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16. Abstract

This study addresses the issues involved with the development of a new interchange at Bicentennial Boulevard and U.S. 83 in McAllen, Texas. There is currently no adequate direct route from north McAllen to the Miller International Airport. Several alternatives designed to meet this need were developed and analyzed.

The recommended design alternative efficiently handles the critical movements which take place at the interchange and generates significant operational benefits for adjacent interchanges. This recommended design also minimized the requisition of additional right-of-way, therefore, maximizing the potential for expeditious implementation. Conservative cost analyses conducted for this alternative indicate a benefit-to-cost (B/C) ratio of approximately 4:1.

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Bicentennial Boulevard Interchange Analysis
McAllen, Texas

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Sponsored by the
Texas Department of Transportation

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IMPLEMENTATION STATEMENT

This research report documents the operational analysis and development of three alternative geometric designs for a new interchange at U.S. 83 and Bicentennial Boulevard in McAllen, Texas. There is currently no direct route to the Miller International Airport and La Plaza Mall from north McAllen, and the existing U.S. 83 interchanges which carry airport traffic are becoming increasingly congested. The results from this study can be used in the development of detailed design drawings for a new interchange at U.S. 83 and Bicentennial Boulevard.

DISCLAIMER

TABLE OF CONTENTS

Page

LIST OF FIGURES x

LIST OF TABLES xi

SUMMARY xiii

I. INTRODUCTION 1
  Background 1
  Traffic Generators and Patterns 3

II. BICENTENNIAL BOULEVARD INTERCHANGE 5
  Alternative Designs 5
  Alternative I 9
    Right-of-Way and Physical Obstructions 9
    Geometry 10
  Alternative II 12
    Right-of-Way and Physical Obstructions 12
    Geometry 14
  Alternative III 15
    Right-of-Way and Physical Obstructions 15
    Geometry 15
  Estimated Construction Cost 18
  Benefits 18
    Alternative I 19
    Alternative II 21
    Alternative III 21

III. CONCLUSIONS AND RECOMMENDATIONS 25

APPENDIX 27

LIST OF FIGURES

Page

Figure 1. Vicinity Map for U.S. 83 Between 23rd Street and 10th Street in McAllen, Texas **2**

Figure 2. Approximate Distance Between Interchanges and Ramps in Study Area--Existing Ramp Configuration **6**

Figure 3. Approximate Distance Between Interchanges and Ramps in Study Area--Proposed Ramp Configuration **7**

Figure 4. Bicentennial Bridge Alternative I **11**

Figure 5. Bicentennial Bridge Alternative II **13**

Figure 6. Bicentennial Bridge Alternative III **16**

Figure 7. Projected Volumes Diverted to Bicentennial Bridge Alternative I **20**

Figure 8. Projected Peak Hour Volumes for Bicentennial Bridge Alternative II . . **21**

Figure 9. Projected Volumes Diverted to Bicentennial Bridge Alternative III **23**

LIST OF TABLES

		Page
Table 1.	Peak-Hour Conditions at the 10th Street Interchange--Existing and Projected	4
Table 2.	Conditions at the 23rd Street Interchange--Existing and Projected	4
Table 3.	Impact of Bicentennial Interchange Designs on Right-of-Way and Adjacent Land Use	10
Table 4.	Estimated Cost of Bicentennial Bridge Extension	18
Table 5.	Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative I Design	19
Table 6.	Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative II Design	21
Table 7.	10-Year Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative III Design	24
Table A-1.	Alternative I Horizontal Curve Specifics	29
Table A-2.	Alternative II Horizontal Curve Specifics	30
Table A-3.	Alternative III Horizontal Curve Specifics	30

SUMMARY

This study addressed the issues involved with the development of a new interchange at Bicentennial Boulevard and U.S. 83 in McAllen, Texas. Currently, there is no direct route from north McAllen to the Miller International Airport or La Plaza Mall. Further, analyses conducted as a part of this study indicated that the interchanges adjacent to Bicentennial Boulevard currently operate with a moderate level of congestion (LOS C and D); however, projected volumes are expected to result in a significant amount of congestion (LOS F) by the year 2004.

The research team developed and analyzed three design alternatives for a Bicentennial interchange (Alternatives I, II, and III). A new bridge would provide direct access to the airport and would provide an additional route to La Plaza Mall, thus relieving congestion at adjacent interchanges. Each alternative differed by the ease with which users could perform certain turning movements. The research team compared the benefits and costs of the three designs and made recommendations regarding the most appropriate design alternative.

After careful consideration and analysis, a team, composed of individuals from the Texas Department of Transportation (TxDOT), City of McAllen and Texas Transportation Institute (TTI), recommended Alternative III for further analysis and detailed design. This recommendation was based on the following:

- Alternative III requires minimal additional right-of-way (R.O.W.) and avoids disruption of private residences. Expeditious implementation is, therefore, most likely for Alternative III.

- Estimated benefits based on traffic diverted from existing 10th and 23rd Street interchanges to the proposed Bicentennial Boulevard interchange far exceed (i.e., B/C=3.8) projected costs for Alternative III.

- The Alternative III cost estimate was the least of the three design alternatives.

- Alternative III directly handles one of the most critical movements at the interchange (westbound to southbound) and operates at an acceptable level-of-service, both now and in the future.

I. INTRODUCTION

BACKGROUND

In recent years, South Texas has experienced major growth, much of which has been concentrated along the United States-Mexico border. Over the past five to ten years, the city of McAllen, Texas has experienced over five percent annual traffic growth. With recent events such as the opening of a new international bridge, plans to expand U.S. 281 south to another new international bridge, and passage of the North America Free Trade Agreement (NAFTA), growth in McAllen is expected to continue at a rapid pace.

One specific area experiencing traffic congestion is along U.S. 83 between the interchanges at 10th Street and 23rd Street. The traffic in this area of McAllen is extremely congested due to major developments--including La Plaza Mall and Miller International Airport, which are located just south of U.S. 83. Both the mall and the airport are directly served by Main Street (the adjacent interchange west of the 10th Street interchange), and neither are directly accessible by other routes. With the increasing congestion in this area, interest has been placed on the development of a new interchange with U.S. 83 that would provide an alternate route to and from the mall and the airport, and thus, relieve congestion at the adjacent interchanges. One possible location for a new interchange is at Bicentennial Boulevard which is located between 23rd Street and Main Street (Figure 1). Bicentennial Boulevard is a north-south collector stretching south through McAllen and ending at the westbound U.S. 83 frontage road.

This report addresses the issues involved with the development of a new interchange at Bicentennial Boulevard and U.S. 83 in McAllen. A detailed discussion of three design alternatives and their respective benefits follow.

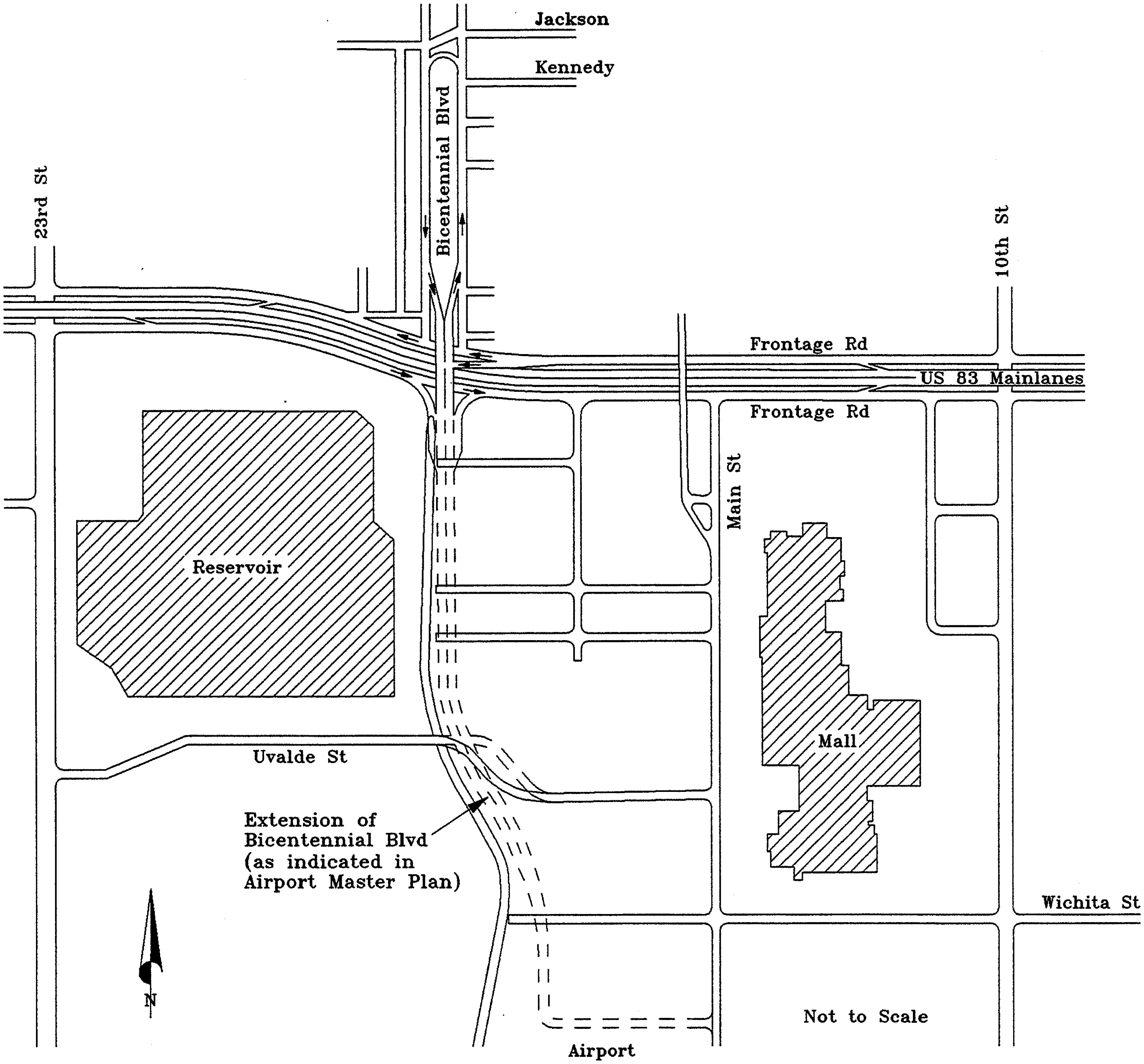


Figure 1. Vicinity Map for U.S. 83 Between 23rd Street and 10th Street in McAllen, Texas

TRAFFIC GENERATORS AND PATTERNS

U.S. 83 is a four-lane, limited-access facility running east-west through McAllen with seven grade-separated interchanges ranging from 500 meters to 1,600 meters (1,600 feet to 5,200 feet) in spacing through the city. Traffic congestion is the result of rapid growth in McAllen along the U.S. 83 frontage roads and cross-street interchanges. This section of the report addresses the traffic generators and traffic patterns that are present in one of McAllen's most congested areas.

Tenth Street is a north-south principal arterial which intersects the U.S. 83 frontage roads in McAllen (Figure 1). There is a large amount of development along 10th Street north and south of U.S. 83 including hotels, restaurants, strip shopping centers, and fast food establishments. Tenth Street also provides indirect access to the Miller International Airport. This development along and near 10th Street currently attracts approximately 4,400 vehicles in the peak hour (5-6 p.m.) through the 10th Street interchange. The 10th Street interchange provides for all traffic turning movements and is served by U.S. 83 exit and entrance ramps through a reverse diamond configuration. Although current operations at the 10th Street interchange are acceptable (i.e., delay is less than 60 seconds per vehicle, and therefore, not LOS F), the expected growth in the area and the lack of available right-of-way for expansion will cause operational problems in the future. Table 1 lists the current and expected delay level-of-service (LOS) at the 10th Street interchange assuming minor geometric improvements (e.g., additional turning bays) to the interchange but no other improvements to the existing transportation system.

Main Street is a north-south minor arterial which terminates at the U.S. 83 frontage roads on both the north and south sides of the freeway (Figure 1). A bridge, connected to Main Street just north and south of the frontage roads, provides access over U.S. 83. The Main Street interchange provides the primary access to La Plaza Mall and Miller International Airport and currently generates approximately 1,200 vehicles during the peak hour. Due to the constrained geometric configuration of the Main Street interchange, traffic growth in this area will eventually cause operational problems.

Twenty-third Street is a north-south principal arterial which intersects the U.S. 83 frontage roads at the west end of McAllen (Figure 1). The 23rd Street interchange with U.S. 83 has entrance and exit ramps in the "diamond" configuration (with the exception of the entrance ramp in the north-east quadrant). Although at this time there is sufficient capacity provided through the 23rd Street interchange, the adjacent development almost entirely prohibits the widening of this interchange. Further, with space for future commercial growth south of the freeway, it is expected that this interchange will operate poorly in the future. Table 2 lists the existing and expected delay LOS at the 23rd Street interchange assuming minor geometric improvements (e.g., additional turning bays) to the interchange but no other improvements to the existing transportation system.

Table 1. Peak-Hour Conditions at the 10th Street Interchange--Existing and Projected

Conditions	Total Interchange Delay (veh-hrs/hr)	Average Vehicle Delay (secs/veh)	LOS
Existing Volumes Optimized Signal Timing Existing Geometric Configuration	31	26	D
10-Year Projected Volumes Optimized Signal Timing Short-Term Geometric Improvements	299	144	F

Table 2. Conditions at the 23rd Street Interchange--Existing and Projected

Conditions	Total Interchange Delay (veh-hrs/hr)	Average Vehicle Delay (secs/veh)	LOS
Existing Volumes Optimized Signal Timing Existing Geometric Configuration	26	24	C
10-Year Projected Volumes Optimized Signal Timing Short-Term Geometric Improvements	153	82	F

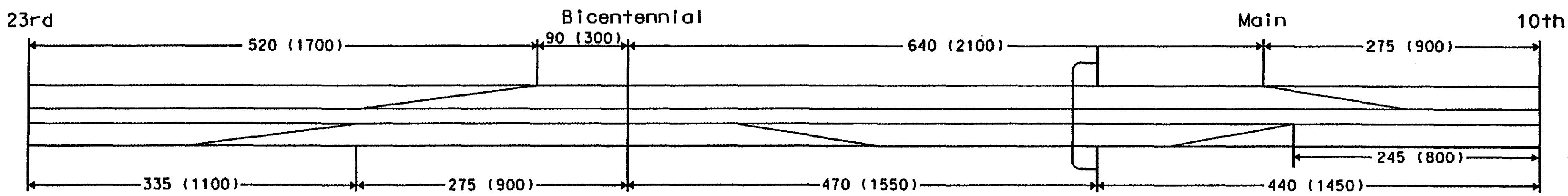
II. BICENTENNIAL BOULEVARD INTERCHANGE

The construction of a Bicentennial Boulevard interchange is expected to have a significant impact on traffic patterns in the area of McAllen described previously. During the peak hour, there are approximately 300 vehicles turning north onto Bicentennial Boulevard from the westbound U.S. 83 frontage road and 400 vehicles turning onto the westbound frontage road from southbound Bicentennial Boulevard. The extension of Bicentennial Boulevard south of U.S. 83, in addition to an overpass, would provide direct access to and from the airport from the north, east, and west and would provide an alternate route to the mall. Thus, the expansion would provide relief to the interchanges at 23rd, Main, and 10th Streets. The degree of relief resulting from a new interchange, however, is dependent on the geometric configuration of the interchange and, specifically, the ease of the interchange movements provided.

ALTERNATIVE DESIGNS

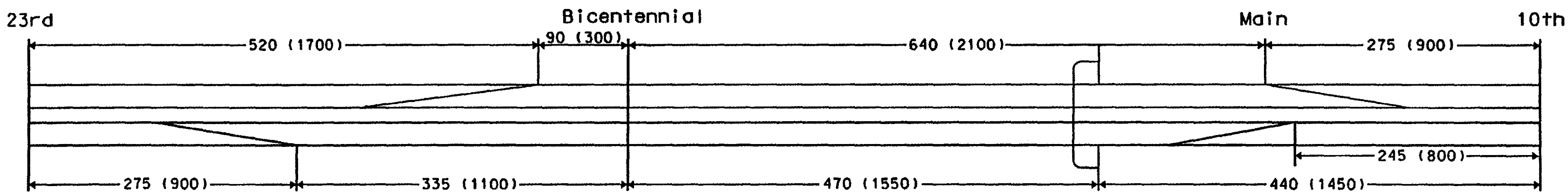
The first step to designing a new interchange with U.S. 83 at Bicentennial Boulevard is to examine the existing transportation system surrounding the proposed interchange. Distances between entrance/exit ramps and interchanges must be sufficient to provide for safe traffic operation, and future LOS for the facility must be acceptable.

Texas design standards state that there must be a minimum of 510 meters (1,670 feet) for a freeway weaving section; however, recent research suggests a minimum of 610 meters (2,000 feet). Further, the minimum distance between an exit ramp and an interchange should be no less than 60 meters (200 feet). This minimum value, however, is based on very low frontage road and exit ramp volumes. Figures 2 and 3 illustrate approximate distances (for existing and proposed conditions) between the 23rd and 10th Street interchanges and their respective ramps. Additional ramps providing access to and from an interchange with the U.S. 83 frontage roads at Bicentennial Boulevard would not provide safe distances for merging and weaving traffic.



Note: All distances are shown in meters (feet).

Figure 2. Approximate Distance Between Interchanges and Ramps in Study Area--Existing Ramp Configuration



Note: All distances are shown in meters (feet).

Figure 3. Approximate Distance Between Interchanges and Ramps in Study Area--Proposed Ramp Configuration

Researchers evaluated traffic volumes along the frontage roads at Bicentennial. There are currently over 2,900 vehicles per hour on the westbound frontage road and over 600 vehicles per hour on the eastbound frontage road. With proposed ramp changes (Figure 3), however, the expected eastbound frontage road volume will be approximately 1,800 vehicles per hour (the westbound traffic volume will not change). Assuming 5.5 percent annual growth over the next 10 years, these heavy volumes will lead to LOS F operations on the frontage roads. Due to these geometric and operational constraints, a Bicentennial Boulevard interchange, in which frontage roads are connected and signalized for every approach, should not be constructed. Therefore, researchers developed alternative designs which would provide grade separation between Bicentennial Boulevard and U.S. 83 but would require either no, or minimal, signalization.

The three alternatives developed involved an overpass connecting Bicentennial Boulevard (18th and 19th Streets) on the north side of U.S. 83 to South 18th Street on the south side of U.S. 83 and access to the bridge from the westbound frontage road. However, the alternatives (Alternatives I, II, and III) provide left turn movements in different ways, and therefore, entail varying right-of-way (R.O.W.) requirements.

For the three alternative designs, researchers assumed that the design speed on the U.S. 83 frontage roads was 100 kph (60 mph), and that the design speed on the existing Bicentennial Boulevard (18th or 19th Streets) was 80 kph (50 mph). The Bicentennial Bridge was designed for a 65 kph (40 mph) design speed in each alternative. AASHTO requirements determined design lengths of acceleration and deceleration lanes, as given in *A Policy on Geometric Design of Highways and Streets*. In addition, the design of the bridge, ramps, and merge lanes on the south side of U.S. 83 was identical for each alternative. Only the north side of the Bicentennial Boulevard interchange design changed from one alternative to another.

None of the alternative designs would allow eastbound frontage road traffic to directly access northbound Bicentennial Boulevard or for southbound Bicentennial Boulevard traffic to access the eastbound frontage road. The demand for these movements did not warrant their provision in the design of this facility. Further, the short distances between adjacent interchanges limited turning movements.

ALTERNATIVE I

Right-of-Way and Physical Obstructions

Of the three alternative designs, Alternative I requires the most additional R.O.W. acquisition. As shown in Table 3, Alternative I would require more than twice as much additional R.O.W. as the other alternatives. Consequently, a total of 68 private residences would be displaced by the construction. In addition, a pump house located in the median of Bicentennial Boulevard would require relocation.

The construction on the south side of U.S. 83 would also require the purchase of additional R.O.W. which, in turn, would displace seven homes along the U.S. 83 frontage road and restrict access to two businesses along the east side of existing South 18th Street. The two businesses, however, currently have access to the eastbound U.S. 83 frontage road. The total R.O.W. required and the number of affected businesses and private residences for each alternative design are shown in Table 3. In addition, an irrigation canal is located just west of existing South 18th Street, which would require modification.

Table 3. Impact of Bicentennial Interchange Designs on Right-of-Way and Adjacent Land Use

Alternative Number	Additional R.O.W.[1] sq. meters x 1,000 (sq. feet x 1,100)	Private Residence Relocations	Driveway Relocations
I	64 (690)	68	3
II	27 (290)	22	3
III	4 (40)	0	1

[1]The approximate additional right-of-way which would be required in association with respective designs.

Geometry

The Alternative I design is illustrated in Figure 4. Horizontal curve and design speed specifics are given in Table A-1 of Appendix. Exclusive lanes for almost every movement to and from Bicentennial Boulevard characterize this alternative design, thereby limiting interaction between vehicles making different movements. For example, westbound vehicles on the U.S. 83 frontage road could access northbound Bicentennial Boulevard via a connector ramp, with a deceleration lane beginning under the Main Street Overpass. The ramp would create its own lane on northbound Bicentennial approximately 200 meters (650 feet) prior to Jackson Avenue. Likewise, southbound Bicentennial Boulevard traffic from the westbound U.S. 83 frontage road would have an exclusive loop ramp with a deceleration lane beginning approximately 105 meters (350 feet) prior to the bridge. The loop ramp would have a 50 kph (30 mph) design speed.

The two lanes on the Bicentennial Bridge in the northbound direction would split just after crossing over the westbound frontage road. The left lane would proceed northbound and down at a five percent grade before aligning with the original Bicentennial Boulevard (18th Street). The right lane would proceed on a 40 kph (25 mph) horizontal curve and five percent downgrade before intersecting the westbound U.S. 83 frontage road at a 90 degree angle. The intersection would be stop-controlled for the ramp traffic only, thereby avoiding potential weaving problems on the frontage road.

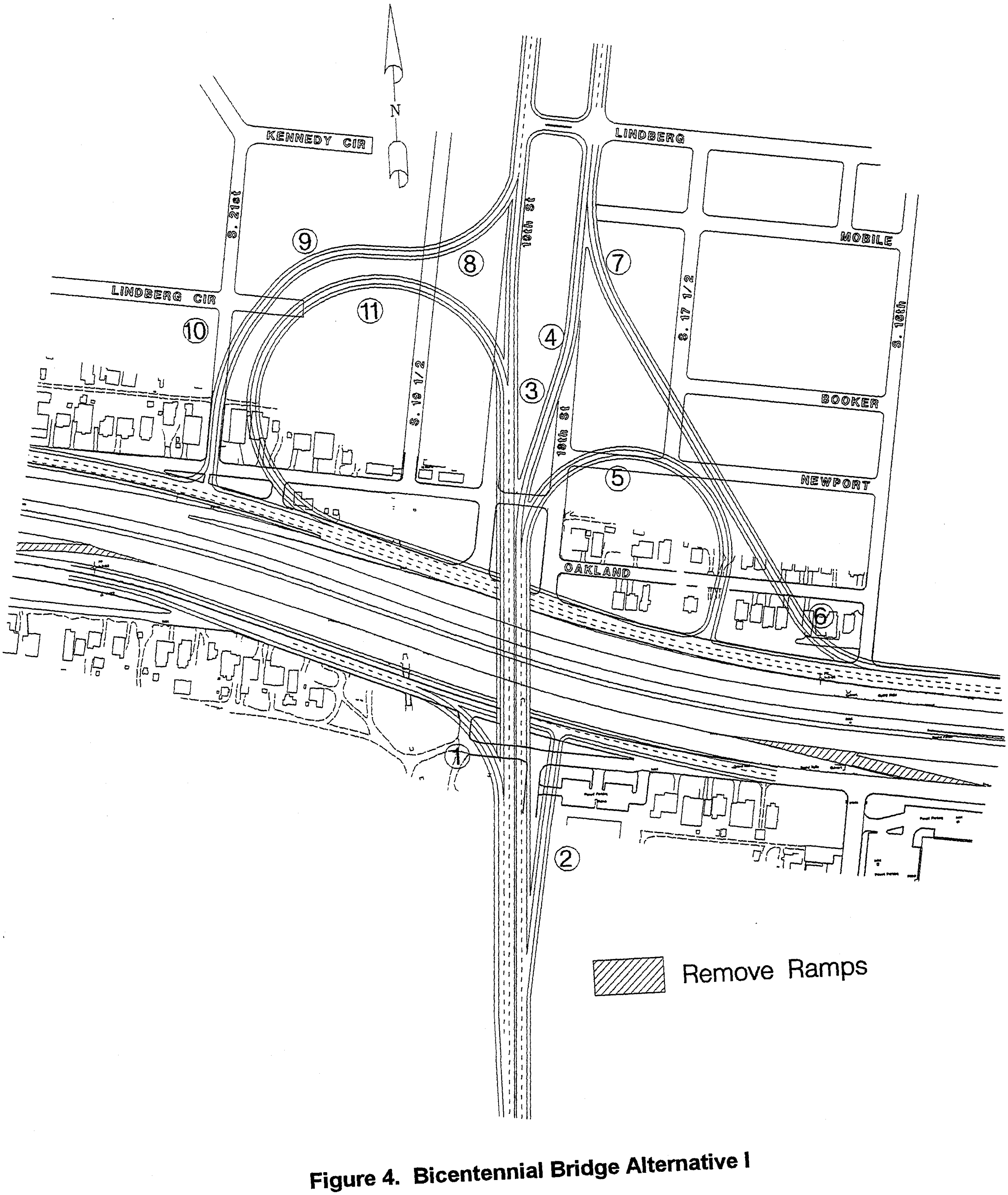


Figure 4. Bicentennial Bridge Alternative I

Southbound traffic on Bicentennial Boulevard originating from Jackson Avenue would travel on the existing Bicentennial Boulevard. Approximately 150 meters (500 feet) from Jackson Avenue, Bicentennial Boulevard would split. After the split, the left lane would continue for approximately 180 meters (590 feet) before joining with the loop ramp from the frontage road, while the right lane would continue to the right and terminate at the westbound frontage road approximately 75 meters (250 feet) prior to the freeway entrance ramp physical gore and 105 meters (350 feet) after the theoretical gore. This intersection would be stop-controlled on Bicentennial only. If implemented, raised pavement markers extending from the physical gore to the theoretical gore on the frontage road would be recommended (in association with this design alternative) to discourage vehicles traversing Bicentennial from crossing three lanes of frontage road in order to utilize the freeway entrance ramp.

The portion of Bicentennial Boulevard south of U.S. 83 is proposed as a four-lane facility with two lanes in each direction. This new facility would take the place of the existing South 18th Street. Eastbound frontage road vehicles could access the southbound Bicentennial Boulevard ramp approximately 180 meters (600 feet) past the proposed U.S. 83 exit ramp gore (Figure 3) and would have an additional 210 meters (680 feet) to complete the merge onto the ramp. An exit ramp would be located on the northbound side of Bicentennial Boulevard allowing access to the eastbound U.S. 83 frontage road. This portion of the design is the same regardless of which alternative is considered. Therefore, it is not discussed in subsequent *Geometry* sections of this report.

ALTERNATIVE II

Right-of-Way and Physical Obstructions

Figure 5 illustrates the Alternative II design, which is characterized by a smaller R.O.W. acquisition than Alternative I. This design would require an additional 35 meters

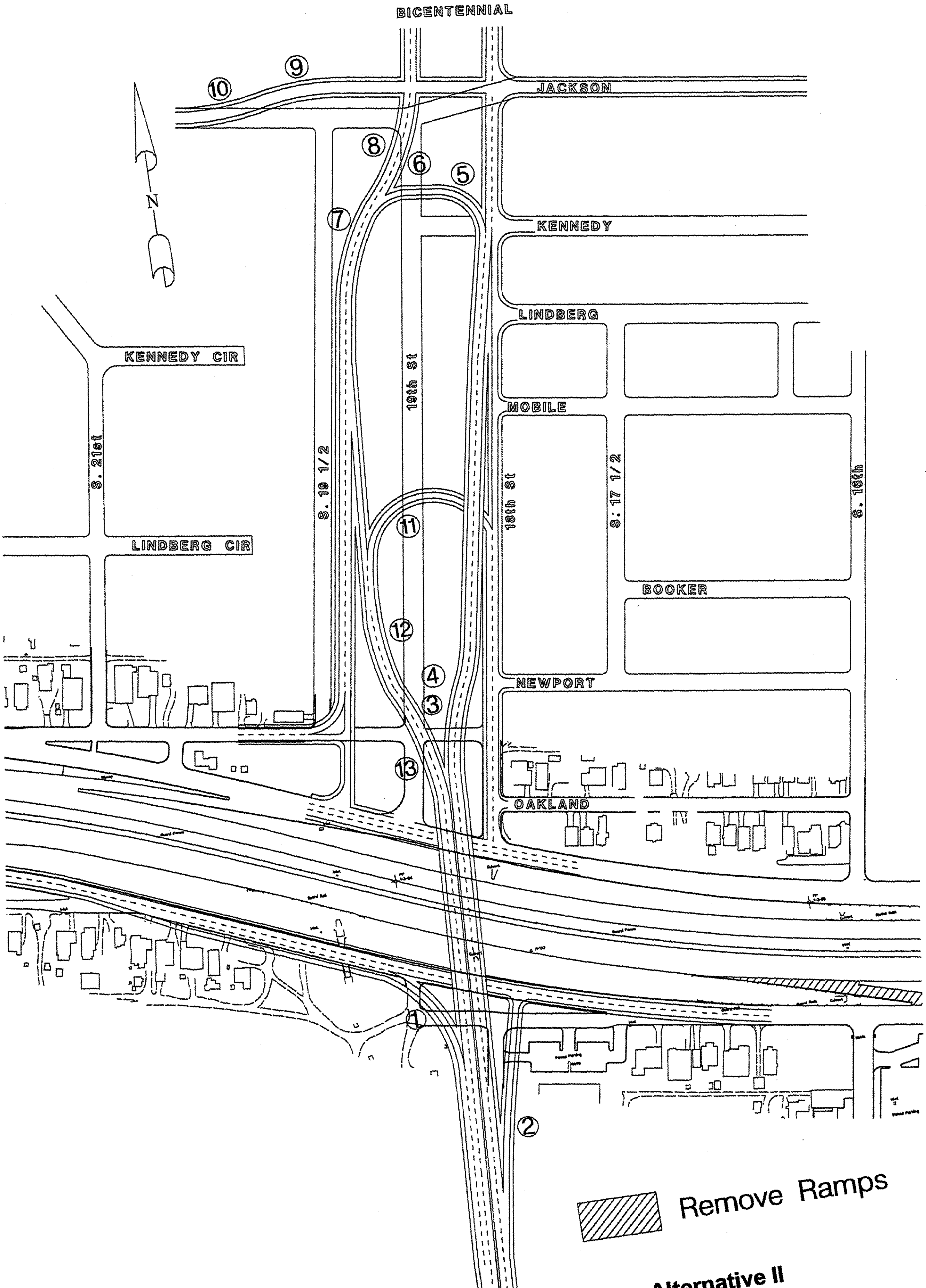


Figure 5. Bicentennial Bridge Alternative II

(110 feet) of R.O.W. between the U.S. 83 westbound frontage road and Jackson Avenue, and would displace approximately 15 homes. Alternative II would not, however, require relocation of the pump house located in the median of the existing Bicentennial Boulevard, because the bridge would be constructed over the pump house.

Geometry

Table A-2, p. 30, of the Appendix, shows the specific curve information and design speeds. The exclusive loop ramp located in the median of Bicentennial Boulevard providing access from the existing northbound left lane of Bicentennial to the southbound bridge characterizes this alternative. Approximately 155 meters (500 feet) north of this loop ramp, one lane of the northbound Bicentennial traffic would connect with the northbound Bicentennial Bridge connector ramp. The far left lane would be dropped at a U-turn lane to southbound Bicentennial Boulevard. Within this 75-meter (250-foot) section, raised pavement markers between the existing right lane and the middle lane (i.e., right lane of connector ramp) are recommended. The combination of the loop ramp design and raised pavement markings would eliminate merging and two sided weaving problems on the northbound section of Bicentennial Boulevard.

Southbound Bicentennial Boulevard (between Jackson Avenue and the westbound U.S. 83 frontage road) would be relocated approximately 35 meters (110 feet) to the west. A reverse curve was designed at Jackson Avenue to allow for alignment with existing Bicentennial Boulevard. After the reverse curve, the U-turn lane originating from northbound Bicentennial Boulevard merges with the southbound lanes. This merge would be yield controlled. An acceleration lane was not designed for the southbound U-turn, because the 175 meters (580 feet) between the U-turn lane and the bridge exit is insufficient (as required by AASHTO design policy). In addition, this 175-meter (580-foot) section could experience weaving between U-turning vehicles and southbound Bicentennial vehicles. The absence of an acceleration lane would minimize weaving problems (i.e., weaving would occur across two lanes instead of three).

ALTERNATIVE III

Right-of-Way and Physical Obstructions

The main objective of Alternative III was to limit construction to within the existing R.O.W. while at the same time, provide for the major movements at the interchange. Therefore, this design requires the least amount of additional R.O.W. to be purchased (Table 3). Likewise, no private residences would be disturbed. Like Alternative I, however, the pump house located on the north side of U.S. 83 in Bicentennial median would have to be relocated.

Geometry

Figure 6 illustrates the design of Alternative III. Table A-3, p. 30, in the Appendix shows specific curve information and design speeds. The addition of Bicentennial Bridge would be achieved by limiting the construction to within the median of existing Bicentennial Boulevard. Existing Bicentennial Boulevard would remain in its current location. However, one lane of the northbound direction would be eliminated at the U.S. 83 frontage road. A U-turn lane would be added in the vicinity of Kennedy Street, while the existing crossover at Kennedy Street would be eliminated. Unlike Alternative II, the U-turn lane would service both northbound bridge traffic requiring access to westbound U.S. 83 and northbound Bicentennial Boulevard traffic requiring access to the southbound bridge. As a result, the 174-meter (570-foot) section between the gore of the bridge and the U-turn would be susceptible to substantial weaving.

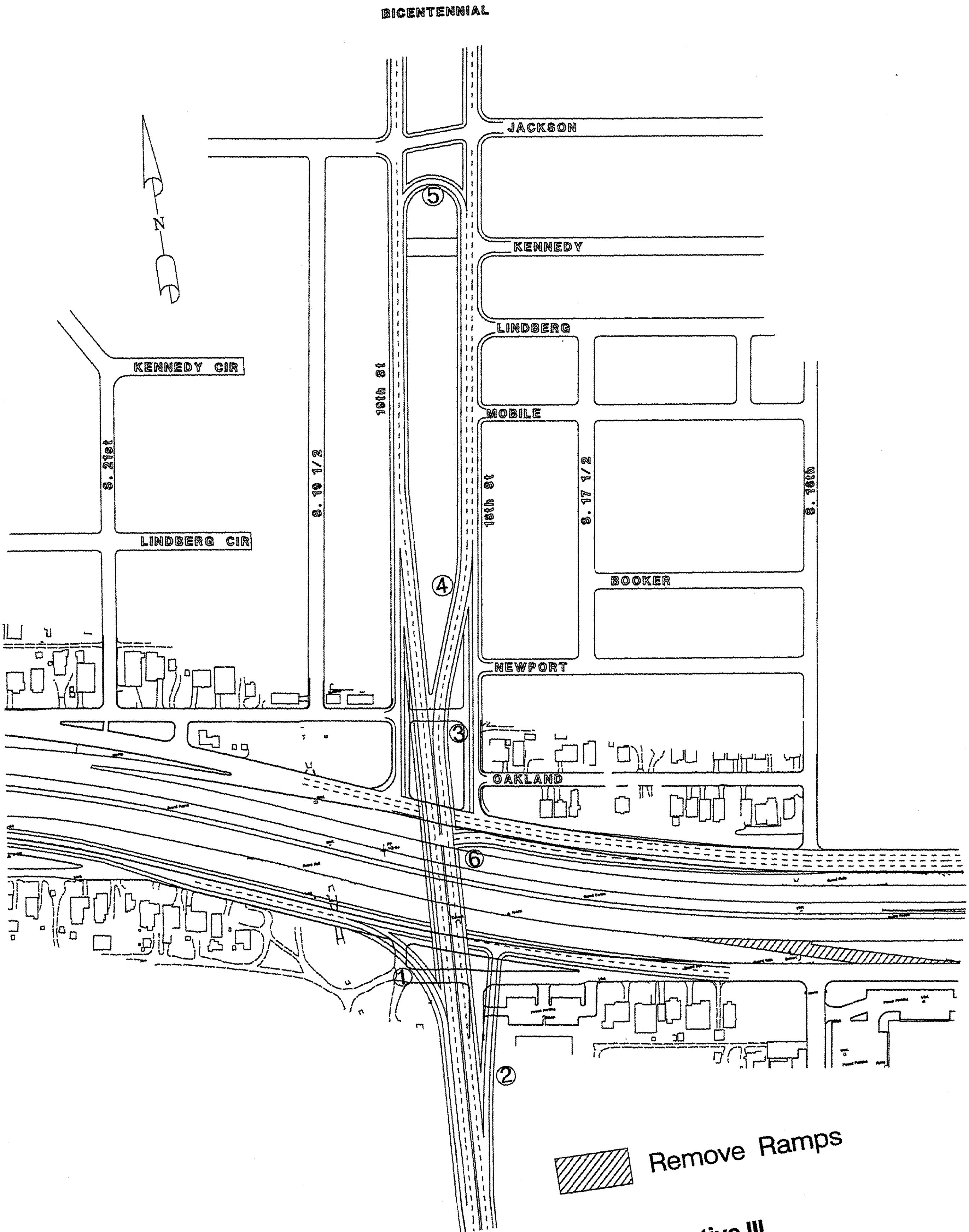


Figure 6. Bicentennial Bridge Alternative III

The left lane of the northbound bridge is tapered as it approaches existing northbound Bicentennial Boulevard. This lane was discontinued and dropped at the U-turn (as in the Alternative II design), because weaving would have occurred over three lanes rather than two. For the same reason, the U-turn lane was not extended on southbound Bicentennial Boulevard to the bridge exit. In addition, AASHTO design policy required a 215-meter (700-foot) acceleration lane. Because sufficient distance for the acceleration lane would be unavailable, the lane was not included in this design alternative.

Because vehicles from both Bicentennial Bridge and northbound Bicentennial Boulevard would share the U-turn lane provided in the vicinity of Kennedy Street, there is a potential for vehicle spill-over and queuing on the main lanes of Bicentennial Boulevard. To investigate the effects of this occurrence, researchers used NETSIM to simulate the geometry and projected present volumes. NETSIM is a microscopic simulation model used for simulation of arterial networks. Using projected present volumes (presented later in this report) the simulation indicated that the maximum queue length would be seven vehicles, all of which would fit in the U-turn lane provided. However, it is important to consider that these are projected present-day volumes. Ten-year, and certainly 20-year, volumes would cause queuing on the main lanes of northbound Bicentennial Boulevard.

The additional major difference between Alternative III and the other design alternatives is the provision of a direct connector ramp for westbound frontage road traffic desiring to travel southbound on Bicentennial Boulevard (e.g., to access Miller International Airport). A signal will control the intersection of this ramp with Bicentennial Boulevard and limited it to left turns only. Analysis of this interchange using TRANSYT-7F indicated acceptable LOS (i.e., LOS C) for both existing and future conditions.

ESTIMATED CONSTRUCTION COST

The cost of the Bicentennial Bridge extension and other related improvements is dependent on several items, including the construction cost, R.O.W. cost, cost of relocating the pump house and cost of modifying the irrigation canal. For the purpose of cost estimation in this report, the construction and R.O.W. costs were estimated to obtain a general project cost for each alternative. Construction costs were based on whether the facility is at-grade, elevated on fill dirt, or elevated on a structure. The costs per square meter of construction used for each of these facilities were $108, $215, and $376, respectively. Right-of-way costs were based on $108 per square meter ($10 per square foot) as suggested by TxDOT Pharr District officials. Table 4 shows the estimated construction cost and R.O.W. costs for each alternative. The cost of each alternative, based on construction only, does not vary significantly. The bulk of the construction cost for each alternative is the elevated section, with Alternative II requiring the most elevated construction. The R.O.W. costs primarily distinguish one alternative from another. Total costs range between $5.1 and $12.6 million.

Table 4. Estimated Cost of Bicentennial Bridge Extension

Alternative Number	Construction Cost (millions)	R.O.W. Cost (millions)	Total Cost (millions)
I	$5.7	$6.9	$12.6
II	$6.0	$2.9	$8.9
III	$4.8	$0.3	$5.1

BENEFITS

In order to determine the benefits each Bicentennial Boulevard Interchange design would have on 23rd, Main and 10th Streets, traffic operations at these interchanges (with a new interchange at Bicentennial) had to be analyzed. The percentage of traffic diverted from these adjacent interchanges to a new Bicentennial Boulevard interchange was conservatively assumed to be 15 percent. Cost benefits for all three alternatives in the tenth year (2004) were then calculated based on a value of time of $10.78 per person-hour, a vehicle occupancy of 1.25 persons per vehicle, 250 working days per year, and projected peak hour volumes.

Alternative I

Because the three alternative designs have different left turn treatments, researchers assumed that varying traffic volumes would be diverted from adjacent interchanges depending on the ease of these left-turn movements. Figure 7 shows the traffic volumes associated with the assumption that 15 percent of the allowable traffic movements would be diverted from 10th, 23rd and Main Streets. Because the left-turn movement from northbound to westbound is easier to make with the Alternative I design than either the Alternative II or Alternative III designs, researchers assumed that 25 percent of this movement would divert to the Bicentennial Boulevard Interchange. The delay benefits for the 10th and 23rd Street Interchanges are shown in Table 5.

Table 5. Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative I Design.

Location	Total Interchange Delay (veh-hrs/hr))		Benefit per Year Millions[1]	Present (1994) Value Benefit Millions[2]
	With No Bicentennial Blvd. Interchange	With a Bicentennial Blvd. Interchange		
10th St. Interchange	299	151	$0.499	$13.56
23rd St. Interchange	153	56	$0.326	$8.86
Total	452	207	$0.825	$22.42

[1]Cost benefit in the tenth year assuming a value of time of $10.78 per person-hour, a vehicle occupancy of 1.25 persons per vehicle, and 250 working days per year. Assumed to be the average benefit per year over the next 20 years.
[2]The present value of the per-year cost benefit over the next 20 years assuming a four percent discount rate.

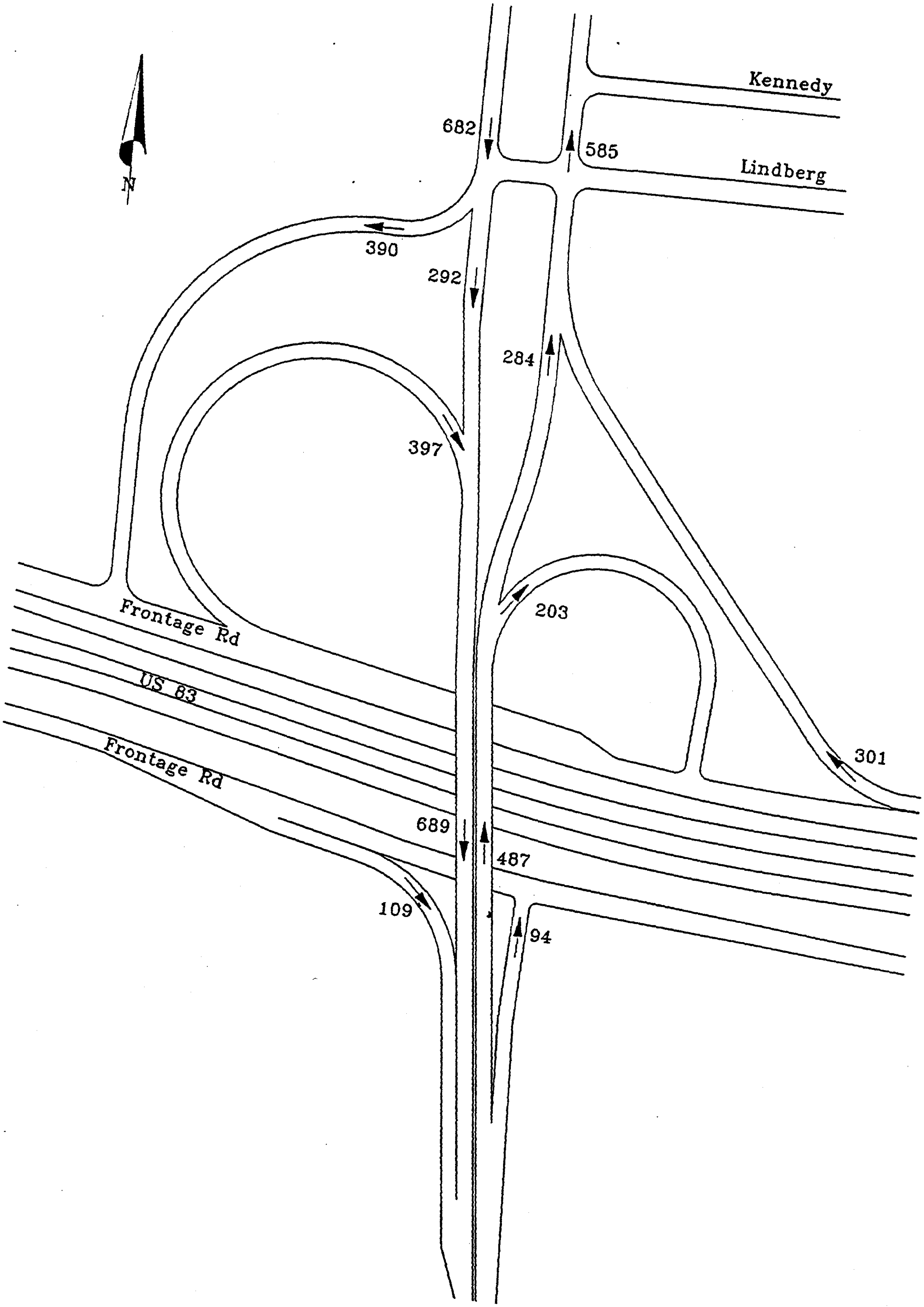


Figure 7. Projected Volumes Diverted to Bicentennial Bridge Alternative I

Alternative II

Figure 8 shows the traffic volumes at Bicentennial interchange associated with the assumption that 15 percent of the allowable traffic movements would be diverted from 10th, 23rd and Main Streets. Compared to Alternatives I and III, Alternative II would not provide an easy left-turn movement. Thus, for the Alternative II design, researchers assumed that 20 percent of the left turn movements from adjacent interchanges would be diverted to the Bicentennial Boulevard Interchange. These assumptions result in a reduction in delay benefit at the adjacent interchanges. Table 6 shows the delay benefits for the 10th and 23rd Street Interchanges.

Table 6. Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative II Design

Location	Total Interchange Delay (veh-hrs/hr))		Cost Benefit per Year Millions[1]	Present (1994) Value Benefit Millions[2]
	With No Bicentennial Blvd. Interchange	With a Bicentennial Blvd. Interchange		
10th St. Interchange	299	159	$0.471	$12.80
23rd St. Interchange	153	63	$0.303	$8.24
Total	452	222	$0.774	$21.04

[1]Cost benefit in the tenth year assuming a value of time of $10.78 per person-hour, a vehicle occupancy of 1.25 persons per vehicle, and 250 working days per year. Assumed to be the average benefit per year over the next 20 years.
[2]The present value of the per-year cost benefit over the next 20 years assuming a four percent discount rate.

Alternative III

The traffic volumes for Alternative III that are associated with the assumption that 15 percent of the allowable traffic movements would be diverted from 10th, 23rd and Main Streets are shown in Figure 9, p. 23. Because Alternative III provides an efficient left-

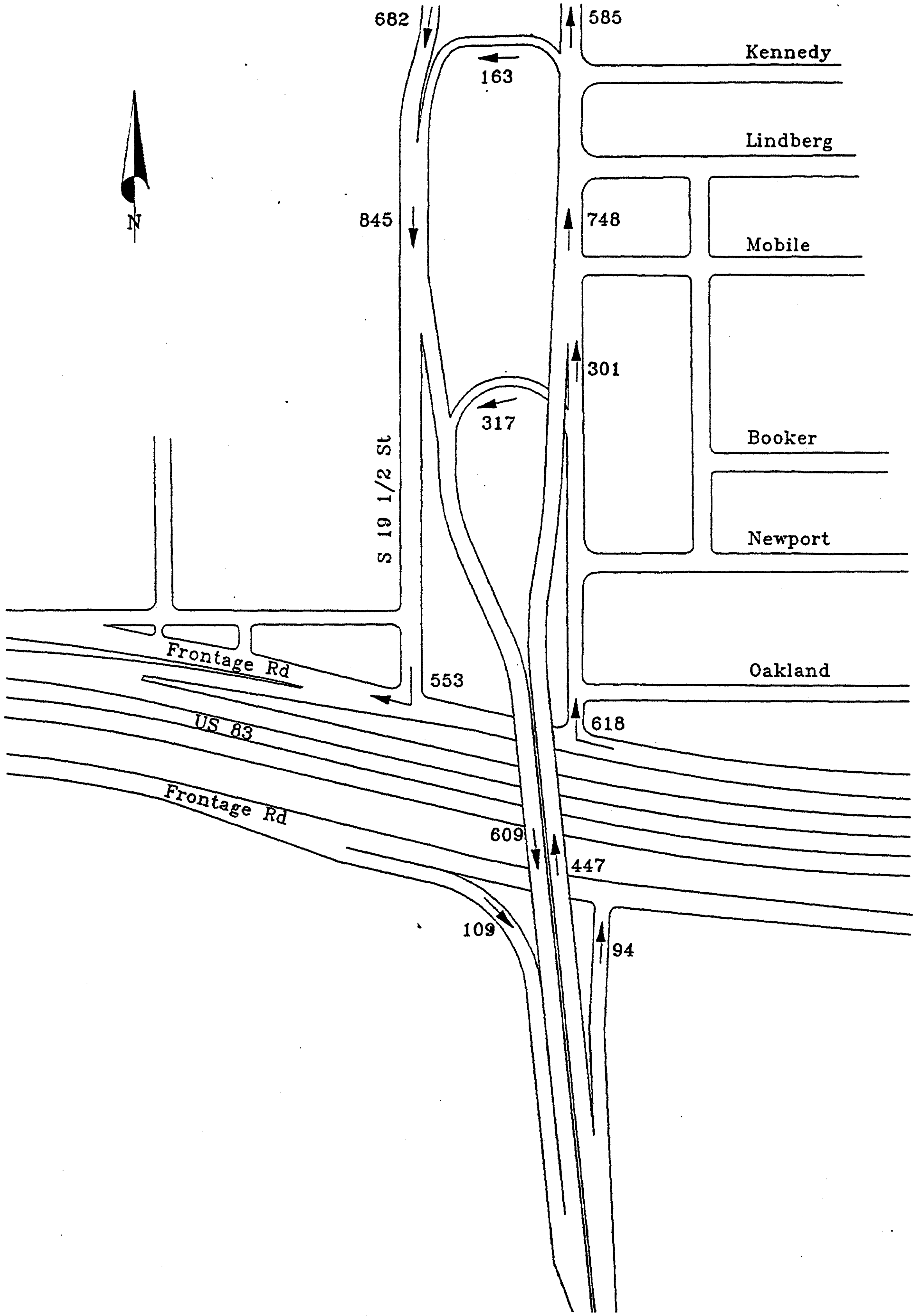


Figure 8. Projected Peak Hour Volumes for Bicentennial Bridge Alternative II

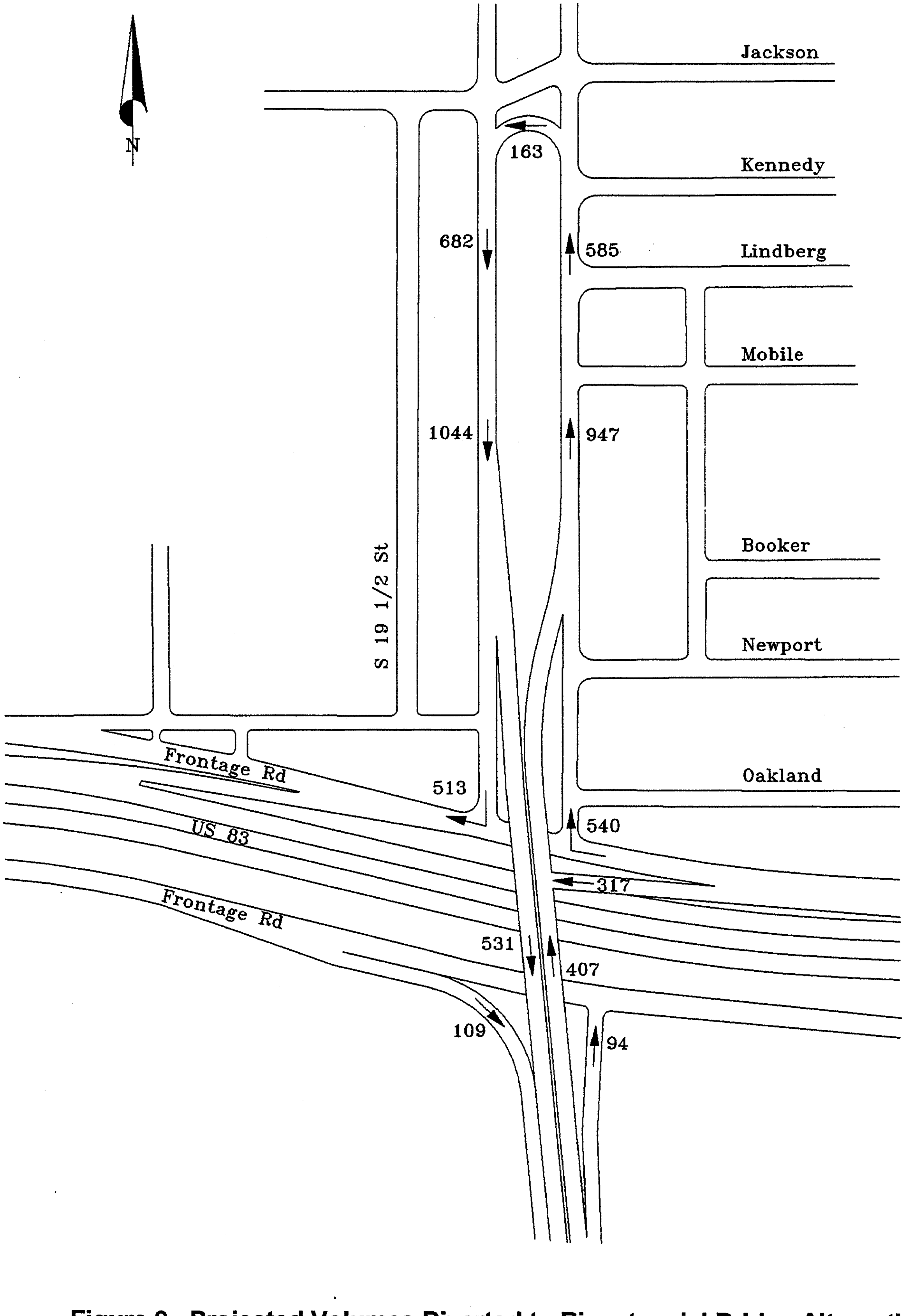


Figure 9. Projected Volumes Diverted to Bicentennial Bridge Alternative III

turn movement (for the westbound to southbound movement) it was assumed that 20 percent of this movement would divert from the adjacent interchanges. The placement of a signal within this interchange, however, adds slightly to the overall delay (relative to Alternatives I and II). Table 7 shows the delay benefits for the 10th and 23rd Street Interchanges.

Table 7. 10-Year Benefits at the 10th and 23rd Street Interchanges as a Result of a Bicentennial Boulevard Interchange--Alternative III Design

Location	Total Interchange Delay (veh-hrs/hr)		Cost Benefit per Year Millions[1]	Present (1994) Value Benefit Millions[2]
	With No Bicentennial Blvd. Interchange	With a Bicentennial Blvd. Interchange		
10th St. Interchange	299	167	$0.445	$12.08
23rd St. Interchange	153	72	$0.273	$7.42
Total	452	239	$0.718	$19.5

[1]Cost benefit in the tenth year assuming a value of time of $10.78 per person-hour, a vehicle occupancy of 1.25 persons per vehicle, and 250 working days per year. Assumed to be the average benefit per year over the next 20 years.
[2]The present value of the per-year cost benefit over the next 20 years assuming a four percent discount rate.

III. CONCLUSIONS AND RECOMMENDATIONS

Increasing congestion and development in the areas of the 10th and 23rd Street Interchanges in McAllen, Texas have spurred the investigation of an additional interchange to be constructed at Bicentennial Boulevard (18th and 19th Streets). The new interchange would provide direct access to Miller International Airport and would provide an additional route to La Plaza Mall (significant traffic generators in the area). Three design alternatives were considered for the proposed interchange at Bicentennial Boulevard. Each alternative differed by cost and the ease with which users could perform certain movements, with cost and movement simplicity decreasing with increasing alternative number. A brief description of each alternative follows.

- Alternative I: This alternative would supply the least complicated turn movements and provides a separated lane or facility for each major movement (based on traffic volumes) required at the interchange (Figure 4). Consequently, the alternative also requires the most additional R.O.W. to be purchased and disrupts approximately 68 private residences. This alternative is projected to provide the greatest relief to 10th and 23rd Streets, specifically a $22.4 million benefit over the next 20 years. The estimated cost of Alternative I is $12.6 million.

- Alternative II: This alternative requires minimal additional R.O.W. purchase, while still separating many of the major movements (Figure 5), thereby reducing potential operational problems. This alternative requires the second-most additional R.O.W. to be purchased, displacing approximately 22 private residences. Estimated benefits over the next 20 years based on the diversion of vehicles from the 10th and 23rd Street Interchanges exceed $21.0 million, while the projected construction and R.O.W. costs are $8.9 million.

- Alternative III: The final alternative limits construction of the new facility to within the existing R.O.W. on the north side of U.S. 83, while requiring only minimal additional R.O.W. to the south of U.S. 83. This alternative, however, combines several of the major movements so that vehicles with different destinations must share lanes, thereby increasing vehicle interaction (Figure 6). In addition, this alternative provides a direct connector for left turns associated with westbound vehicles wishing to travel southbound at the interchange. The benefits over the next 20 years are estimated to be $19.5 million, while construction and R.O.W. costs are estimated at $5.1 million.

With continuous input from TxDOT and McAllen officials, researchers revised and developed the three alternatives into their present form. After careful consideration and analysis, a team of TxDOT, City of McAllen, Airport and TTI officials recommend Alternative III for further analysis and detailed design. Although this alternative will not provide direct connectors for every possible movement at the interchange, it is recommended for several other reasons, including the following:

- Alternative III requires minimal additional R.O.W. and avoids disruption of private residences. Expeditious implementation is, therefore, most likely for Alternative III.

- Estimated benefits based on traffic diverted from existing 10th and 23rd Street interchanges to the proposed Bicentennial Boulevard interchange far exceed (i.e., B/C=3.8) projected costs for Alternative III.

- The Alternative III cost estimate was the least of the three design alternatives, thereby increasing the probability of construction funds successfully being acquired.

- Alternative III directly handles one of the most critical movements at the interchange (westbound to southbound) and accomplishes an acceptable level-of-service, both new and in the future.

APPENDIX

Table A-1. Alternative I Horizontal Curve Specifics

Curve Number[1]	Radius meters (ft)	Design Speed, kph (mph)	Superelevation
1	80 (260)	50 (30)	0.08
2	175 (575)	65 (40)	0.04
3	175 (575)	65 (40)	0.04
4	175 (575)	65 (40)	0.04
5	70 (225)	40 (25)	0.06
6	145 (475)	65 (40)	0.06
7	145 (475)	65 (40)	0.06
8	75 (240)	50 (30)	0.10
9	75 (240)	50 (30)	0.10
10	145(275)	65 (40)	0.06
11	85 (275)	50 (30)	0.06

[1] See Figure 4 for location of curve numbers.

Table A-2. Alternative II Horizontal Curve Specifics

Curve Number[1]	Radius meters (ft)	Design Speed, kph (mph)	Superelevation
1	80 (260)	50 (30)	0.08
2	175 (575)	65 (40)	0.04
3	175 (575)	65 (40)	0.04
4	175 (575)	65 (40)	0.04
5	25 (75)	25 (15)	0.04
6	25 (75)	25 (15)	0.04
7	145 (475)	65 (40)	0.08
8	145 (475)	65 (40)	0.08
9	145 (475)	65 (40)	0.08
10	145 (475)	65 (40)	0.08
11	35 (120)	30 (20)	0.06
12	175 (575)	65 (40)	0.04
13	175 (575)	65 (40)	0.04

[1] See Figure 5 for location of curve numbers.

Table A-3. Alternative III Horizontal Curve Specifics

Curve Number[1]	Radius meters (ft)	Design Speed, kph (mph)	Superelevation
1	80 (260)	50 (30)	0.08
2	175 (575)	65 (40)	0.04
3	175 (575)	65 (40)	0.04
4	175 (575)	65 (40)	0.04
5	20 (70)	25 (15)	0.04

[1] See Figure 6 for location of curve numbers.