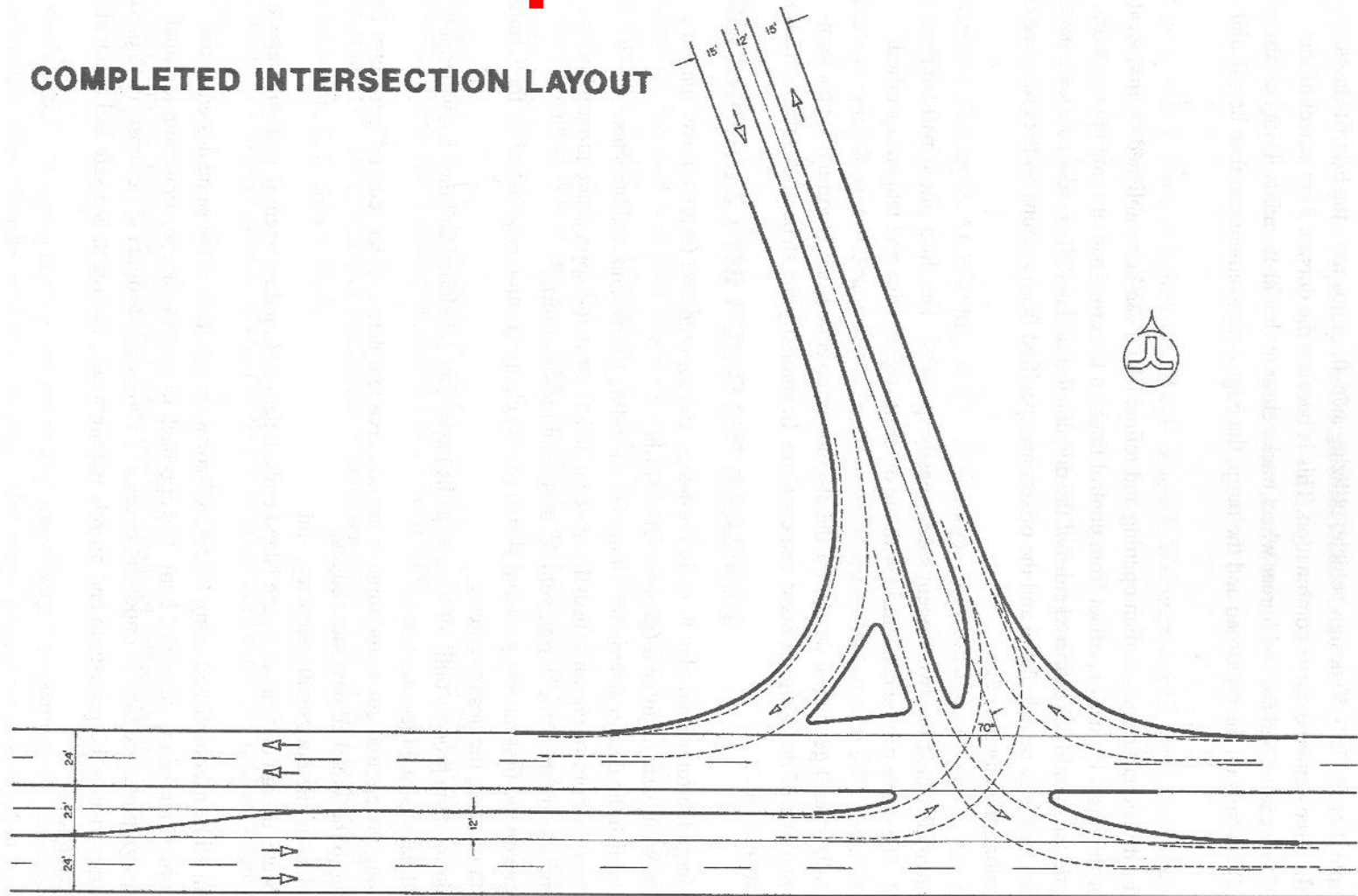


Figure 9-25. Right Turns Plotted; Channelization Design Completed.

Source: Joel P. Leisch.