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Evaluation of the Effects of Ramp Location on Land Use and Development

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16. Abstract

A body of research indicates that investments in transportation infrastructure are often related to land use and development. Still, there is much to learn about the land use--freeway ramp relationship. Case studies were conducted on several ramp locations in Texas to assess the effect of different land uses and examine the traffic generated on the adjoining frontage roads and intersections. This research considered the development impacts that occur at ramp locations under a variety of conditions including diverse frontage road designs. The findings are structured to equip planners and engineers with information they need to improve the planning, design and location of future ramps. It will also provide a basis for improved communication between community, urban and transportation planners and engineers.

The study indicates that often there is an incompatibility between the commercial development and the interchange design, particularly the ramp and frontage road. The ramp design and locations of driveways providing access to developments require careful consideration beyond the current driveway access guidelines (in Texas) to preserve desired operational speeds and safety standards. The findings will be instrumental in reducing future modifications due to traffic impacts resulting from new development.

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Abstract

Many studies have been conducted indicating that investments in transportation infrastructure are often crucial to the economic health of a particular region. One thing seems certain from the available research: when a new freeway ramp is constructed, new development or higher land use development often occurs. Officials now recognize the need to understand and manage economic growth near freeway ramps. This research analyzed the development impacts that occur at 14 ramp locations in Texas under a variety of conditions including diverse frontage road design, various land use policies, and growth rates of communities. The study had two important findings: 1) ramps contribute to land development around interchanges, and 2) land development contributes to traffic problems around the interchanges. The study recommends strategies to improve communication among city officials and engineers leading to better traffic flow and circulation

Implementation Statement

The findings of this research can be used by TxDOT to improve its communication and coordination with communities and local governments when planning for ramp redesign or new construction. The study indicates that often there is an incompatibility between the commercial development and the interchange design, particularly the ramp and frontage road. The ramp design and locations of driveways providing access to developments requires careful consideration beyond the current driveway access guidelines to preserve desired operational speeds and safety standards. The findings will be instrumental in reducing future modifications due to traffic impacts resulting from new development.

Disclaimer

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George Adams, City of Austin, Planner

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Lubbock District:
Kerry Miller, TxDOT

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Kirk Barnes, TxDOT
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Odessa District:
Gary Law, TxDOT
Douglas Eichorst, TxDOT
Carolyn Yarborough, TxDOT
Kenneth Neal, Pecos City, City Manager
Becky Hamm, City of Midland
Jim Compton, City of Midland

Corpus Christi District:
Eddie Eubanks, TxDOT
Norma Garcia, City of Gregory
Fernando Gomez, City of Gregory, Mayor
Joe Martinez, son of *Mac's Barbecue* owner

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Summary

Many studies have been conducted indicating that investments in transportation infrastructure are often crucial to the economic health of a particular region. One thing seems certain from the available research: when a new freeway ramp is constructed, new development or higher land use development often occurs. Changes in development affect traffic volumes and flow and sometimes impact safety. Officials now recognize the need to understand and manage economic growth near freeway ramps. The challenge facing planners and transportation professionals is how to assess and manage the traffic impact that results from changing development in the area of freeway ramps. Several states have enacted comprehensive access management guidelines and policies to assist state DOTs and local jurisdictions in coordinating with developers to reduce congestion, improve interior lot circulation, and strategically locate and design driveways along state controlled frontage roads.

This research analyzed the development impacts that occur at 14 ramp locations in Texas, under a variety of conditions including diverse frontage road designs, various land use policies, and growth rates of communities. The study had two important findings: 1) ramps contribute to land development around interchanges, and 2) land development contributes to traffic problems around the interchanges. The recommendations are structured to equip TxDOT planners and engineers with information needed to improve planning, design and location decisions for ramp relocation or new ramp construction. A more proactive role is suggested for developers to design their properties with attention to increased interior traffic flow, so that circulation will occur on the property instead of on the frontage road.

The recommendations are advanced in order to prolong the viable utility of TxDOT facilities, to reduce consumer complaints regarding congestion, and to improve safety. In addition, the goals of improved mobility will be addressed. Greater financial responsibility will be placed on developers to thoughtfully design their driveway locations and throughways to provide access to interior parcels. As a result of this research, TxDOT and local

communities will be better able to guide land development in the vicinity of ramps so as to improve the safe and efficient operation of transportation facilities.

Several specific recommendations and implementation strategies are detailed in the report. They are summarized as follows:

Recommendations:

1. Strictly enforce existing policies.
2. If diamond interchange is constructed, locate the on-ramp as far from the intersection as practicable.
3. Consider purchase of driveway access as another mechanism to control the number of driveways from the frontage road.
4. Increase proactive liaisons between local officials and TxDOT.
5. Require developers of large parcels with multiple driveways to use signage to direct customers to exits that will cause the fewest conflicts on the frontage road.
6. Increase the utilization of signs on the highways that inform drivers of services and businesses that are located at the upcoming exit.
7. If existing driveway locations no longer meet minimum criteria, prohibit dangerous turns into property using barriers, striping or signage.
8. Over the long term, institute truck stop zones to concentrate trucking activities in desired locations and away from other through and local traffic.
9. Explore designs that allow for pedestrian and non-motorized transportation, particularly for key urban locations.

Implementation Strategies:

- Develop a brochure that will help improve the level and frequency of communication with city and local planners.
- Develop a training session for TxDOT design engineers that raises awareness of the kinds of problems identified in this report and presents strategies for addressing them.
- Revise formal procedures and planning and design guidelines.

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Chapter 1: Introduction

Study Problem Statement

The question of which land uses are most appropriate next to freeways is a growing area of interest for community planners and transportation professionals around the nation. Of particular focus has been the effect of different land uses and the traffic generated on the adjoining frontage roads and intersections. It is well documented that there is a positive relationship between land use and transportation infrastructure. Research designed to document the impacts of freeway ramps and their influences on land uses is not new, but there is still much to learn about the land use-freeway ramp relationship.

Studies indicate that investments in transportation infrastructure are often crucial to the economic health of a particular region. However, given the largely completed interstate highway system, it is anticipated that the construction of new freeways will not occur with the same frequency as in past years. Now many investments in transportation infrastructure will consist of modifying existing facilities. In many instances, freeway modifications, expansions, and ramp reversals have encouraged similar land use responses as new construction.

One thing seems certain from the available research: when a new freeway ramp is constructed, new development, or higher land use development often occurs. When a change in land use occurs after the implementation of a new or modified freeway ramp, the transportation professional can anticipate increased traffic on the freeway, the ramps, and any frontage roads that may exist in the area. Officials now recognize the need to understand and manage economic growth near freeway ramps. The problem facing planners and transportation professionals becomes how to assess and coordinate the traffic impact of changing land uses in the area of freeway ramps. Several states have enacted comprehensive access management guidelines and policies to assist state DOTs and local jurisdictions in coordinating with developers to reduce congestion, improve interior lot circulation, and the location and design of driveways along state controlled frontage roads.

There is an immediate need for TxDOT to determine the future impacts of land uses near ramps. Officials indicate that many of the future highway projects will consist of modifying existing ramp and freeway designs. Freeway ramps require modification for various reasons. Many of them are no longer functional, some areas have issues of safety, and others are a hindrance to future economic development. Although many studies may document the impacts of freeway ramps and land use in other parts of the country, a study specifically examining this relationship in Texas is desirable. Texas' use of frontage roads encourages unique patterns of land use and traffic that deserve special consideration. Therefore, the ability to develop strategic methodologies to guide Texas' transportation officials when planning future ramps and ramp modifications will ultimately save money in the future, delay increases in congestion, and encourage economic growth.

Study Objectives

The objective of this research is to analyze the development impacts that occur at ramp locations under a variety of conditions including diverse frontage road designs, various land use policies and growth rates of communities. The findings are structured to equip TxDOT planners and engineers with information needed to improve planning, design and location decisions for ramp relocation or new ramp construction. Communication with city and community planners can be improved with the help of the examples, guidelines, and recommendations provided. As a result of this research, TxDOT can provide local communities with information that will assist them in guiding land development in the vicinity of ramps so as to improve the safe and efficient operation of transportation facilities.

General Methodology and Data Sources

This project followed the case study approach and required the identification of ramp locations throughout the state as the initial step in the process. As part of this initial step, a survey was developed and distributed to each TxDOT district soliciting responses from the district engineer as to which ramp location s/he believed deserved in-depth analysis. Eighteen TxDOT districts recommended a total of 66 ramp sites throughout the state by the January 31, 1998 deadline (Figure 1-1a and Appendix A-5). The list was reduced to 14 based on variables such as age of the ramp, location in relation to the nearest metropolitan city, and the type of adjacent land uses. This list included elevated and depressed sections from San Antonio and Austin to determine if land use response was influenced by freeway gradation. The locations selected for study and their basic characteristics are shown in Table 1-1 and Figure 1-1b.

Table 1.1 Ramp Locations Identified for Study

Ramp Location	*Highway/Intersection*	*Section Location*	*Adjacent Land Use*
Austin	U.S. 183/ S.H. 360	Suburban	Commercial
Beaumont	I.H.-10/Walden Road	Suburban	Commercial
College Station	S.H. 6/Rock Prairie	Small Urban	Commercial
Gregory	S.H .35/Volpe	Small Town	Commercial
Dallas	I.H. 30/Proposed Crockrell Hill	Urban	Undeveloped/Proposed Commercial
El Paso	I.H.10/Hawkins	Urban	Commercial/Industrial
Houston	U.S. 59/Beechnut	Urban	Commercial
Lubbock	Loop 360/Slide	Suburban	Commercial
Marshall	I.H. 20/U.S. 59	Rural	Commercial
Midland	I.H. 20/S.H. 349	Small Urban	Commercial
Pecos	I.H. 20/U.S. 285	Rural	Commercial
San Antonio	U.S. 281/F.M.1604	Suburban	Commercial
Sugarland	U.S. 59/Sam Houston Tollway	Suburban	Commercial
Texarkana	I.H. 30/Richmond/Summerhill	Urban	Commercial

Figure 1-1a. Submitted Ramp Locations

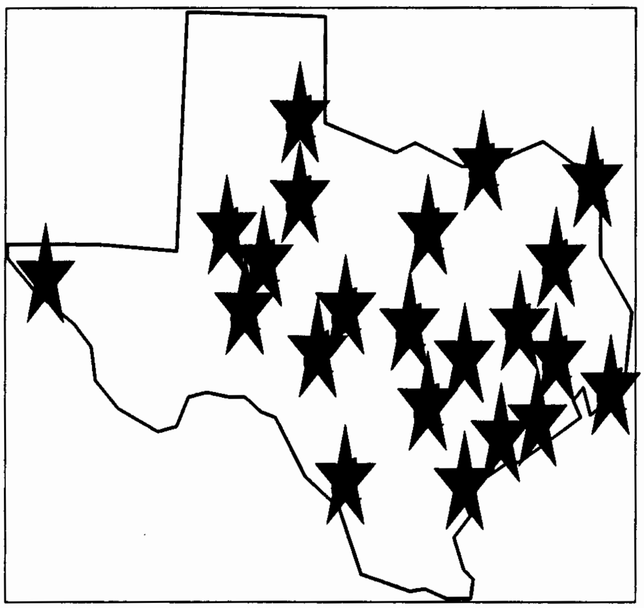
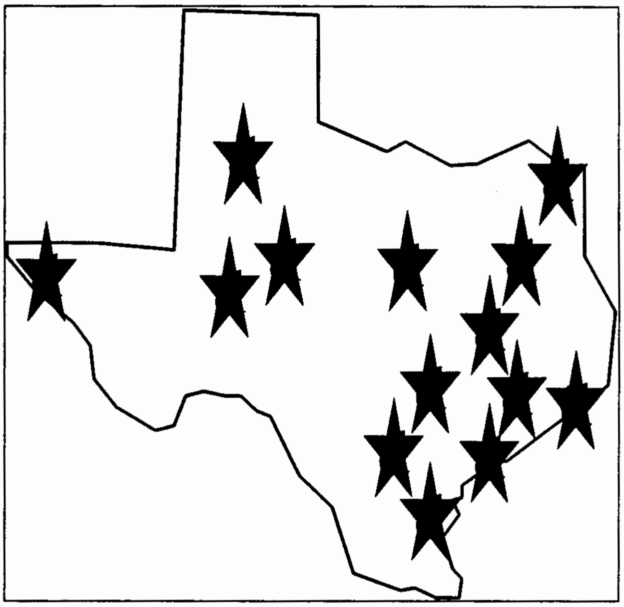


Figure 1-1b. Selected Ramp Locations



Note: A complete list of the submitted and selected ramps can be found on page A-5.

The study team chose the case study approach as the method for compiling the data. This method allows researchers to gain insight and interpret observations from the locations identified, even though each ramp may exhibit characteristics unique to its location. Furthermore, the case study method facilitates findings of a descriptive, qualitative, and quantitative nature.[1] The tasks used to collect data for this study included visiting each ramp location, making a visual observation of the types of traffic conditions, collecting relevant traffic data, and conducting interviews of local city and TxDOT officials. The basic instruments for gathering field data were the data collection checklist, the field observation checklist, and interview questions (See Appendixes A-3, A-6 and A-8).

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[1] Yin, Robert K., *Case Study Research: Design & Methods,* Publisher (Beverly Hills, Calif: Sage Publications, 1984).

Chapter 2. Background and Literature Review

The study of land use at freeway ramp locations, particularly as it affects traffic and trip generation activities is important to transportation professionals. Although few studies have focused specifically on the question of the impact of ramps on land use, many studies have touched on broader questions related to this topic. One such body of literature explores the degree to which freeways contribute to economic development and provides some evidence on land use impacts around freeway interchanges. Another body of literature assesses the state of the practice for access management and provides some guidance on techniques for controlling land use so as to preserve the efficiency of transportation facilities.

The Impact of Freeways on Development

Freeways potentially impact development at several different scales. First, freeways may contribute to an increase in overall development in a region by facilitating the movement of goods and people. Second, freeways may channel the growth in a region into particular corridors (whether or not they increase overall development) by increasing the accessibility of the areas served by the freeway relative to other parts of the region. Third, freeways may influence the kind of development that occurs, in terms of both the types of businesses and the design of business sites; freeways attract business oriented toward the passing traffic and designed for automobile access. A number of studies over the years have shed light on the degree to which these impacts occur and in what situations.

Several researchers have examined the broad question of whether investments in the highway system contribute to the overall development or economic growth of a region. Despite the commonly held assumption that such investments are necessary for economic growth, most researchers have found that new facilities, such as freeways, have a minor impact on the economy of a region, at least relative to other more important factors. These studies have used a variety of indicators of economic activity, including employment, income, and property values. Two studies are widely cited on this point. A 1987 study showed that highway expenditures in central counties in a metropolitan region resulted in employment increases above the normal trend of the economy, but these increases were counterbalanced by employment losses in adjacent counties.[2] A 1980 study of beltways around metropolitan areas found "no increase in economic well-being stemming from beltway construction," not even a measurable short-term boost to the economy from highway construction expenditures.[3] More recently, Boarnet suggests that the link between highway investments and economic growth are more tenuous than they used to be, since new facilities or expansions to existing facilities represent a marginal increase in overall capacity in a region.[4] Transportation investments may be a necessary condition for economic growth, but they are not a sufficient condition.

However, this research shows that transportation investments do have a significant impact on where in a region growth occurs. The Payne-Maxie et. al. 1980 beltway study compared 27 metropolitan areas with beltways to 27 metropolitan areas without beltways. The study showed that, depending on facility design and local land use policies, beltways tend to channel growth into the beltway corridor. In addition, more closely spaced interchanges and the presence of frontage roads increased the amount of development attracted to the beltway corridor. More recently, a study of freeway expansions between 1970 and 1988 in metropolitan areas of California found significant increases in residential, commercial, and industrial development in the corridor following freeway expansion. The impact of the expansion was significant even after controlling for other factors that might have contributed to increased development, such as economic conditions or policy influences. These results suggest that "expanding highway capacity results in increased traffic-generating activities along the adjacent corridor".[5]

As has been well documented over the years and as is readily observable today, highways tend to attract certain kinds of land uses. The attractiveness of major automobile arterials and highways as a location for economic activity, especially retail and service businesses, was documented as early as the 1930s and again in the 1950s. Proudfoot's 1937 study documented the presence of large, widely-spaced stores along the principal arterials linking outlying areas to the central city, a form of development entirely new to cities and a direct response to the growing

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[2] Yorgos J. Stephanedes and David Eagle, "Highway Impacts on Regional Employment," *Journal of Advanced Transportation* 21 (Spring 1987): 69-79.

[3] Payne-Maxie Consultant and Blayney-Dyett, Associates, *The Land Use and Urban Development Impacts of Beltways* (1980).

[4] Marlon G. Boarnet, "New Highways and Economic Growth: Rethinking the Link," *Access*, no. 7 (Fall 1995): 11-15.

[5] Mark Hansen, David Gillen, and Mohnish Puvathingal, *Freeway Expansion and Land Development: An Empirical Analysis of Transportation Corridors* (Berkeley, CA: Institute for Transportation Studies, UC Berkeley, 1998).

use of the automobile.[6] Garrison's 1950 study analyzed the kinds of businesses found along highways and identified several common groups of businesses, including clusters of gas stations, restaurants, and auto repair shops.[7]

More recent studies echo these findings. For example, a 1987 study of development around interstate interchanges in nonmetropolitan areas of Kentucky found that the share of businesses serving the surrounding population, as opposed to through traffic was significant.[8] This study defined interchanges with a large concentration and a broad mixture of businesses as "Interstate Villages" because they function as the central place for the surrounding region or as tourism-driven service centers. The development in these areas was largely unregulated, however. A 1992 study of 22 interchanges along I-40 in rural areas of North Carolina concluded that the greatest growth potential is at interchanges near large urban areas and at interchanges with high-volume roads along the corridor that have sewer and water service and are near a regional town.[9] This study points to the important role that utility provisions can play in enabling or limiting growth.

Several of these researchers have stressed the importance of land use regulations to ensure that the development along freeways and at interchanges does not overwhelm the capacity of the facilities and does not conflict with local land use goals. Hansen found that, in general, a 10% increase in freeway capacity in metropolitan areas is immediately followed by a 2% increase in traffic which builds to a 9% increase in traffic within four years; he concludes, "adding lane-miles does induce substantial new traffic."[10] The beltway study found that the new facility can lead to increases in traffic elsewhere in the system, "Without coordinated land use and transportation planning, a beltway can increase traffic on intersecting local streets and radial highways in the corridors they serve because of their effects on development patterns and the accessibility they offer."[11]

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[6] Malcom Proudfoot. *Intra City Business Census Statistics for Philadelphia, PA* (Washington, DC: U.S. Bureau of Foreign and Domestic Commerce, 1937).
[7] W.L. Garrison, et al. *Studies of Highway Development and Geographic Change* (Seattle: University of Washington Press, 1959).
[8] Henry E. Moon, Jr. "Interstate Highway Interchanges as Instigators of Nonmetropolitan Development," *Transportation Research Record*, no. 1125 (1987): 8-14.
[9] D.T. Hartgen, J.E. O'Callaghan, W.A. Walcott, and J. Opgenorth, "Growth at Rural Interchanges: What, Where, Why," *Transportation Research Record*, no. 1359 (1992): 141-150.
[10] Mark Hansen, "Do New Highways Generate Traffic?" *Access*, no. 7 (Fall 1995): 16-22.
[11] Payne-Maxie Consultant and Blayney-Dyett, Associates, *Beltway Impacts*.

Researchers also suggest that changes in local land use patterns triggered by a new freeway may be of concern. Development drawn to freeways and interchanges may mean a decline in business activity elsewhere, especially in traditional downtown commercial districts. The beltway study argues that, "land use planners should coordinate with transportation planners to avoid creating opportunities for development which would conflict with local or regional policies or harm older business districts."[12] The most significant policy implication of the findings on beltway impacts on development is that a coherent and effective land use policy is required to control beltway-induced development in growth areas and to enforce conformance with local land use plans and objectives."[13] In particular, planners must anticipate the development that will occur around interchanges. Payne-Maxie, et al., argue, "Highly accessible interchange areas offer attractive opportunities for commercial and industrial development; transportation planners should recognize this effect and plan accordingly."[14] There are many examples of an interactive pattern of traffic and development effects: a freeway ramp is constructed, new development or a higher use development occurs. Thereafter, the subsequent increase in traffic is higher than anticipated, resulting in unanticipated traffic maneuvers and vehicular conflict. An earlier researcher noted that by fostering economic development, highway improvements may vary well bring about their own obsolescence.

Access Management

The field of access management explicitly addresses the importance of planning and regulating development for preserving the efficiency of transportation facilities. More specifically, access management is "a comprehensive approach for improving traffic operations by managing the location, design, and operation of driveways, median openings, and street connections to a roadway."[15] The level of access control for a particular facility depends on the position of that facility in the overall transportation hierarchy. Freeway frontage roads, which serve both mobility and access purposes, are prime candidates for innovative access management techniques. The benefits of access management are numerous, from reducing access-related

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[12] Payne-Maxie Consultant and Blayney-Dyett, Associates, *Beltway Impacts*.
[13] Payne-Maxie Consultant and Blayney-Dyett, Associates, *Beltway Impacts*.
[14] Payne-Maxie Consultant and Blayney-Dyett, Associates, *Beltway Impacts*.
[15] Kristine M. Williams and J. Richard Forester, "Land Development Regulations that Promote Access Management," *Synthesis of Highway Practice* 233 (Washington, DC: National Cooperative Research Program, Transportation Research Board, 1996).

accidents to preserving efficiency and protecting level of service.[16] By helping to maintain traffic speeds and thus capacity, access management can stabilize public expenditures and put off the need for expensive capacity expansion projects. Access management may have important aesthetic benefits, by reducing the number of curb cuts and increasing the area available for landscaping. The objectives of access management often converge with those of local efforts to manage growth and reduce suburban sprawl. Strip development and inadequate connectivity among land uses, common yet undesirable characteristics of suburban development, also negatively affect traffic operations.

Several kinds of techniques contribute to effective access management programs.[17] One set of techniques relates to the location and design of driveways, including minimum driveway spacing, corner clearance standards, geometric design standards such as driveway throat length, and encouragement of or requirements for joint access. Subdivision regulations, which guide the division and subdivision of land into lots, blocks, and public ways, can also be used as an access management technique. In the subdivision review process, planners and engineers can review the location of access points and internal circulation patterns for the proposed development. Zoning, which controls the width, depth, and size of lots and sets standards for parking, among other things, may also be used as an access management tool. Corridor overlay zones, for example, have been used to add special access management requirements along high-priority corridors.

Access management studies also stress the need for coordination between transportation and land use planning, particularly at the local level where land use decisions are made. The lack of coordination is largely blamed for the poor state of access management in most communities: "competing objectives and inadequate coordination of transportation and land development practices continue to impede access management."[18]

Several states are recognizing the importance of taking a more proactive position in working with local governments in an effort to better coordinate transportation and planned land uses. Among those that have enacted or are considering comprehensive access management policies are Colorado, Florida, New Jersey, and Oregon. One of the strongest policies is New

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[16] Williams and Forester, *Land Development Regulations*.
[17] Williams and Forester, *Land Development Regulations*.
[18] Williams and Forester, *Land Development Regulations*.

Jersey's "State Highway Access Management Code". This code calls for "owners of large, proposed traffic generators [to] pay their fair share of the cost of highway improvements that are needed to accommodate the added traffic from their developments."[19] This requirement results in a complex multi-step process including a traffic impact study which theoretically determines how much traffic the roadway can accommodate. If roadway conditions are projected to deteriorate based on a proposed development, the costs needed to mitigate the deterioration are calculated. The traffic analysis is recalculated after the costs to mitigate are incorporated to determine whether the projected future traffic conditions are acceptable.

A critical component of New Jersey's process is the "fair share cost determination". Fair share indicates that the assessment is based on the traffic generated by the specific development at the specific location. New Jersey's calculation is designed to reflect findings from a previous Supreme Court case ruling on the legality of assessments charged to private owners for public projects (Dolan vs. City of Tigard, 1994). The Supreme Court stressed the necessity of computing an "individualized determination" that is specific to the parcel and development receiving the assessment. The Court also emphasized the importance of determining the correct portion of the assessment relative to the "nature" and "extent" of the impact.[20]

Conclusions

The experiences from freeway and ramp construction around the nation confirm that there is a relationship between development and highway access. This relationship may result in travel volumes that exceed original design parameters. A few states and communities have chosen to proactively work with developers to share responsibility for increased traffic or to alter where and how vehicle maneuvers occur (e.g., on the property rather than on a frontage road). The objective of these activities is to better serve the public by improving traffic flow and increasing safety.

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[19] Arthur Eisendorfer and Sandra Goslin, "Equitable Traffic Impact Assessments," paper presented at the 1999 Annual Meeting of the Transportation Research Board (Paper No. P99-3766).
[20] Eisendorfer and Goslin: 15.

CHAPTER 3: Review of TxDOT Policies

TxDOT's policies on interchange design and access management provide important context for the case studies presented in Chapter 4. These policies guide the configuration of interchanges, including ramps and frontage roads, and influence the number and location of access points to the frontage roads from adjacent properties. The case studies show that these policies function as guidelines, leaving room for TxDOT districts to respond to unique local conditions when designing interchanges and managing access.

TxDOT Interchange Design Policies

The design of interchanges, including the type and location of ramps, is guided by two documents: the AASHTO "Greenbook" and TxDOT's "Highway Design Division Operations and Procedures Manual." However, these manuals do not dictate specific designs for specific situations. Instead, the TxDOT design engineer uses these manuals for guidance in determining the most appropriate design for each situation.[21] As a result, interchange design depends partly on the approach of individual engineers and may vary somewhat from district to district.

In general, TxDOT's goal is to provide the highest degree of mobility on the through facility and only secondarily on the ramps. Providing access to development and structuring land use is a distant third, according to some.[22] However, others put more emphasis on the role of ramps in encouraging development.[23] Either way, the design must balance the goal of mobility with the goal of access - and provide sufficient levels of both at a reasonable cost. This philosophy is apparent in many of TxDOT's standard design approaches. One example is the use of two-way frontage roads with buttonhook ramps for low-volume, rural interchanges, a relatively inexpensive design that provides ample mobility and access but can but can be upgraded as traffic volumes increase.[24] Another example is the shift from diamond interchanges to X interchanges: a diamond interchange provides little local access, but gets a motorist directly

[21] Interview with, Elizabeth Hilton, Field Coordination Engineer, TxDOT, May 1999.
[22] Interview with, Clay Smith, San Antonio District, TxDOT, June 1998.
[23] Interview with, Glenn McVey, Austin District, TxDOT, June 1998.
[24] Interview with, Gary Law, Odessa District, TxDOT, September 1998.

to the cross street, while an X interchange gives a longer frontage road with the maximum amount of access without sacrificing through mobility.[25]

Interchange design is also guided by the procedures of the Highway Capacity Manual, which are used to evaluate the capacity needs for the interchange and the effectiveness of proposed interchange designs. This exercise is called a "project design specific forecast" and is completed, on request from the district, by the Traffic Analysis Section of the Transportation Planning and Programming Division. In urban areas (i.e. population greater than 50,000), TxDOT relies on the regional travel model, using demographic forecasts from the Metropolitan Planning Organization (MPO), to forecast future traffic flows region wide; these forecasts then provide the basis for a more specific corridor analysis.[26] In rural areas, TxDOT uses a regression model, analysis of current conditions in the community, and professional judgement to generate traffic forecasts.[27]

One of the key assumptions in these evaluations is the intensity and type of future development in the interchange area, which will dictate the volume of traffic the interchange must serve in the future. In evaluating capacity needs, TxDOT generally looks both two or three years into the future, to assess near-term needs, and twenty years into the future, to ensure that the interchange will also serve long-term needs.[28] Forecasting development twenty years into the future is an extremely uncertain exercise, however. For urban areas, TxDOT is dependent on the MPO to provide reasonable and accurate demographic forecasts and is sometimes put in the position of having to use forecasts that are not likely to prove accurate in the long run.[29] In many cases around the state, the development forecasts used have failed to accurately anticipate future development, leading to obsolescence of the interchange design and a need for upgrading sooner than is optimal. On the other hand, overestimating future levels of traffic can lead to overly expensive interchanges and wasteful use of limited construction funds. Despite the uncertainties involved, these methods are the most accurate to-date.

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[25] Smith.

[26] Interview with, Deborah Graham, Traffic Analysis Engineer, Transportation Planning and Programming, May, 1999.

[27] Graham.

[28] Hilton.

[29] Graham.

TxDOT Access Management Policies

Access to frontage roads is guided by two TxDOT documents: "Highway Design Division Operations and Procedures Manual" and "Regulations for Access Driveways to State Highways."

The Design Manual discusses two options for controlling access. The first option is through deed restrictions "whereby the rights of access to the highway from abutting property owners is denied with ingress and egress to the mainlanes only at selected interchange ramps."[30] This approach can be used when the freeway is developed by "designation" under House Bill 179[31]; this category includes all Interstate Highways. The second option is through the construction of frontage roads "to restore access to abutting properties, but permitting access to the mainlanes only at selected interchange ramps."[32] This option must be used for highways developed "solely by design" (i.e. not designated under H.B. 179); for these facilities. TxDOT is not empowered to purchase access rights. Either way, "direct access from private property to the mainlanes is prohibited without exception."[33]

TxDOT's ability to regulate driveway location and design derives from the State's police powers and is based on "the interest of providing for highway safety and utility"[34] Deed restrictions are used when right-of-way is purchased from abutting property owners.[35] The State's police power can be used when deed restrictions are impractical, such as where no right-of-way is purchased from abutting property owners and/or where landlocking or "other substantial or material damage" results from access restrictions.[36] The State does not have the regulatory power to "landlock" property by completely denying access without compensation.[37] This combination of powers and restrictions generally means that either TxDOT must provide access to a property by constructing a frontage road or the agency must purchase access rights, thereby in effect paying property owners for the absence of access.

TxDOT's policy on driveways, described in "Regulations for Access Driveways to State Highways," guides the number, location, and design of driveways. Property owners or

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[30] TxDOT, "Highway Design Division Operations and Procedures Manual," pg. 4-83
[31] "Highway Design Manual," pg. 4-84
[32] "Highway Design Manual," pg. 4-83
[33] "Highway Design Manual," pg. 4-83
[34] "Highway Design Manual," pg. 4-84
[35] "Highway Design Manual," pg. 4-86
[36] "Highway Design Manual," pg. 4-87
[37] "Highway Design Manual," pg. 4-84

businesses wishing to construct or revise a driveway access to a state highway must secure a permit from TxDOT that stipulates terms and conditions based on the driveway regulations. The purpose of these regulations is to provide both "reasonable safety" for traffic on state highways and "reasonable access" for property owners.[38] The regulations include both general principles and specific requirements for driveways. In general, the regulations stipulate that "locations of access driveways shall be selected to provide maximum safety for highway traffic and for users of the driveway."[39]

An important principle for driveways along frontage roads is that "it is considered desirable to restrict access in the vicinity of the ramp gore area" in order to "assure maximum safety to the traveling public."[40] The requirements state that access will be denied "where practical" in the gore area and refer to the TxDOT Design Manual for specific dimensions and additional details. The Design Manual stipulates that access be denied for 300 feet for exit ramps (50 feet before and 250 feet after the junction of the ramp with the frontage road) and for 150 feet for entrance ramps (100 feet before and 50 feet after the junction), as shown in Figure 3-1.[41]

Other specific requirements for driveways are delineated by the Driveway Policy, as shown in Table 3-1 and Figure 3-2. The length of frontage of an individual property determines design criteria such as minimum and maximum curb return radii, minimum island width, desirable and maximum driveway widths, and driveway angles. The location of ramps is controlled by limits on the maximum number of driveways based on length of frontage and by minimum and desirable corner clearance, that is, the distance between the driveway and the start of the arc of the corner with an intersecting road or highway. A similar requirement is also defined in the Design Manual (Figure 3-3) which specifies minimum and desired separation distances between the ramp and the cross street. For example, for a frontage road with a volume of 1500 vehicles per hour, the minimum separation distance is 500 feet while the desired separation distance is 1000 feet.

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[38] TxDOT, "Regulations for Access Driveways to State Highways," Adopted September 1953, Revised August 1996, pg. 9
[39] "Regulations for Access Driveways," pg. 8
[40] "Regulations for Access Driveways," pg. 6
[41] "Highway Design Manual," pg. 4-83

Table 3-1. Regulations for Access Driveways to State Highways

Frontage (X)	Curb Return Radii		Island Width	Corner Clearance		Number of Driveways	Driveway Width	
	Min.	Max.	Min.	Des.	Min.	Max.	Min.	Max.
up to 58'	2 1/2'	30'	none	5'	none	1	30'	45'
58' to 95'	2 1/2'	30'	none	20'	5'	1	30'	45'
58' to 95'	2 1/2'	30'	x/8	5'	none	2	30'	45'
96' to 135'	2 1/2'	30'	x/8	10'	5'	2	30'	45'
136' to 320'	5'	30'	x/6	20'	15'	2	35'	45'
321' to 600'	10'	30'	x/3	20'	20'	3	40'	45'
601' & up	* special design							

* Such frontage development may generate large traffic volumes requiring use of channelization or other special designs. The district will have the Austin office review such permits.

Source: "Regulations for Access Driveways to State Highways," TxDOT, Adopted September 1993, revised August 1996.

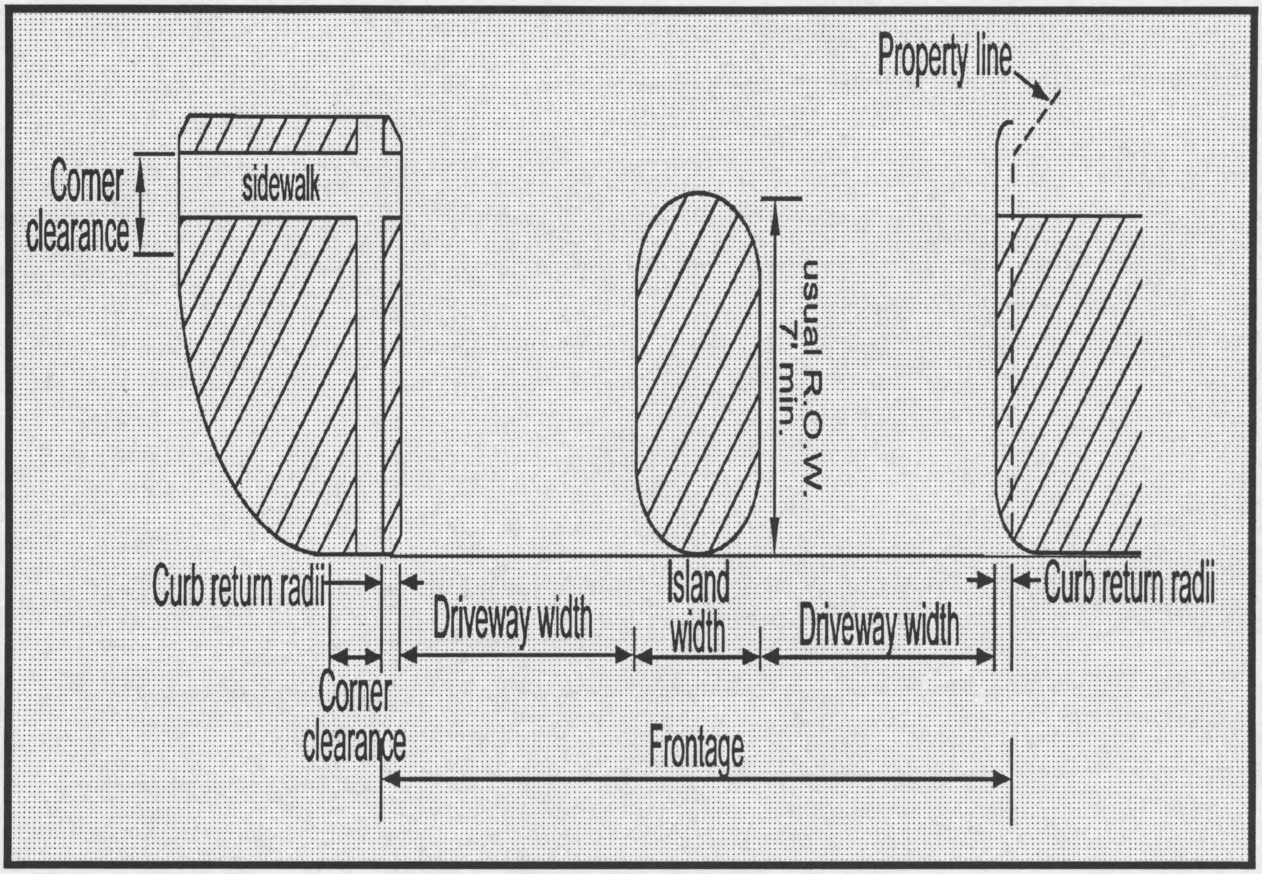
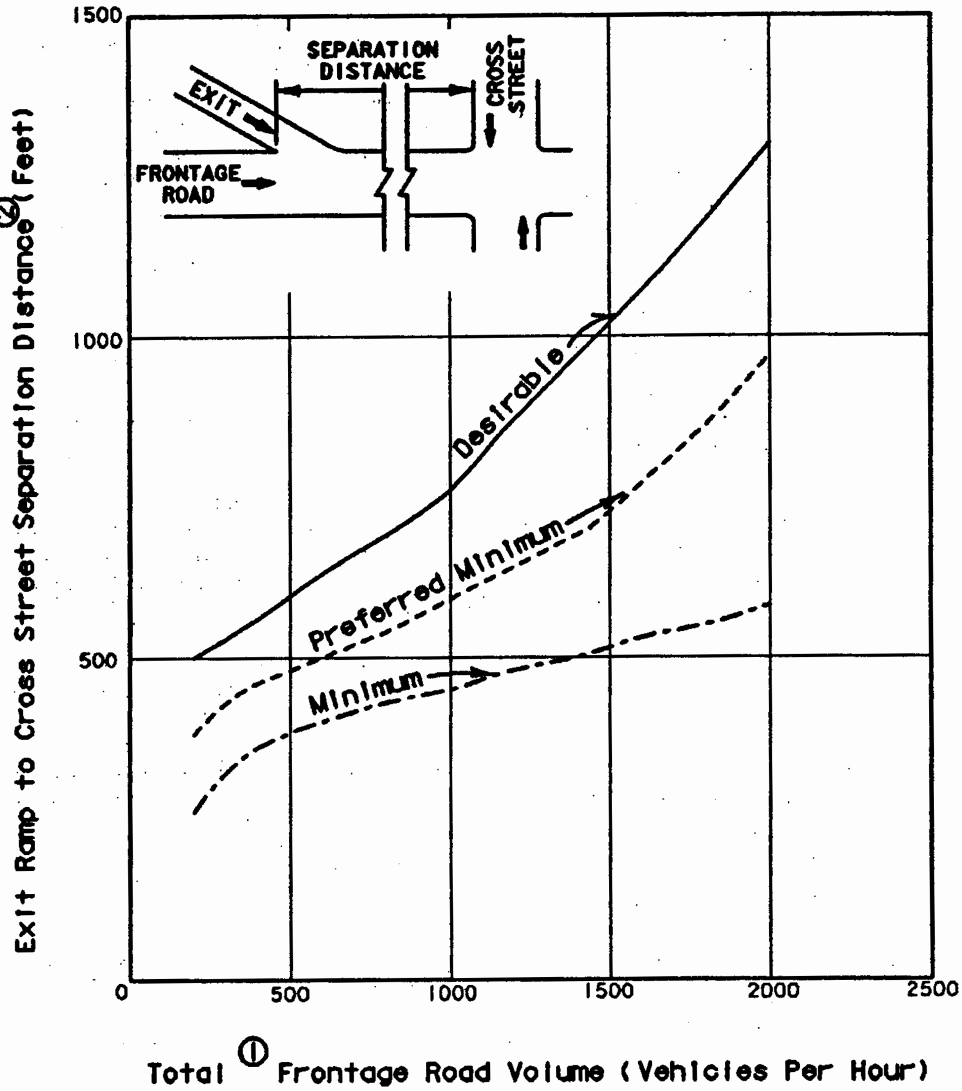


Figure 3-2. Definition of Dimensions for Access Driveways

EXIT RAMP TO CROSS STREET SEPARATION DISTANCE



① Includes exit ramp volume

② Based on accommodating traffic weaving, braking, and storage for typical traffic control and distribution conditions. For additional information, see Research Report 178-2F by C. J. Messer, et al, TTI, 1976.

Figure 3-3. Separation Distances Between Ramp and Cross Street

Source: TxDOT Design Manual

Chapter 4: Case Studies

The study team visited 14 communities, identified through a statewide survey, to determine existing conditions and traffic patterns at ramp locations across the state. Urban and rural locations were identified, as well as those with varying land uses to evaluate the relationship between development, ramps, and associated traffic. Interviewers met with TxDOT and community engineers and planners in each location to obtain information about the ramp design, the history of land uses at the intersection, and about city development policies. Data were collected on population, employment, building or lot sizes, property values, and traffic volumes and accident rates, as available. Each case study reflects the unique aspects of the ramp and the community values and policies.

Austin Case Study
Location: U.S. 183 and S.H. 360, principal focus northbound, prior to intersection

Introduction

The northbound U.S. 183 exit to S.H. 360 is one of several that gives access to a portion of land called the "Golden Triangle," at the northwestern end of Austin city limits. The area is at the northernmost end of an urban aquifer recharge area, in the Shoal Creek watershed. The ramp provides access not only to S.H. 360, but also to an intermediate street called Stonelake Blvd. and the resulting business driveways along its length of the frontage road.

The ramp was first planned in the mid 1980's when U.S. 183 was expanded into an eight lane limited access roadway and was opened to traffic in 1994. At that time TxDOT was in the habit of placing ramps in such a way as to allow traffic flow up the frontage road to enable land development to occur.[42] TxDOT's decisions regarding ramp location and date of construction do not seem to have been directly influenced either by developers or the City of Austin. Substantial development has occurred since the opening of the ramp, however.

This ramp is located in a high growth corridor in a rapidly growing metropolitan area. The population in the Austin Metropolitan Statistical Area (MSA) grew from 536,688 in 1980 to 781,572 by 1990, a 45.6% change. 42 current estimates put the population of the MSA at

[42] Interview with Glenn McVey, Austin District, TxDOT, June 1998.

990,367 in 1997, a 27% change in seven years.[43] Much of the City of Austin's recent growth has taken place along the northwest corridor, where U.S. 183 has improved access from the suburbs to the central Austin area. Growth in this area consists mostly of middle and upper middle class residential development and commercial development that serve this population.

Development in Ramp Vicinity

The first applications for development permits were filed in 1985 and the first development along the frontage road served by this ramp occurred in 1990. The first sites to be developed were at the intersection of S.H. 360 and the frontage road. Later development spread along the frontage road and more recently into the less easily accessed interior sites.

The development along the stretch of U.S. 183 served by this ramp occurred in response to TxDOT's plans to construct the northern extension of MoPac and widen U.S. 183. The first plans for development were submitted to the city planning office in the early 1980s. At this point the entire site along the frontage road was undeveloped and heavily wooded. Trammel Crowe assembled the entire parcel from multiple owners and submitted a zoning site plan. At that time, the city required a site plan before a developer could receive a zoning change. The city accepted the plans, including a mall and substantial office space, and changed the zoning to Commercial Highway - an intensive zoning classification allowing for 95% impervious cover and 120 foot heights.[44]

In the mid 1980s, when Austin (and all of Texas) experienced a period of economic decline, Trammel Crowe placed the project on hold and held the property until the economy picked up again in the 1990s. Eventually they subdivided the parcel from five primary lots and sold it to a multitude of landowners. The subsequent development reflects this division. In the early 1990s, interest in developing the area resurfaced as the ramp construction was completed. The first projects were the strip mall that now contains Circuit City and Sam's Club, on the northern side of U.S.360.[45]

Since then, most of the buildable sites have been developed. The Gateway Center, on the northeast corner of the intersection of the frontage road with S.H. 360, contains several large

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[43] McVey.
[44] *County and City Data Book 1994*, US Department of Commerce, Bureau of the Census, Washington, D. C. US Government Printing Office, 1994.
[45] Interview with George Adams, City of Austin, April 1998.

stores, including the Container Store, Linens and Things, Old Navy, CompUSA, REI (an outdoor gear store), and Whole Foods (a healthfood supermarket), as well as several restaurants. The other sites in this area are less directly accessible from the ramp and developed after the Gateway Center. The strip center that abuts both U.S. 183 and MoPac and that contains a Babies 'R' Us, Circuit City, Cost Plus, and other discount stores, can only be accessed from the southbound MoPac frontage road, meaning that drivers using the ramp under study must turn right on S.H. 360 and circle back round to the east and south to reach the center. The parcels behind these strip centers, also reached via a right turn onto S.H. 360, have development more recently as a multiplex cinema, business-oriented hotels, and a luxury condominium complex; two more hotels were under construction as of 1999.

The design of the shopping centers in this area offer few alternatives to driving. A sidewalk runs along the frontage road. However, it would be a steep climb for anyone in a wheelchair, is separated from the stores by large parking lots, ends abruptly at the southern end of the development, and does not connect the strip centers to even the neighboring hotels. The crosswalks across the driveways are poorly marked, although they do have ramp cuts. Although the businesses have provided parking facilities for bicycles, as required by the city's land development code, these facilities are rarely used. There is no public transit that provides service to the site.

Current zoning maps show much of the area undeveloped although this is no longer the case. As of 1997, the zoning was predominantly CH-CO (Commercial Highway with a conditional overlay), with a small amount of MF-3-CO (Multifamily Residence with a conditional overlay) and an even smaller amount of LI (Light Industry). The city has no particular plans for the surrounding undeveloped land.[46] Much of this land is owned by the University of Texas and therefore out of the city's control.

This site was developed in direct response to TxDOT's plans for construction, both the widening of U.S.183 and the adjacent construction of MoPac Loop 1. Because these facilities provide such a high level of access to this site, the city had no reason to deny an intense zoning category. If the city were to deny that permit in this area, they would be forced to grant it elsewhere, most likely somewhere that the city would be responsible for creating and maintaining

[46] Adams.

the necessary transportation infrastructure. Once the plans came out for this interchange, this land was destined to be developed as intensively as possible.[47]

Two key factors made the development along this ramp possible.[48] The first is the existence of the early 1980s site plan. Because the property had previously been rezoned and planned for development, later developers had an easier time getting through the City's regulatory process. Most of the parcels are still zoned from this time with additional requirements that show up as conditional overlays. Each plot has a different condition attached to it. Most of these conditions attempt to retain some trees on the site.

The second feature is the site's location in the Shoal Creek watershed. Because this watershed is designated as urban, the development allowed in this area under city regulations is much more intense than that in a suburban or rural watershed. There are no cut/fill limits, no critical water quality zones, and no impervious cover limits as there would be if the site had fallen into the Bull Creek watershed just over the hill.

The only controversy regarding what type of development would occur in this area came before the construction of the ramp from the Balcones Woods neighborhood further north on U.S. 183. The residents were concerned with excluding "undesirable uses" such as auto repair, adult entertainment and pawnshops along the frontage roads. These restrictions were subsequently written into zoning restrictions as conditional-use overlays. There was no environmental opposition to the development or to the ramp itself.[49]

Traffic Conditions in Ramp Vicinity

TxDOT considers the resulting traffic patterns in the vicinity of the ramp problematic. Now that the area is extensively developed with a mix of retail, restaurant, and hotel uses, traffic is often quite heavy and serious conflicts have arisen. The ramp was apparently located so as to maximize the potential for development, but the development that has occurred has created traffic flow problems.

Cars exiting the ramp frequently weave across a three lane frontage road in order to reach the driveways for the developments, while cars exiting the commercial developments often weave from the driveways across three lanes to the left turn lane at the intersection at the S.H.

[47] Adams.
[48] Adams.
[49] Adams.

360. These movements occur in spite of lane striping that makes it illegal to do so.[50] In addition, the offramp feeds into two left turn only lanes, so that cars hoping to continue through the intersection frequently get stuck trying to move to the right. If motorists miss the driveway they need, it is difficult for them to double back without using the parking lots as a street.

The location of the ramp in relation to the nearby freeway interchange creates other problems. Because one of the three northbound freeway lanes on U.S.183 exits at this ramp, traffic on the highway is effectively bottle necked, backing up traffic for miles at peak hours. In addition, because the ramp is so close to the major interchange of U.S. 183 and MoPac, traffic weaving across lanes as they come through the interchange creates a dangerous location for a ramp. One TxDOT engineer believes that had the ramp been planned under today's policies, it would have been located much closer to S.H. 360 to reduce the possibility of weaving.

Issues

The development in this area has been piecemeal and has not followed an overall plan. As a result, the traffic flow is not as smooth or safe as it could be. Neither the city nor TxDOT is happy with the lack of coordination between the resulting developments. The city would prefer to have greater access for pedestrians between the various stores and possibly transit on the site. TxDOT would prefer more on-site coordination so that less traffic would be forced onto the frontage roads when going from one development to the next. Changing this situation would require the City to create new policies governing the site plan development process for large scale (and small) development projects.

The lack of internal linkages throughout the development for both pedestrians and motorists disturbs some city officials. In response to this problem and similar situations in other developments, city officials are moving forward on their Smart Growth Initiative, a series of more significant code revisions, the purpose of which is to coordinate future development. However, these changes come too late to influence any of the development at this particular site, even those still under construction.[51]

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[50] McVey
[51] Adams.

Lessons Learned

Ramps are often seen as a success if they enable development to occur along the frontage road. However, the development that a ramp enables may create traffic problems along the frontage road and even on the freeway itself. This problem is exacerbated by a lack of regulating policies and area planning that would encourage more internal circulation, easing the pressure on the ramp and frontage roads.

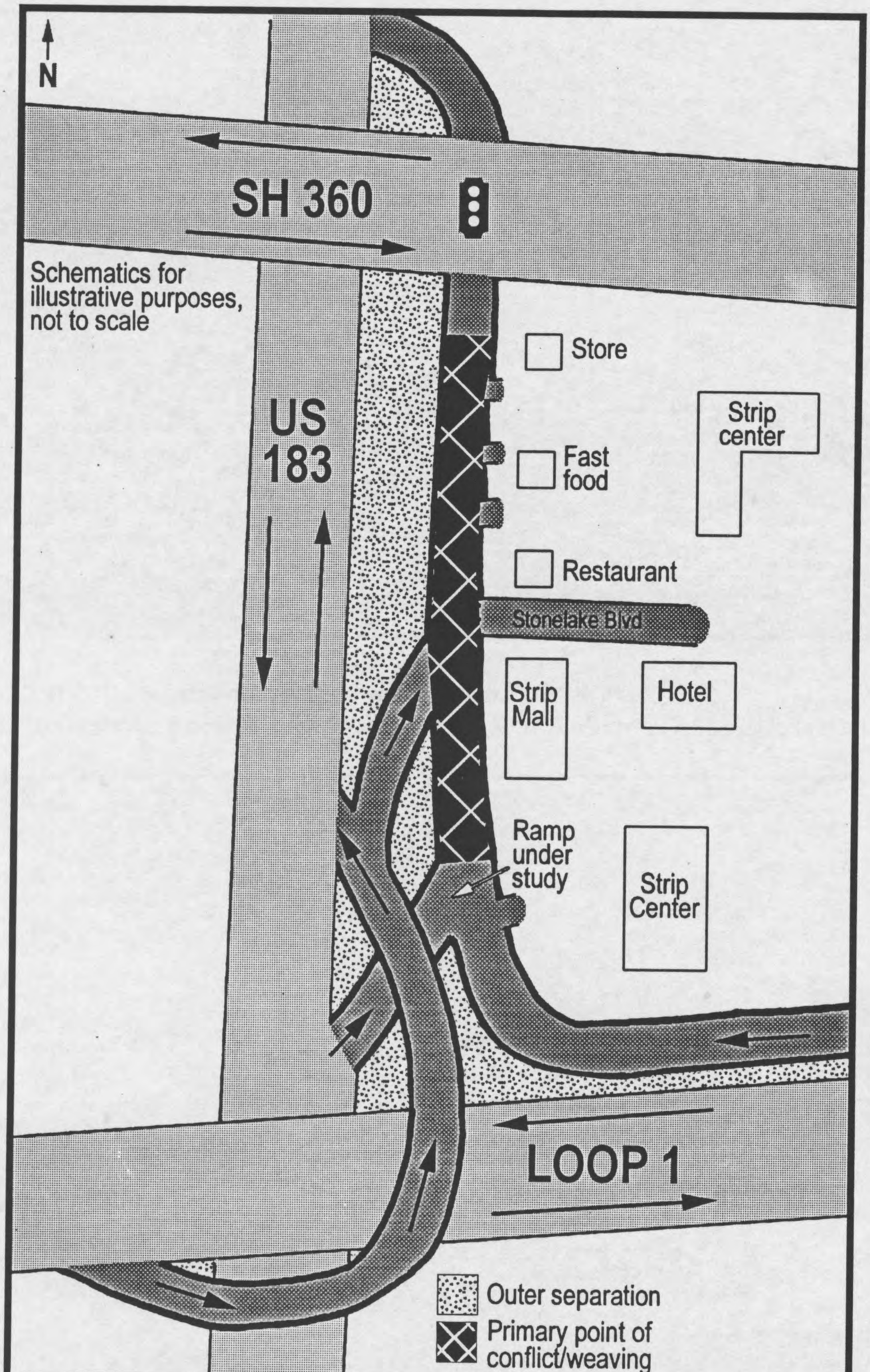

Figure 4-1. Austin Case Study Schematic

Figure 4-2a. Austin: Looking Northbound
Looking North on US 183 Frontage Road Traffic Merging at Ramp and Commercial Driveways

Figure 4-2b. Austin: US 183 Frontage Road
Vehicle Making Illegal Lane Change from Driveway

Beaumont Case Study

Location: I.H.10 and Walden Road; principal focus eastbound, after intersection.

Introduction

The Walden Road location is in an urbanized area, but is characterized as suburban by local officials.[52] The highly commercial area has grown rapidly in recent years. In addition to the service-oriented businesses at the ramp location, the opposite side of the intersection is the site of a busy truck stop. The confluence of both activities has resulted in unanticipated congestion at this ramp location. The ramp was constructed between 1958 and 1962 as part of the construction of that portion of I.H. 10. The ramp design is conventional diamond with traffic controlled by stop signs. The frontage roads are one-way along this section of the interstate.

During the 1980s, Beaumont had been in a somewhat static economic position and population growth had been stable, as well. The Beaumont-Port Arthur metropolitan area experienced a 3.8% decrease in population between 1980 and 1990; that trend reversed between 1990 and 1994 with a 4.2% population increase.[53] The city began to experience growth and an improved economic condition. Beaumont community leaders viewed development positively and encouraged city planners and engineers to work cooperatively with developers.

Development in Ramp Vicinity

The dominant land use is commercial, oriented towards entertainment. Two moderately priced restaurants and a fast food establishment are near the eastbound entrance ramp (farside of the intersection), as well as a multiplex movie theater. There is a truck stop at the southwest corner, also. A secondary impact to the ramp is experienced due to the nature of activity across the interstate on the north side of the intersection. A truck stop, gasoline station, and Holiday Inn are east of Walden Road and generate a high level of traffic. A post office is located west of Walden Road, slightly behind two high value restaurants. The traffic from the commercial areas north of the interstate intensify the issues experienced on the south side.

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[52] Joint Interview with TxDOT Engineer, Duane Browning, and City of Beaumont Engineer, Jim Cline, on June 23, 1998.

[53]

Prior to ramp construction and through the last 10 years, the property near the ramp was rural; a small church was located at the southeast intersection. In the early 1990's a housing development was undertaken nearby which stimulated the current growth in the area. The 1990 census shows 2,267 people in the census tract nearest the intersection. One of the first post-1990 changes occurred when a developer bought the church and constructed a fast food restaurant. Other higher quality restaurants followed. Next a multiplex movie theater was constructed near the eastbound on-ramp.

While not visible from the intersection, it is likely that the population from the nearby residential community provides the base of demand for the restaurants and Movie Theaters. This area functions as the only truck stop location in Beaumont. Consequently, the volume of trucks is quite high. Property contiguous to the intersection is largely undeveloped.

This ramp was constructed thirty years before the commercial development began. Therefore, the ramp construction did not cause the development of the commercial uses at this intersection, but contributed to the desirability of the site through accessibility and proximity to the interstate.

The City of Beaumont views new development positively and will accommodate developer desired plans if they are not in violation of design standards. There are currently four zoning designations for the area near I.H.10 and Walden including Light Industrial, General Commercial-Multiple Family Dwelling, Residential Multiple Family Dwelling, and Commercial-Manufacturing. In the past twenty years, only one major zoning change occurred; one small area which was Agricultural-Residential transitioned to Commercial-Manufacturing.[54]

The plans for frontage road and other freeway improvements in the Beaumont area are coordinated through the TxDOT office and the appropriate offices for the City of Beaumont, generally Traffic Engineering and City Planning. An access development plan is forwarded to the City and forms the basis for discussion. If differences of opinion exist, they are reconciled and the plans are moved forward. A friendly working relationship is maintained between TxDOT and the City of Beaumont.

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[54] Interview with Cheryl Robinson, Senior Planner, City of Beaumont, June 23, 1998; and Beaumont Zoning Document, Article 2, District Regulations, Sec. 30-7 to 30-18.

Issues

The development near the Walden Road exit has generated a high level of traffic, particularly on weekends. Many of the movie theater and restaurant patrons approach from the westbound lanes, traveling through the intersection to access the properties. Also utilizing the intersection are trucks destined to the truck stop. Because the trucks accelerate more slowly and require more time to travel through the intersection, other vehicles experience additional delay. The queue becomes very long to clear the intersection during the weekend, which is the peak time to access the Movie Theater.

The second problem arises because the eastbound access ramp on the south side is located before the access/egress point to the two restaurants. The legal and appropriate way to enter the interstate is to travel along the frontage road, make the u-turn and then travel back through the congested intersection to make another u-turn in order to enter the interstate. Another option would be to travel through all the restaurant and fast food driveways to get to Walden Road. Some roadway users illegally enter the freeway from a TxDOT maintenance vehicle pathway.

TxDOT's current plans are to add a turn-around from westbound to eastbound. This modification would allow traffic headed to the south side of the interstate to avoid traveling through the 4-way stop signs at the intersection.

Lessons Learned

The mixing of significant truck traffic with other intense vehicular movement seriously impedes the volume movement through the intersection. Discussion of signalization raises questions for area engineers, who indicate they are unsure that signals will improve the problem. They question whether there will just be longer queues, caused in large measure by only a few trucks being able to clear the intersection per cycle.

The location of driveway entrances designed to facilitate movement from and to the properties do not provide easy access to the freeway. The overall coordination of circulation between the properties generating trips and the interstate does not seem to have been a priority.

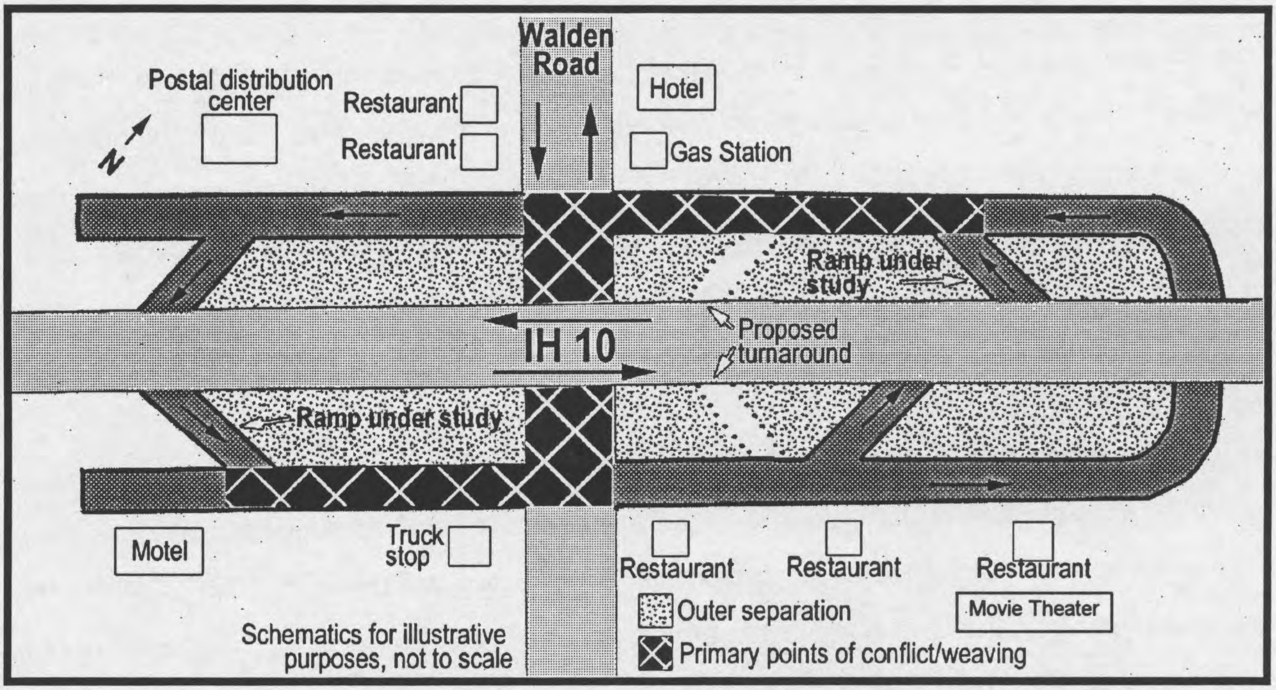

Figure 4-3. Beaumont Case Study Schematic

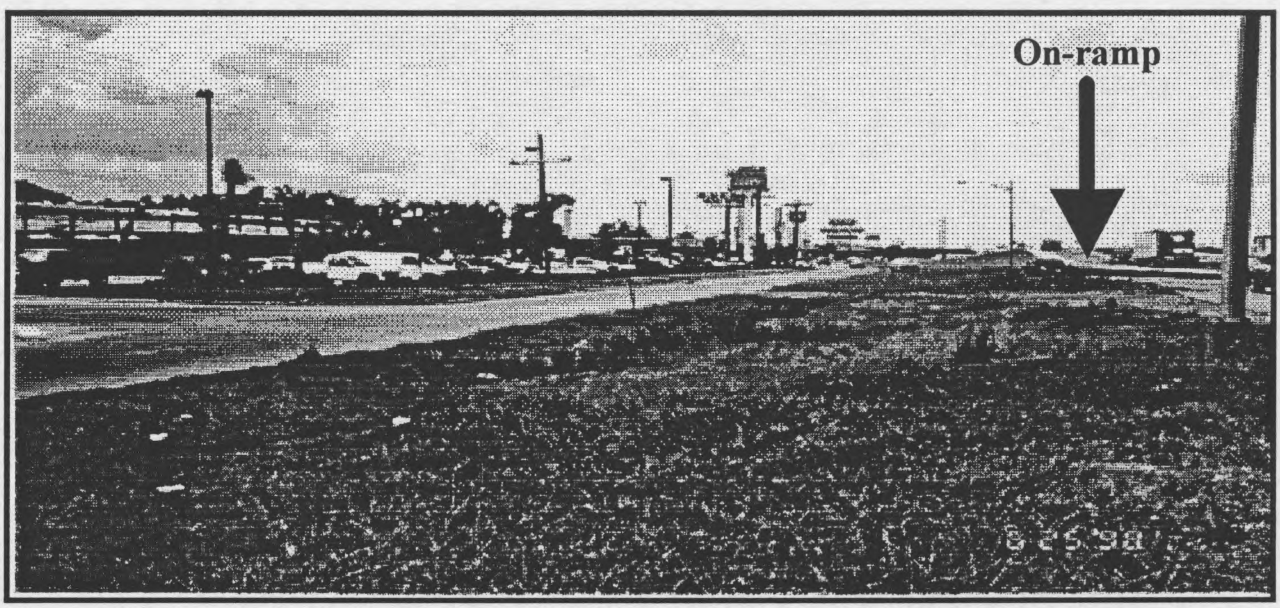

Figure 4-4a. Beaumont: Looking west
IH-10/Walden, North of Interstate, Westbound Frontage Road

Figure 4-4b. Beaumont: Looking east
IH-10/Walden; South of Interstate, Eastbound Frontage Road
Development left to right: Chedder's, Joe's Crab Shack, Waffle House, Chevron, Multiplex Theater, Jack-in-the-Box

Figure 4-4c. Beaumont: Looking west
IH-10/Walden; North of Interstate, Westbound Frontage Road

College Station
Location: S.H. 6 and Rock Prairie, principal focus southbound, prior to intersection.

Introduction

Located in Brazos County in central Texas, the City of College Station is generally regarded as a college town, as the city is the home to Texas A&M University. Abutting College Station to the north is the City of Bryan, the Brazos County seat, effectively prohibiting College Station's growth in that direction. Therefore, city officials have prepared comprehensive plans indicating that the growth of the city will be toward the south, along Texas State Highway 6 (S.H.6). City officials also determined that City boundaries would not exceed the major natural barriers found in Brazos County, including Carter Creek, and the Brazos River. The 1990 census indicates that College Station's population has steadily increased since 1950. The City's comprehensive plan states that the greatest population gains occurred during the 1970s, as the annual growth rate was just over 11%, increasing from 17,676 persons in 1970 to 37,272 persons in 1980. The expansive growth continued in the early 1980s as the annual growth rate was near 10% for the first three years of the decade. In 1990 the population was 52,456, and City planning officials estimated that in 1995 that the City would experience a 2.1% increase making the population 58,000. In 1989 as part of the comprehensive planning update process, City officials anticipated College Station's population growth to be somewhere between 2 and 4 percent until 2015, as illustrated in the following table.[55] City officials believe the continued growth of employment centers in Bryan and the proximity to Texas A&M University have been prime factors in the City's growth.

[55] College Station Comprehensive Plan, City of College Station, Texas, April 1997, p.4.

Table 4-1

Population: Base Year and Projections

Year	Low (2%)	Medium (3%)	High (4%)
1995	58,000	58,000	58,000
2000	64,000	67,200	70,500
2005	70,700	78,000	85,800
2010	78,000	90,400	104,000
2015	86,200	104,700	127,000

Development in Ramp Vicinity

The ramp under consideration in this study is the southbound off-ramp from S.H. 6 to Rock Prairie Road. The location is considered a small city suburban area in a rapidly growing part of College Station/Brazos County. This ramp connects to a two-way frontage road where adjacent land use is commercial. The conflict arises when traffic exiting S.H. 6 must yield to those traveling the frontage road, potentially causing traffic to back onto S.H. 6. TxDOT officials stated that plans are being considered for converting this two-way frontage into a one-way frontage when the planned overpass at Bering Road, less than a quarter-mile south of the intersection of Rock Prairie and S.H. 6, is constructed.[56] Officials believe this overpass will greatly reduce anticipated congestion at the Rock Prairie intersection and provide greater access to future development in the region. Still, a firm schedule for the construction of the new overpass or the transition to a one-way frontage was unknown as of this study.

Officials were not sure when this ramp became operational, but estimate it to be the 1960s. The ramp design is not the conventional interchanges found elsewhere in Texas because of the two-way frontage and the proximity of the convergence of S.H. 6 and Texas Avenue (Business Highway 6).

[56] Interview with Kirk Barnes, TxDOT Engineer, June 9, 1998.

Before the ramp was constructed, the area surrounding Rock Prairie was classified as Agriculture/Open District (A-O). Many of the zoning changes in the area have occurred since the late 1970s, transitioning from agricultural to land uses such as general commercial (C-1, C-2), to low to medium density residential (R-4, R5).[57] Since most of the rezoning activity in the area occurred during the late 1970s and early 1980s, the current zoning patterns are unlikely to change. The current City policy is to encourage growth, but in a controlled, orderly manner.[58] Officials at both TxDOT and the City cite that the rapid development has generated increased interest in mobility and safety. Currently, a high level of coordination exists between TxDOT and the City in terms of traffic management in and around major intersections and access points in the region. None of the current businesses near the ramp appears to be high generators of vehicle traffic. However, there is a gas station, an oil change business, and a bank at the intersection of the frontage and Rock Prairie that will ultimately encourage traffic, if residential development continues as planned.

Conditions in Ramp Vicinity

The study team observed traffic exiting the southbound ramp and recorded traffic counts during a non-peak hour. Estimates indicated that for a typical non-peak hour, 30 cars will exit the ramp and proceed north along the frontage, while 492 cars will exit and proceed along the frontage to Rock Prairie Road. The configuration of the frontage road allows motorists to go north to access Texas Avenue. Otherwise, Texas Avenue would not be accessible to those traveling along Rock Prairie, except by minor collectors through planned neighborhood development.

Issues

The new residential development near Rock Prairie has significantly increased the number of vehicles using the southbound exit to Rock Prairie. Further, TxDOT and City officials anticipate residential and commercial development to continue the current growth

[57] City of College Station, Ordinance Nos. 1143, January 25, 1979; 1157, April 12, 1979; 1223, June 26, 1980; 1234, August 14, 1980; 1244, September 25, 1980; 1356, May 13, 1982; 1377, July 22, 1982; 1403, January 27, 1983; 1632, February 13, 1986; and 2072, June 23, 1994.

[58] Interview with Edwin Hard, City of College Station Transportation Planner, June 23, 1998.

pattern well into the next decade. The major point of traffic conflict occurs where the exit ramp intersects the two-way frontage. Currently, motorists seem to negotiate the interface smoothly. However, officials acknowledge that this is a major safety hazard and plan to transition the frontage to one-way when a planned overpass is constructed.

TxDOT and City officials recognize that the two-way frontage poses severe safety concerns from a traffic management standpoint. It is unclear as to which department, local TxDOT office or local planning/public works department should initiate the process to convert to a single direction frontage road.

The decision to wait until the overpass is constructed to modify the frontage to one-way may not be acceptable given the predicted increase in traffic levels and the competitive nature of acquiring federal and local funding for construction projects. Currently the community's plans for development are not adjacent to the frontage either north or south of Rock Prairie. Officials at TxDOT indicated that the local TxDOT office may relocate to this area, but the configuration, design, and location of the new facility is unknown. A positive relationship exists between the City and TxDOT.

Lessons Learned

Due to the nature of the existing businesses, the amount of traffic generated is not enough to cause conflict in traffic flows at this ramp. The number and positioning of driveways are well within TxDOT and City standards. The principal issue appears to be the existence of the two-way frontage road. Local officials believe the two-way frontage road will be converted to a single direction frontage road at some point in the future. Once this occurs, any potential traffic conflicts should be alleviated.

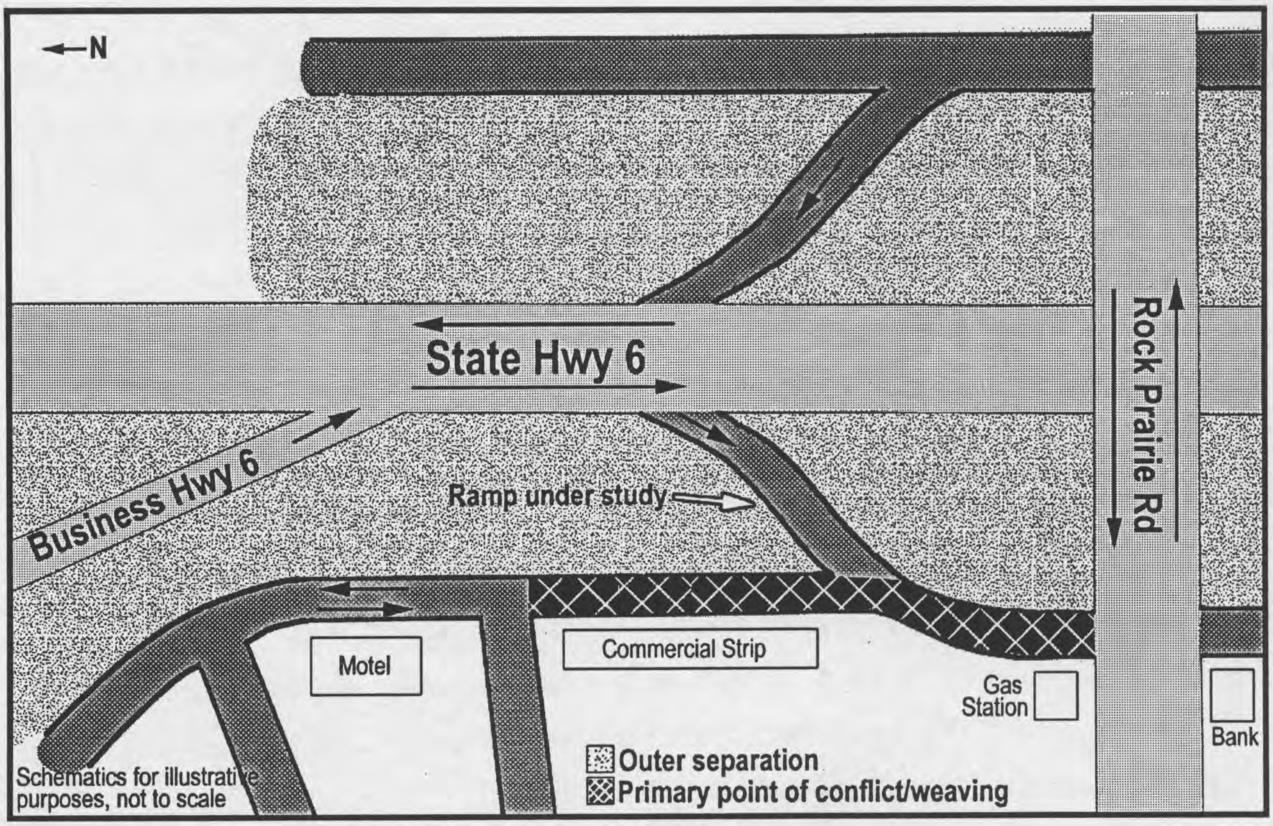

Figure 4-5. College Station Case Study Schematic

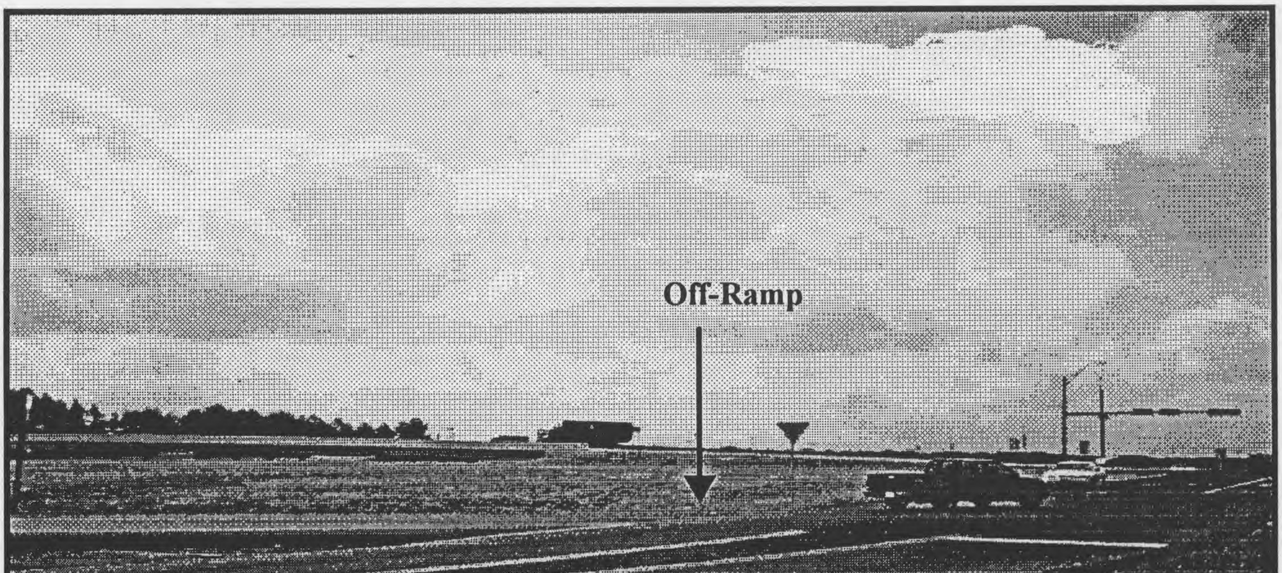

Figure 4-6a. College Station: Looking South
Facing South Along Two-Way Frontage of Hwy. 6 and Rock Prairie Road.
Notice the Potential Conflict on the Two-Way Frontage

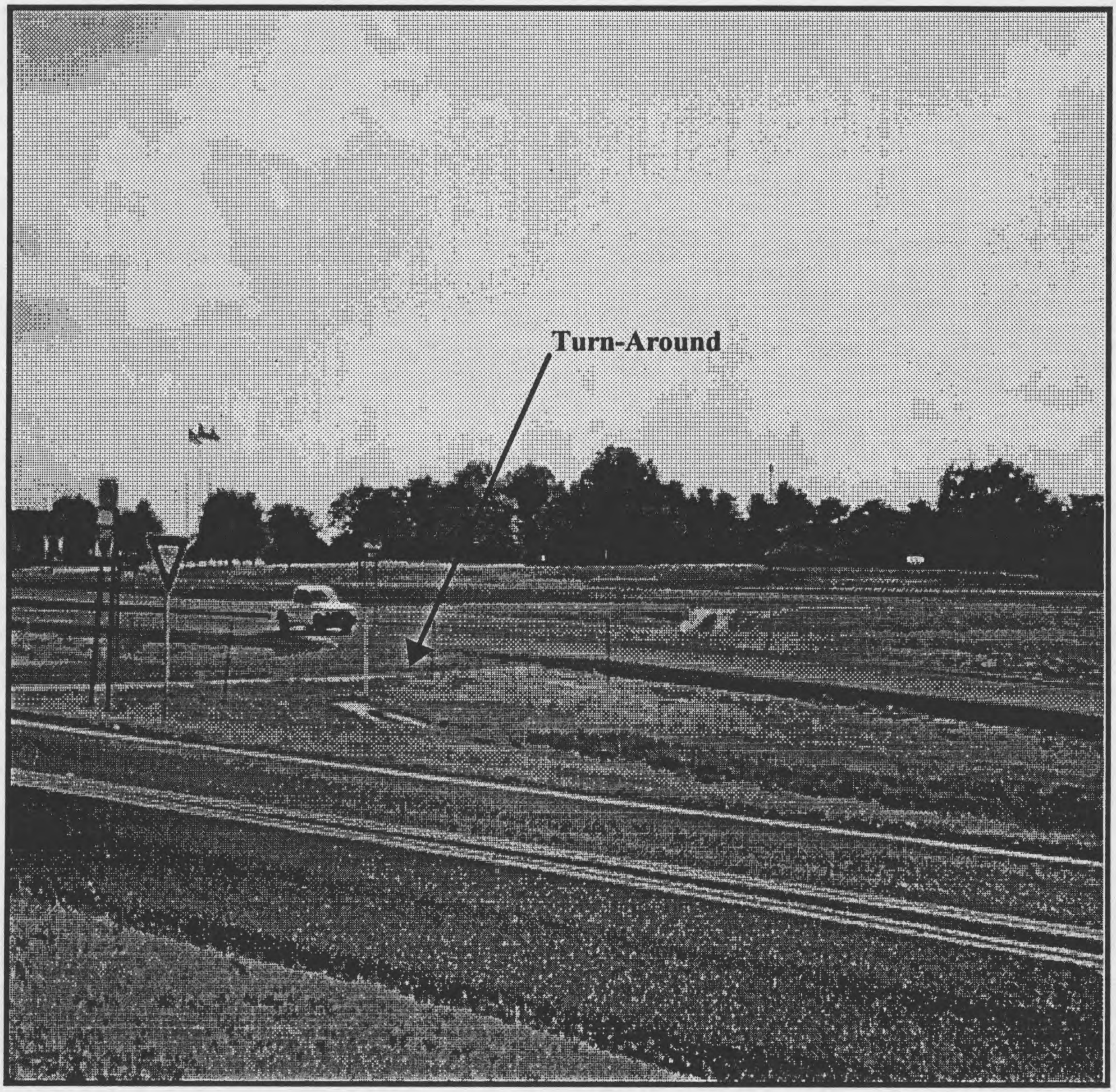

Figure 4-6b. College Station: Looking South
Facing the South Bound Exit Ramp from Hwy. 6 at Rock Prairie Road. Notice Traffic has the Option of Continuing South to the Intersection of Rock Prairie Road or Use the Turn Around and Travel North on the Two-Way Frontage

Dallas Case Study
Location: I.H. 30 and Cockrell Hill Rd. (proposed interchange)

Introduction

The Dallas/Ft Worth region is one of the most progressive metropolitan regions in the country. In 1990, Dallas had a population in excess of 1 million residents, and the estimates for 1996 indicate a 4.5 percent increase to 1,053,292. Officials expect the region's renewed economic strength to continue into the next century. The ramp at I.H. 30 and Cockrell Hill Rd. is under construction and will be a part of the 1.5 mile extension of Cockrell Hill Road north from Davis Street to I.H. 30.

Development in Ramp Vicinity

The land adjacent to the proposed extension and ramp is currently undeveloped. However, a developer has presented plans to the city and other area officials for a retail development on the south side of I.H. 30 once the associated construction is complete. The exact nature of the retail stores is unknown, but City officials are in the process of changing the zoning to accommodate the anticipated land use changes.

Traffic Conditions in Ramp Vicinity

TxDOT officials anticipate traffic volumes of 6,700 to 7,000 vehicles south of I.H. 30 on Cockrell Hill Road by the year 2000. To the north of I.H. 30, also on Cockrell Hill Road, TxDOT is projecting year 2000 traffic volumes to be around 4,400 vehicles. The proposed design of the interchange at Cockrell Hill Road and I.H. 30 will be a standard diamond interchange. There will be frontage roads north and south of I.H. 30 from Cockrell Hill Road east to Chalk Hill Road (There are no plans to extend the frontage road west to Westmoreland Road). The north side frontage road will consist of two lanes, while the frontage road to the south of I.H. 30 will have three lanes. The extension of Cockrell Hill Road from Davis to I.H. 30 will have six lanes. However, there are no sidewalks planned for the extension or provisions for public transit.[59]

[59] Interview with Walter Shumac, Dallas District, August 1999.

Issues

The residents of the Cockrell Hill subdivision support the development of retail stores and the extension of Cockrell Hill Road to I.H. 30. The increased access to I.H. 30 is perceived to provide greater mobility to the residents in the area. However, there have been questions as to the potential for increased congestion on Cockrell Hill Road south of Davis. This section of Cockrell Hill has about 25-30 feet of pavement for two lane traffic. TxDOT officials agree that this section of Cockrell Hill Road will need monitoring to ensure the traffic volumes do not exceed capacity in the future. The relationship between TxDOT, the City of Dallas and the residents of the local community has been very positive. The only concern appears to be the potential of increased congestion in residential areas and the possibility of unexpected land use changes to something other than retail. City officials plan to use existing zoning ordinances to ensure compatibility with surrounding land uses and believe them to be adequate to maintain the existing character of the residential area.

Lessons Learned

This location will provide an opportunity to use the lessons learned from other sites statewide. The coordination between the City of Dallas, TxDOT and private developers to design facilities that will not hinder area traffic flows. The cooperation should extend beyond internal circulation and include sidewalks to facilitate future public transit use.

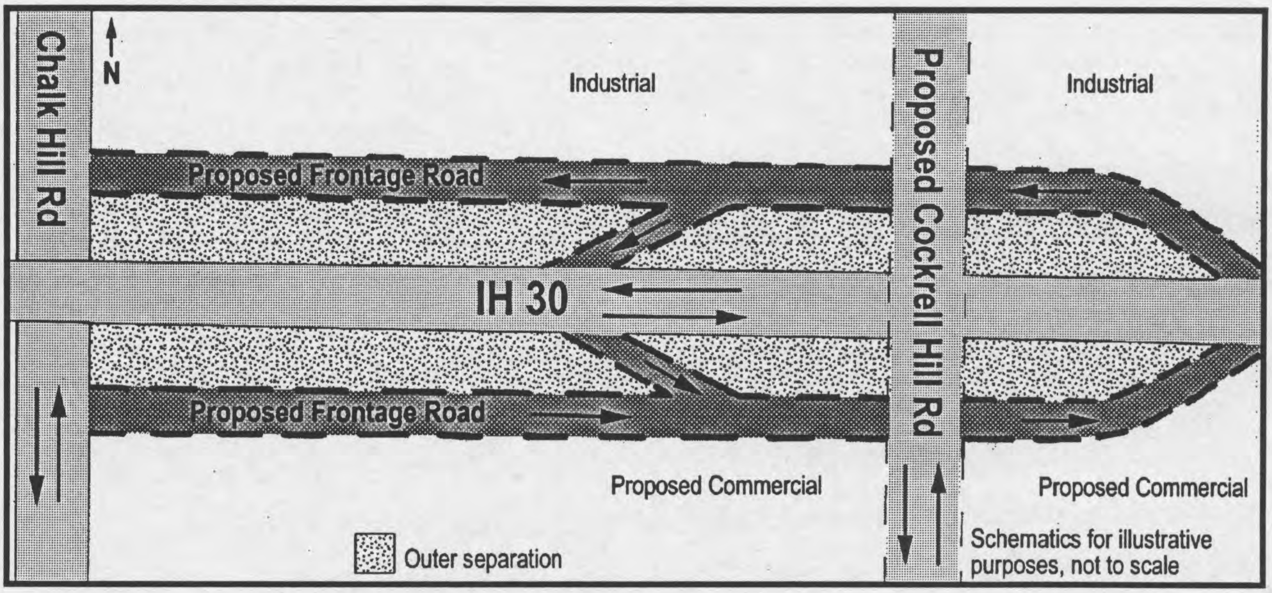

Figure 4-7. Dallas Case Study Schematic

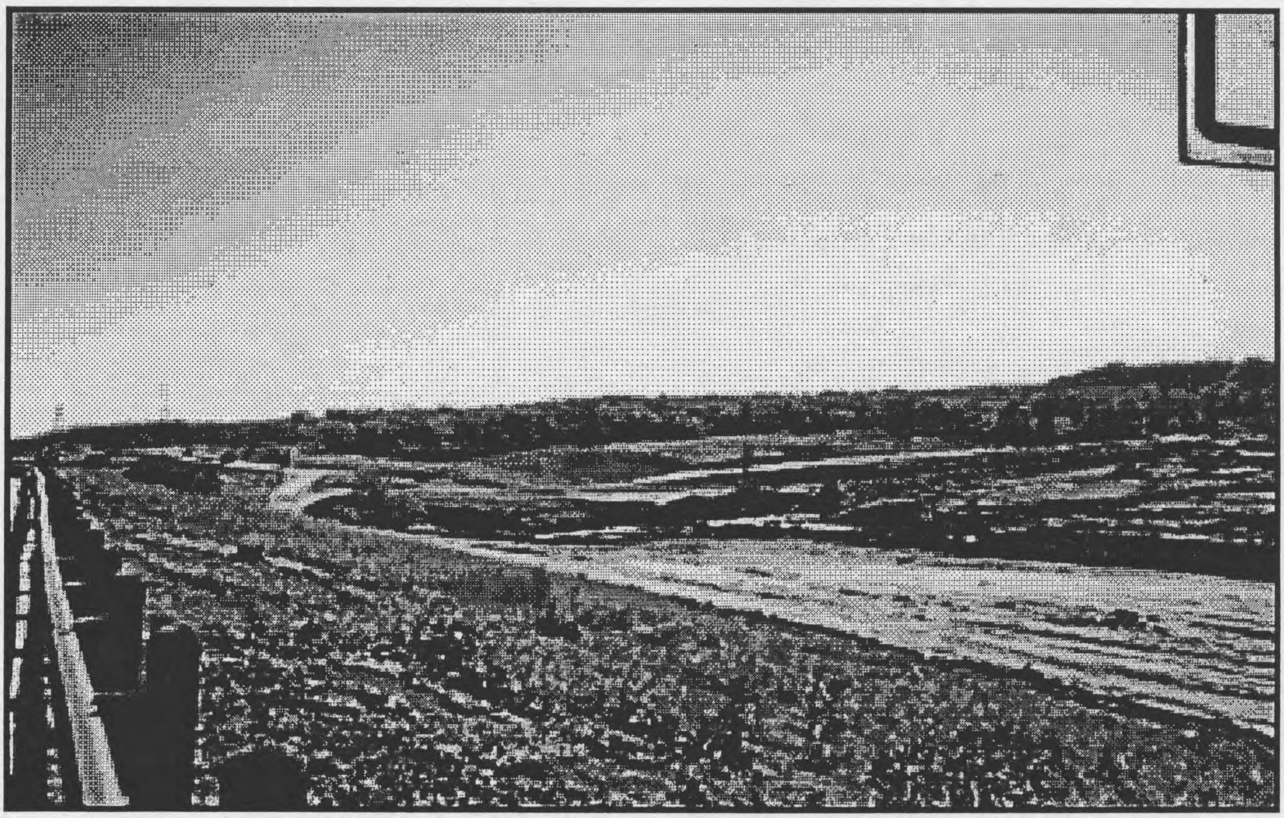

Figure 4-8. Proposed Interchange Site
The Construction of the Extension of Cockrell Hill at I.H. 30

El Paso
Location: Westbound along I.H. 10 at Hawkins

Introduction

The intersection of I.H.10 and Hawkins is in an urban area on the east side of El Paso. El Paso is known for the high number of trips that occur daily into and from Mexico. Juarez, Mexico is contiguous to El Paso and inhabitants view the two cities as one large region. The area around the ramp identified for analysis is a mix of commercial and industrial uses that generate a high volume of traffic. Original construction occurred in the 1960's; the roadway was expanded with the addition of a mainlane in 1990. The interchange is a typical diamond design.

El Paso has experienced steady growth from a 1980 population of 425,259, to over 515,000 in 1990 and an estimated 627,000 in 1998. However, the interrelatedness of El Paso and Juarez boost the number to 2.5 million. Many people cross the border daily to work, shop, or for recreational purposes.

Development in Ramp Vicinity

The primary land use near the westbound ramp is an abandoned clothing factory. The corner next to the vacated industry is occupied by a gas station. Much of the traffic exiting at that location, however, is destined to the Cielo Mall west of the intersection. The mall was constructed in 1970, after the interstate opened, but before the widening occurred. On the opposite side of the interstate is an industrial area accompanied by high truck volumes.

Issues

The number of trucks traversing the intersection reduces the number of vehicles that can clear the intersection during a signal cycle. The city of El Paso made a decision to lengthen the cycle for north-south traffic to give more time for the trucks to travel through the intersection. Consequently, westbound traffic on the frontage road waits longer on the red cycle. The City and TxDOT hold differing opinions regarding the effectiveness of the signal cycling decision. During rush hour, vehicles sometime are queued to the point that vehicles back up onto the mainlanes of the freeway.

A second issue is weaving that occurs as vehicles exit the freeway and turn right onto Hawkins or into the gas station. There are three driveways located along the frontage road between the exit ramp and the Hawkins intersection, including one to the vacant clothing factory. The weaving problem would be further exacerbated if a business were to inhabit the closed clothing industry building. The westbound frontage road at Hawkins has roughly 12,000-15,000 ADT. Accidents recorded in 1997 at the location were the highest in the City with 67 incidents.

The relationship between the City and developers regarding decisions about access locations is characterized as "very good". The City considers its requirements about driveway policies to be more stringent than TxDOT's. The City thinks the idea of shared access is undesirable and has had both positive and negative experiences with shared land use.[60]

While specific plans and proposals have not been advanced, TxDOT would like to move the ramp to the west so that traffic exits west of the Hawkins intersection.

Lessons Learned

The presence of the trucks delays the through-movement traversing the intersection. A tradeoff made by City officials which allows an increased number of trucks through each cycle, further delays the westbound traffic on the frontage road some of which has exited the interstate. The number of driveways and distance to the Hawkins intersection seems to be potential cause of weaving and will be particularly important to address should a business choose to re-inhabit the vacant clothing company.

[60] Interview with Ted Marquez, City of El Paso, Engineer July 8, 1998.

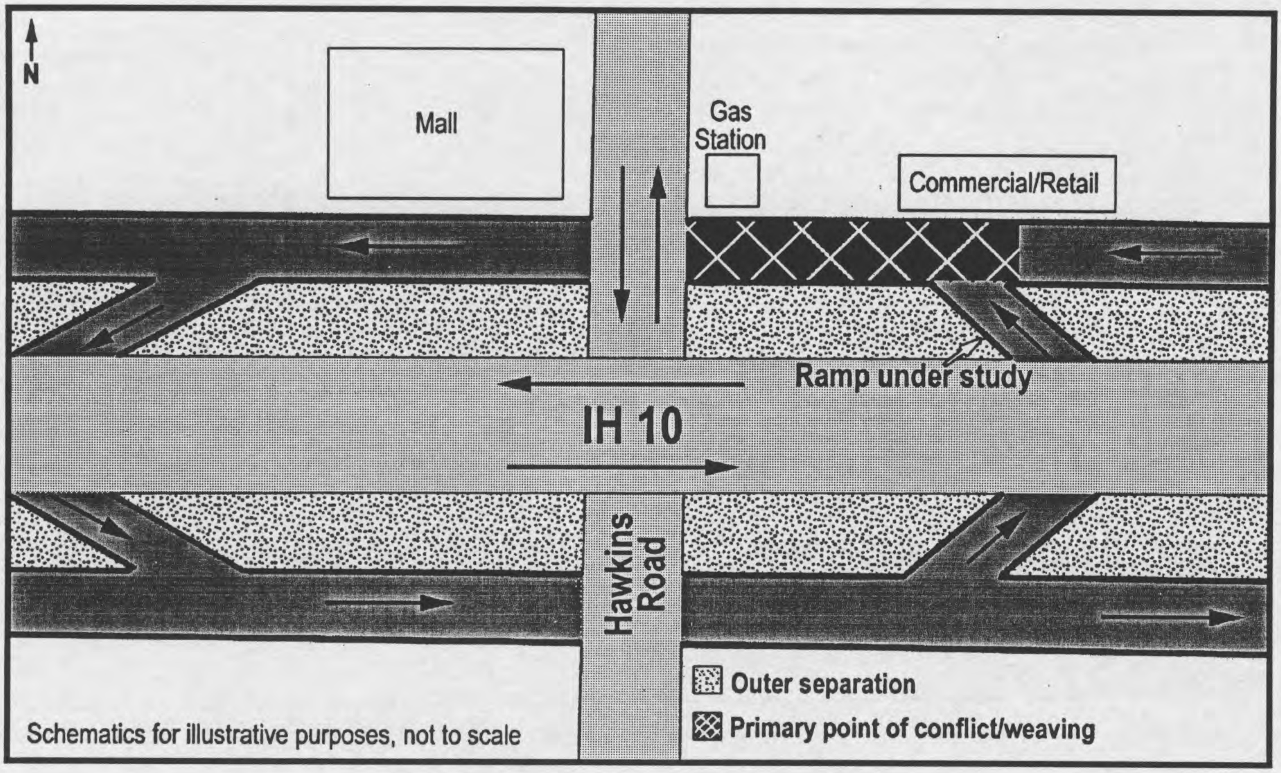

Figure 4-9. El Paso Case Study Schematic

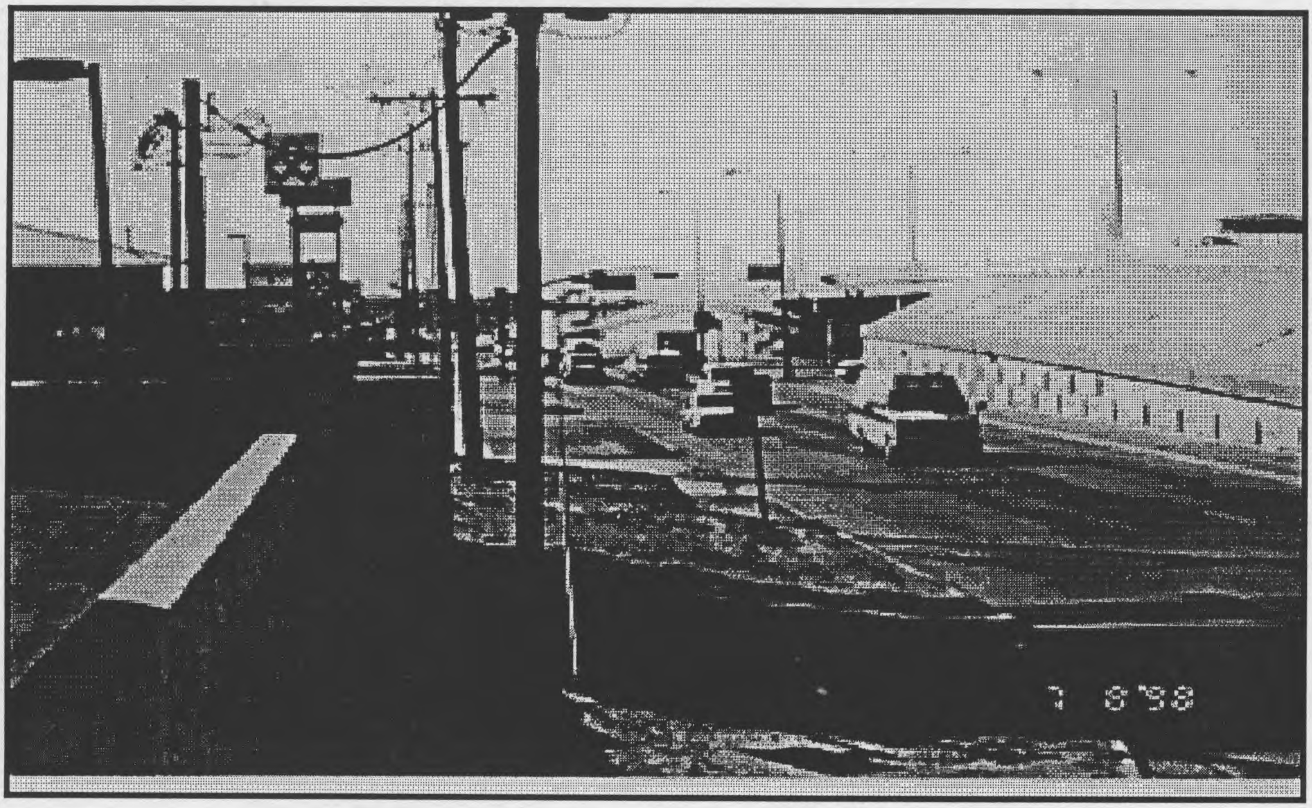

Figure 4-10a. El Paso: Looking East
View from the North Side of I.H. 10 Facing East Towards Hawkins Road.
Notice the Proximity of Driveway Cuts Accessing the Frontage Road

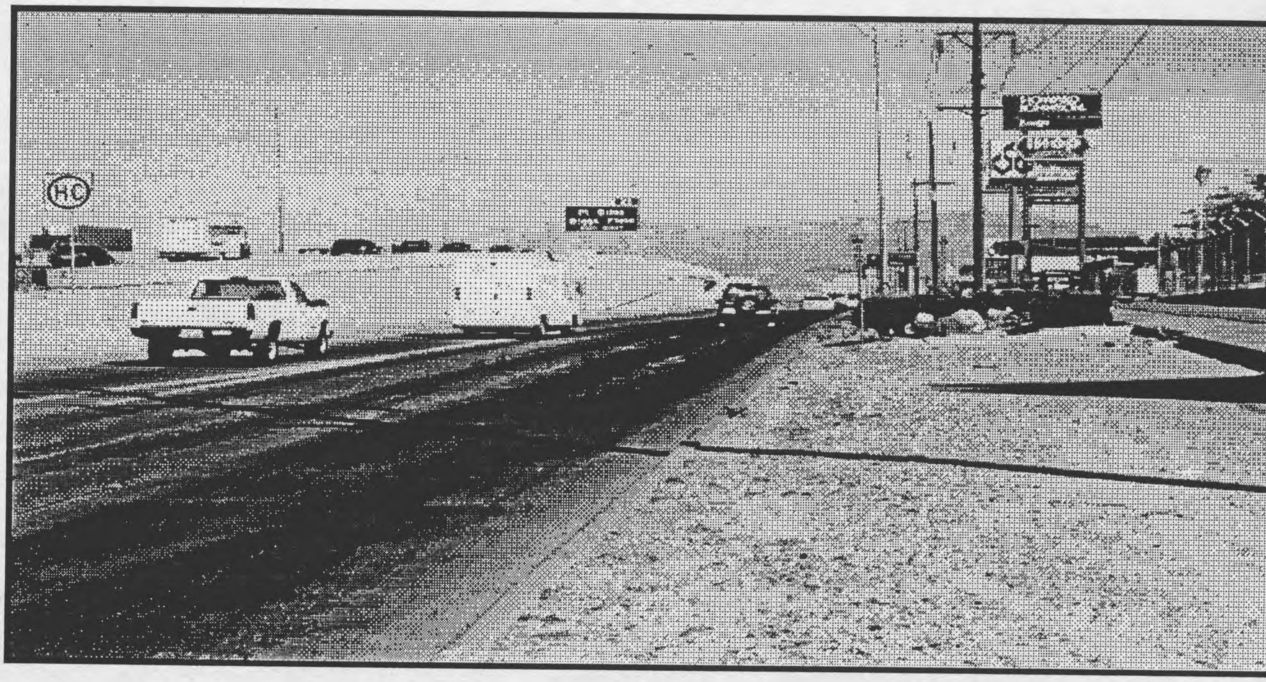

Figure 4-10b. El Paso: Looking West
View from the North Side of I.H. 10 Facing West Towards Hawkins Road. Notice the Various Land Uses to the Right. There is a Large Shopping Mall just Past Hawkins Road on the Frontage Road.

Gregory Case Study
Location: S.H. 35 and Volpe, principal focus southbound, prior to intersection

Introduction

This exit from southbound State Highway 35 (S.H. 35) provides access to the small town of Gregory, twenty miles north of Corpus Christi. The ramp was first planned in 1984, and construction was completed in 1994. No new development occurred after the opening of the ramp. Instead, several businesses have closed since its opening.

The ramp was planned when S.H. 35 was converted into a four-lane limited access roadway. At that time the neighborhood leaders (led by Mac Martinez of Mac's BBQ) petitioned TxDOT for a ramp that was not included on the original plans. The ramp allows freeway traffic to enter the frontage road without coming through a major intersection to the north of the businesses. TxDOT felt that there was little demand for this ramp but that it was feasible to construct both financially and physically. During construction, TxDOT opened a temporary ramp from the two-way frontage road that exited just north of the businesses. When construction was completed, the frontage road was converted to one-way.

TxDOT's decision to build this particular ramp was a direct result of local community pressure for its existence. TxDOT constructed it in an effort to appease local political officials, the City and the public in the area. However, TxDOT's decisions regarding the specific ramp location were based primarily on issues involving highway configuration rather than local preferences. The permanent ramp is located relatively far from the businesses in order to avoid conflict with a merging on-ramp from the interchange just to the north of the case study ramp. The City was in strong support of the ramp when it was first discussed. TxDOT also supported the ramp at that time in order to build good relations with the local community.

The predominantly working class population of Gregory has remained relatively stable over the last few decades at 2500 residents. Located at the intersection of S. H. 281, S.H. 35 and S.H. 202, the town relies on nearby chemical plants for its employment. The City is currently struggling for revenue, although it has hopes of attracting a new subdivision.

Development in Ramp Vicinity

The development along the frontage road served by this ramp historically consisted of a small row of locally owned businesses including a fruit stand, laundromat, tire shop, hair stylist, gas station, Dairy Queen and Barbecue restaurant. In the secondary area, behind this commercial development, development consists of low- and middle-income housing. Local roads provide back access to the commercial development from the residential area. However, these roads are unpaved and deeply rutted.

Originally located on the two-way frontage road of the Old Highway 35, the businesses have experienced a sharp decline since the conversion of the highway to a limited access roadway and a one-way frontage road. All but three of the locally owned businesses that existed five years ago have closed their doors. A combination of factors appears to have led to the decline of business since the construction of the permanent ramp.

The first is that motorists cannot see the businesses from the highway until they have passed the exit, making it difficult for the businesses to capture much pass-by traffic. At the ramp's exit point, motorists are unable to see any signs of development along the frontage road. This is due to the ramp's distance from the businesses and the braided geometry of the ramp, curving under an overpass which blocks any sight lines that may have existed. The lack of sight lines is exacerbated by the fact that this type of highway does not qualify for logo signs posted on the freeway because it is "too urban" according to the state legislature's criteria. However, two green regulation exit signs are posted.

The community leaders believe other factors play into the decline of businesses in this area. Another factor is the manner by which northbound traffic must approach the site. Northbound motorists must exit early, drive up the frontage road on the opposite side of the freeway, past the businesses, and then double back at the next turnaround. Their trip is further complicated by the turnaround, which merges with through traffic and then splits towards the freeway and towards the frontage road. Motorists may end up back on S.H. 35 headed south to Corpus Christi, instead of on the frontage road. The leaders feel that the conversion of the one-way frontage to two-way would eliminate all of these barriers.[61] In addition, leaders believed the

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[61] Interview with Joe Martinez, son of Mac Martinez – the owner of Mac's BBQ and primary community activist, October, 1998.

permanent exit was going to be located further south on the frontage road, where the temporary exit was located, allowing for access immediately before the businesses.

One engineer at TxDOT believes that design has little to do with the economic health of the site. He feels the businesses have declined simply because of limited demand for their services. He cited the proximity to Portland and Corpus Christi just to the south of Gregory as a disincentive to stop so close to a major arrival point.[62] He believes another problem with this particular site is the limited amount of acreage between the frontage road and the residential lots to the rear. The lack of depth to the lots keeps larger scale enterprises from locating along this frontage road.[63]

Traffic Conditions in Ramp Vicinity

While the ramp and the one-way frontage road provide important access to the businesses in this area for both through traffic and local residents, their design makes getting to the businesses relatively inconvenient.

The inconveniences for through-traffic are not obvious from casual observation of a map, but are made clear by physically attempting to get to the businesses from the freeway. The geometry of the interchange makes the businesses hard to see from the freeway and puts motorists on the frontage road some distance before the businesses. These conditions discourage motorists coming from the north. Coming from the south, motorists face a series of potentially-confusing exits, a long trip up the east frontage road past the businesses on the opposite side of the highway, and a complicated turnaround that merges into the left lane of oncoming traffic and then forks. Should drivers choose the first branch, they will be deposited back on the freeway heading towards Corpus Christi. TxDOT does not consider the resulting traffic patterns particularly problematic from the standpoint of safety and traffic flow. Local community members claim the exit was supposed to be located further south on the frontage road where the temporary exit was located, allowing for access immediately before the businesses.

The change from a two-way to a one-way frontage road has made travel in this area less convenient for local residents. TxDOT officials agree that some local traffic that used the

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[62] Interview with Eddie Eubanks, TxDOT Engineer, Corpus Christi District, October 1998.
[63] Eubanks.

previous two-way frontage road has been funneled into the neighboring residential area since the ramp was constructed, although they do not consider this a significant problem. One problem they do recognize is the tendency of local residents to drive the wrong way on the frontage road rather than go around (to the other side of the freeway or on local streets) to get to these businesses. Exacerbating this tendency is the low likelihood of receiving a ticket. Local law enforcement is provided by the sheriff, an elected position, who is unwilling to anger constituents by ticketing in a controversial area.

Issues

When talking with the different parties involved, it becomes evident that the perspectives on the situation vary widely. TxDOT engineers feel they have worked hard to accommodate local concerns and requests and have received little appreciation for their efforts. A braided ramp was constructed at considerable expense in response to the request of local officials for access from the freeway to this area. Local residents feel they have been provided with a ramp that ignored their input on the design characteristics that would best serve their community.

The local community in this situation advocates converting the frontage road to two-way in order to alleviate some of the problems. "We don't have the answer; we thought a two-way might get the traffic off the residential streets."[64] They believe a two-way road would allow people from town and northbound motorists to more easily access the site. "The target is to get more businesses back and facilitate the traffic flow [to] those that exist." They have taken their case to the Texas Transportation Commission in Austin, appealing the local District Office's decision to leave the one-way frontage road as it stands. They feel they have had the support of some TxDOT engineers in their attempt to change the frontage road. However, the Commission denied the appeal, citing safety as a primary consideration.

TxDOT believes that one-way frontage roads are inherently safer than two-way frontage roads. One engineer described it as a natural progression when a two-way street is converted to a one-way, creating a more efficient system.[65] Changing back to a two-way street is seen as a reversal of progress, of the facility's natural evolution.[66] For the most part TxDOT does not consider the traffic problems in this area to be a priority. One engineer concluded that the desire

[64] Interview with Fernando Gomez, Mayor Pro Tem of Gregory, October 1998.
[65] Eubanks
[66] Eubanks

for a two-way frontage road among the residents is primarily about convenience, rather than true need. He believes that some of the loudest voices may be motivated by self-interest, although local leaders have brought in their state representatives by framing the problem as one of economic development in a small minority community.

Instead, TxDOT proposes that the City of Gregory should correct the problems of local access by paving and extending one of the residential streets, Alamo, to the frontage road, so that Alamo allows access to the frontage road up stream from the businesses, eliminating the need for a two-way road.[67] Officials in City Hall say it is unlikely that the city would be able to afford to extend and pave Alamo Street. At the same time, they mention the economic burden of maintaining the overused residential streets being used as through arterials. This burden is exacerbated by the decline in revenue received by the city with so many local businesses failing.[68]

Lessons Learned

While it is unlikely that small differences in the location of a ramp alone can mean the demise of businesses, a series of design decisions can create an unfriendly environment for businesses along frontage roads. In particular, designs that restrict the visibility of businesses from the freeway and that make it difficult for local residents to reach the frontage road also increase the difficulty for these businesses to draw sufficient numbers of customers. Where possible, the design of ramps and frontage roads should be coordinated with the local street system to provide convenient access for local residents, especially when existing businesses along the frontage road depend on local customers. When the design of the interchange limits the visibility of businesses for freeway traffic, improved signage might increase the viability of businesses.

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[67] Eubanks
[68] Gomez

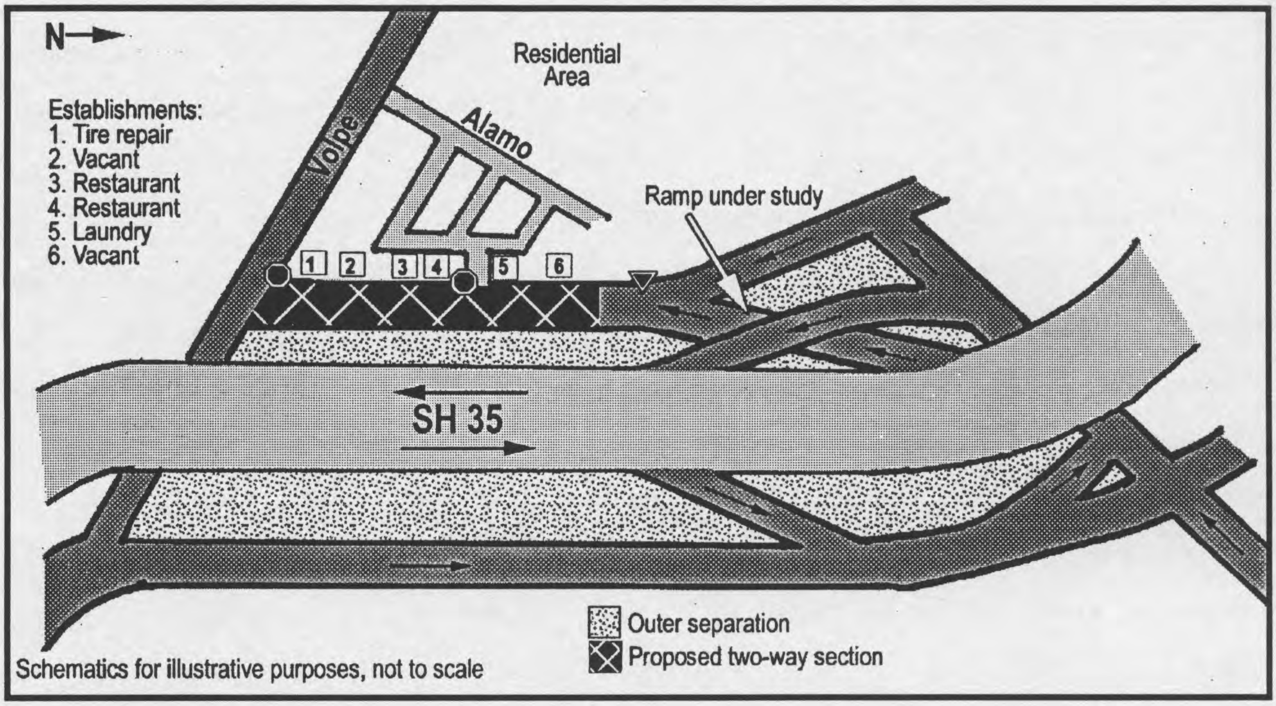

Figure 4-11. Gregory Case Study Schematic

Figure 4-12a. Gregory: Looking North

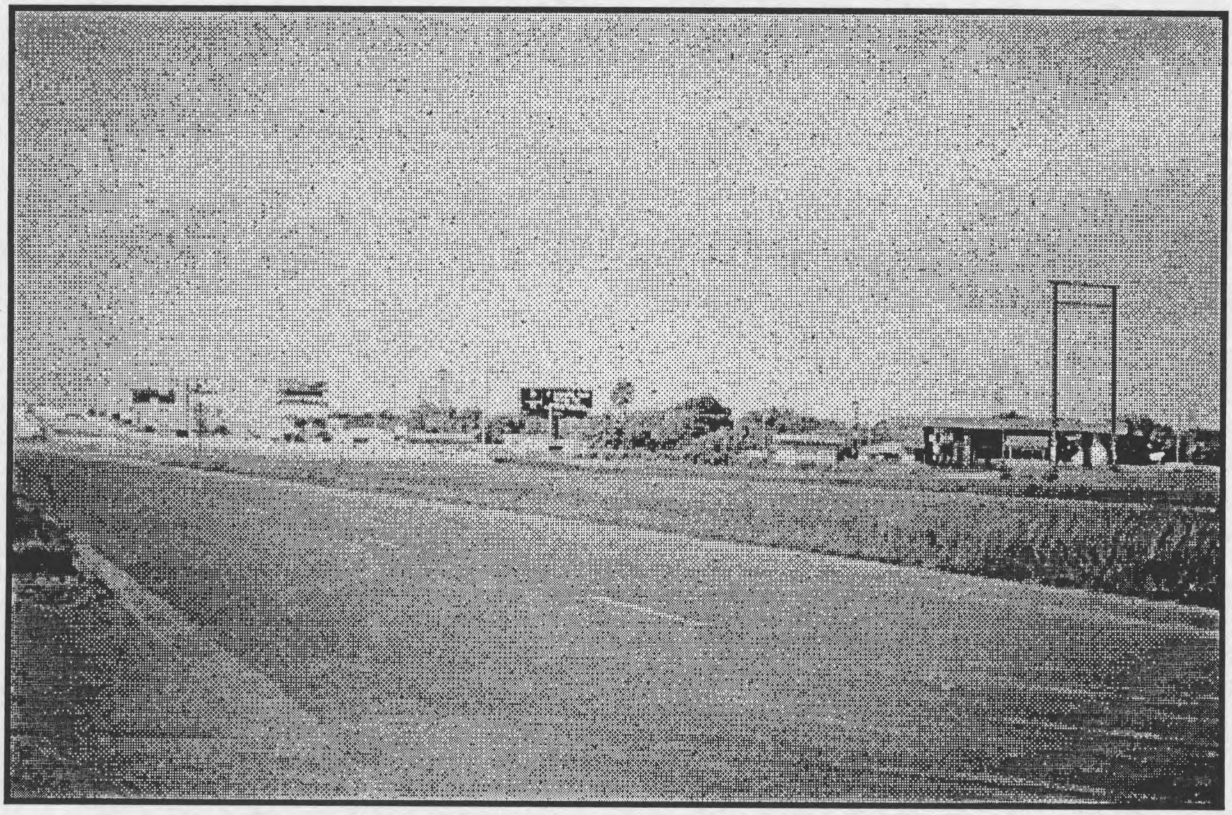

Figure 4-12b. Gregory: Looking South

Houston Case Study
Location: U.S. 59 and Fondren, principal focus northbound, prior to intersection.

Introduction

The ramps chosen for observation in Houston are along the south side of U.S. 59 (the Southwest Freeway), between Fondren and Beechnut. At the time of the Southwest Freeway's initial construction, the surrounding area was largely suburban and undeveloped. Due to the tremendous growth that occurred in the Houston-Galveston region in the 1970s and 1980s, local officials now consider this region as urban. The increased popularity of suburban cities along U.S. 59, particularly Sugar Land, contributes to the increased congestion along the Southwest Freeway. Acknowledging this trend, officials have plans to extend the HOV lanes well beyond the Sam Houston Tollway.

When the freeway was initially constructed, the ramps were designed to the diamond, or 'Y' configuration. However, in the early 1990s, modifications were made in the form of increased capacity to U.S. 59 and the changing of the ramp design from the 'Y' to the new 'X' configuration. The advantage of the X is that the weaving motion that occurs when those cars that are on the mainlanes maneuver to exit, and those cars coming onto the mainlanes are trying to accelerate to highway speeds, will no longer take place on the mainlanes themselves. With the X, the weaving motion takes place on the frontage roads. An additional benefit to the X, from a development point of view, is that cars travel along the frontage roads for longer periods of time. The particular ramps under consideration are those to the east of U.S. 59 between Beechnut, the southernmost major arterial, Fondren. Beechnut and Fondren intersect about two miles east of U.S. 59 forming a triangle. Located within this triangle is Houston Baptist University, which at one time owned all of the land within Beechnut, U.S. 59 and Fondren. However, over the years, parcels of land have been sold, and other land uses have developed.

Development in Ramp Vicinity

Houston is the last major city in the US not to use zoning as a major land use control. Residential development has historically been controlled by deed restrictions, while commercial development has been controlled by economic and market forces. The area along U.S. 59 consists of retail development and institutional uses. There are numerous driveways along the frontage roads, but they all conform to TxDOT standards for driveway spacing adjacent to frontage roads. In 1998, Memorial Hospital began construction of a new facility adjacent to the frontage road. At least one new driveway will be constructed to provide increased accessibility to the facility. The retail development at U.S. 59 and Fondren consists of a strip mall type development with ample parking and accessibility. Due to the sporadic conditions of the Houston economy, many of the businesses in this development have either gone out of business or moved to other locations. Therefore, most of the traffic generators appear to be the Memorial Hospital facilities which have access to Beechnut and the frontage roads. The areas to the west of U.S. 59 are residential, hidden behind a sound wall. The only access to these neighborhoods is along Fondren and Beechnut at points west of U.S. 59. While Houston METRO has routes that travel along the frontage roads, there are no sidewalks, thus making this area very dangerous for pedestrians.

Traffic Conditions in Ramp Vicinity

Because of the redesign of the ramps in the area, motorists traveling north must either enter the freeway before Gessner, or travel a distance of nearly two miles through two major intersections before another opportunity to enter. Therefore, the weaving motion that is occurring between Beechnut and Fondren is taking place at virtually highway speeds. The number of driveways, although within TxDOT limits, adds to the conflict, even though the pavement widths along the frontage are at least 36 feet. The X design places cars on the frontage roads for longer periods of time, and coupled with limited on-ramps increases the area's congestion. It would appear that the area would become undesirable for future development. However, without unified land use controls development can occur, complete with new driveways, as long as TxDOT approves.

Issues

Even though the driveways along the frontage comply with TxDOT requirements, the volume of traffic indicates changes in the driveway spacing may benefit the area. The reduction of the number of driveways by using shared driveways between development would dramatically reduce the variance in speeds found on the frontage. The design of the X was chosen obviously to increase the flow of traffic on the mainlanes, but it also reduces the flow on the frontages. The new hospital facility appears to use a joint-use driveway for at least one access point. But once the construction is complete and the unit is fully operational, the traffic generated cause an interest in additional access points.

Lessons Learned

This is an area that has undergone tremendous change over the last 30 years. Transitioning from suburban to urban led to the modification of ramps and increased highway capacity. Officials believe that with the closing of the 1990s, the land uses will remain constant. The prediction is that congestion along the frontage roads will not increase significantly in the future due to the current land uses. However, some officials admit that if the current land uses change to ones that typically generate increased traffic, the congestion problems will worsen.

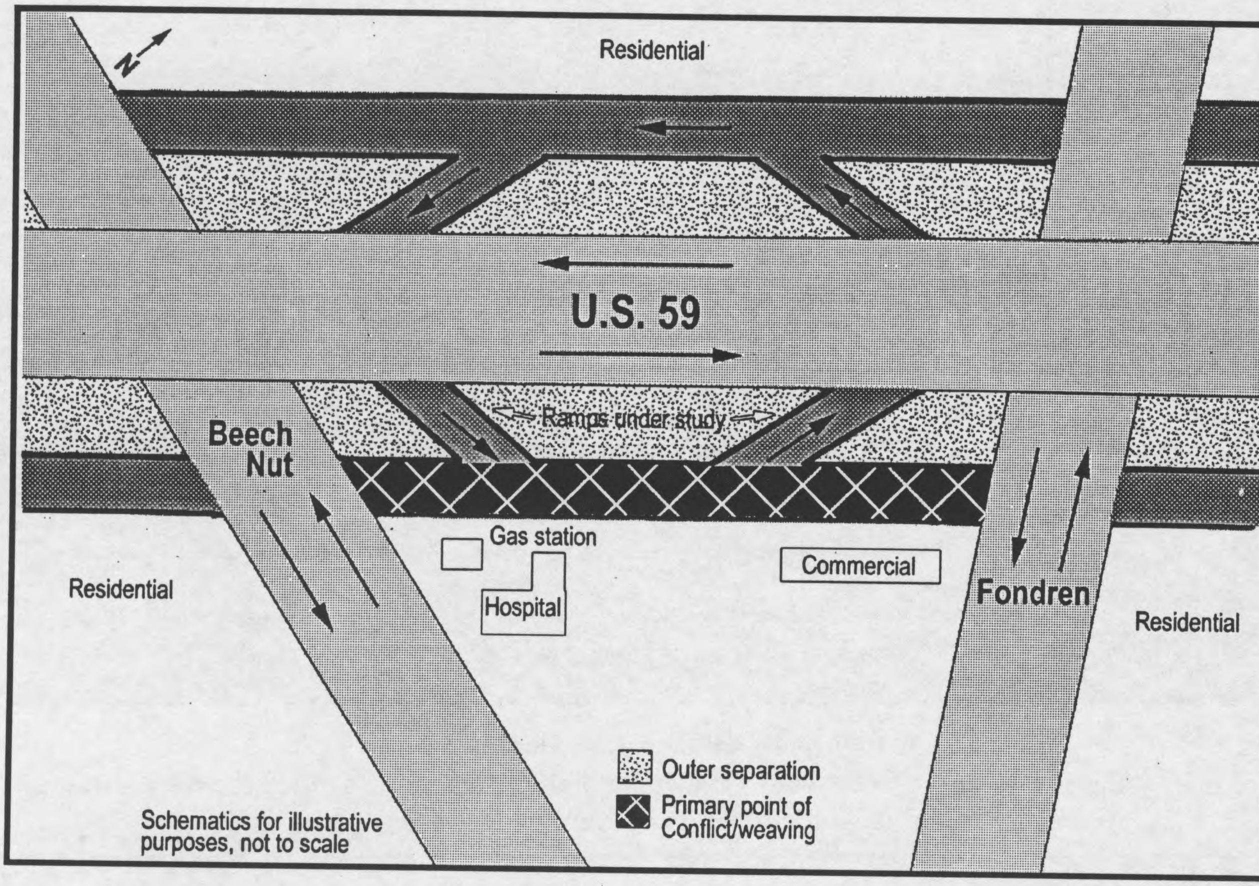

Figure 4-13. Houston Case Study Schematic

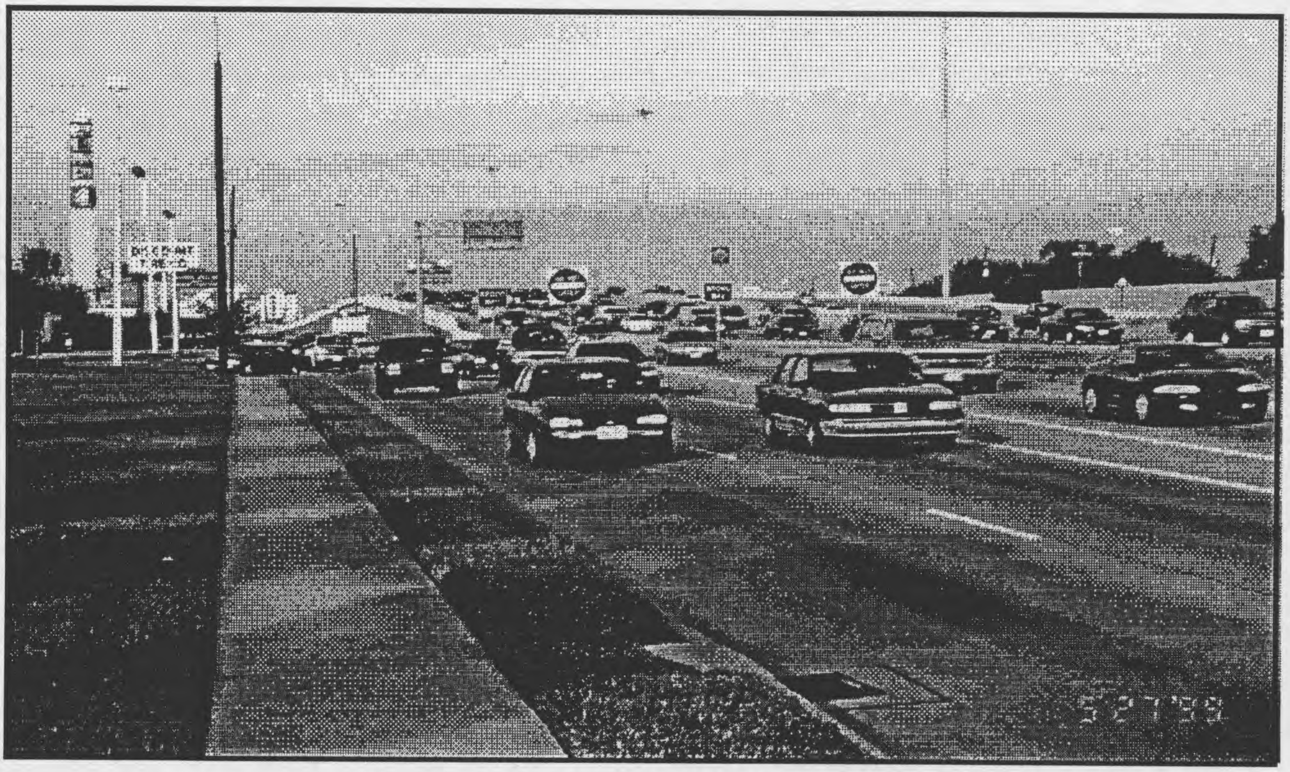

Figure 4-14a. Houston: Looking South
View facing south on the Southwest Freeway, north of Beechnut. Notice the high volume of traffic on the Frontage Road.

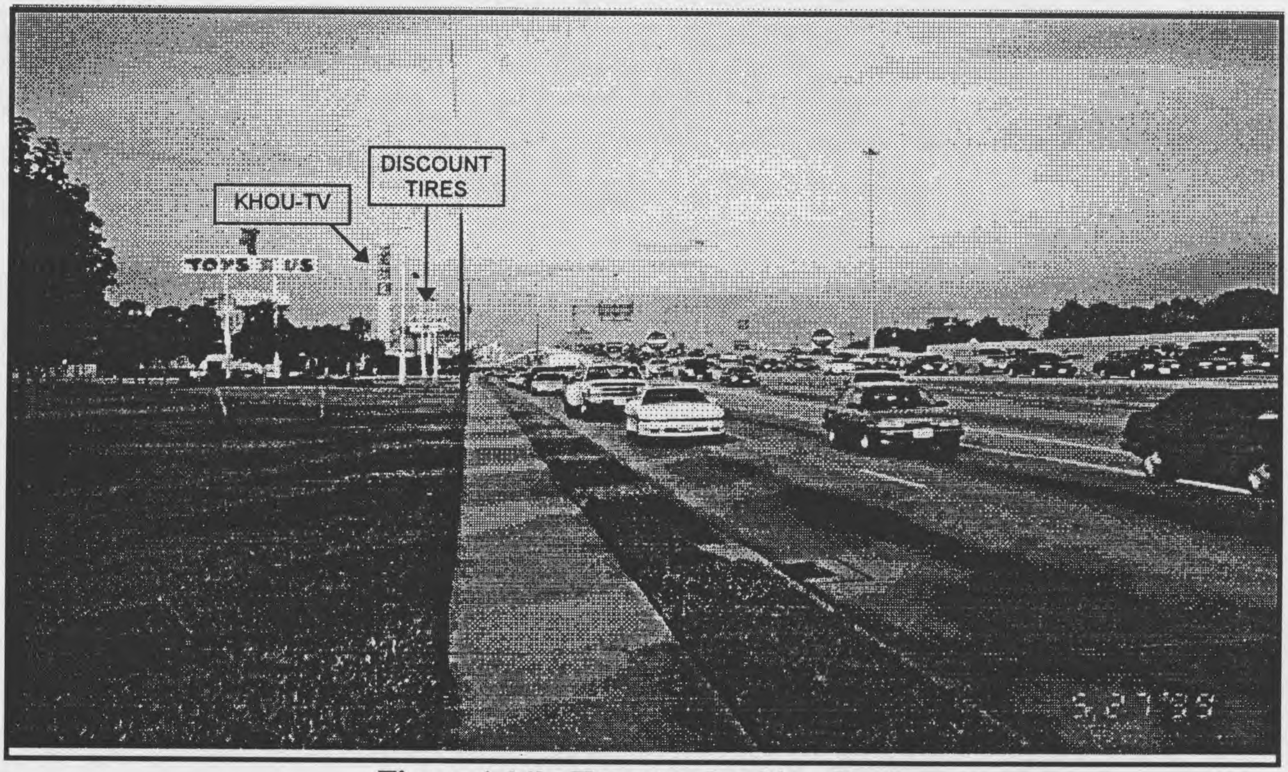

Figure 4-14b. Houston: Looking South
View facing south on the Southwest Freeway, north of Beechnut. Notice the various land uses on the left.

Lubbock Case Study
Location: Loop 289 and Slide Ave., principal focus eastbound, after intersection.

Introduction

The Loop 289 and Slide location is in an urbanized area on the southwest side of Lubbock. The area immediately adjacent to the frontage road and ramp is commercial, however, a multi-family residential area is within a mile. Also, new high value home construction has been underway in nearby subdivisions to the south. The opposite side of the freeway is comprised of an established single family neighborhood of moderate value.

The ramp was originally constructed in 1971 in a diamond configuration. The freeway structure is largely elevated at this location. In 1992, the ramps between Slide and Quaker were reversed. Prior to the reversal, accessing the businesses between Quaker and Slide required vehicles to go through the Slide traffic signal. Therefore, the principal purpose was to provide more convenient access to business along the frontage road between Slide and Quaker.

Lubbock has experienced population growth, but at a decreasing rate since the ramp was constructed. Population increased 16.7% between 1970 and 1980, 7% between 1980 and 1990, and 6.7% (projected) by 2000. The 1990 population of 194,522 increased to 198,832 by 1999.

The area was undeveloped prior to the freeway and ramp construction in 1971. Thereafter, the commercial development began and is the dominant land use. There is some multi-family residential east of the next intersection, Quaker Ave. Prior to the ramp reversal, a car dealership was at the Slide Ave. intersection. It is unknown whether the ramp reversal contributed to the closing of the dealership, but the timing was such as to be considered a contributor. One city planner noted that when the ramp was reversed, "the previous winners became losers, and the previous losers became winners". Also obvious from the field review, is that the building located next to the former car dealership site, is also vacant. It is reported that the building has some structural problems, including leakage, so the ramp reversal cannot be considered in isolation as a variable.

Development in Ramp Vicinity

The dominant land use is commercial at the study intersection. Specifically, a US Post Office is located near the base of the ramp. Other sites include a car dealership as the traveler approaches Quaker Ave. The nearby intersection with the minor arterial allows those exiting the freeway to access a credit union or make another series of right turns to access a commercial strip center along Slide. The strip center includes a restaurant and various shopping opportunities. The land use changed at the intersection of Slide and the frontage road from only permitting a car dealership to allowing the commercial strip center. Multifamily residential is located along the frontage road after crossing Quaker. A major chain hotel is at the next intersection of the frontage road and Quaker Ave. Additional single and multifamily residential are in the neighborhoods adjacent to the freeway and near the ramp.

Issues

The primary issue with the ramp at Slide Ave. is the turning movement of vehicles that exit the ramp and enter either the US Post Office or make the right turn at the minor arterial, Wayne Street. The right turn at both locations is complicated by the high speeds traveled by vehicles on the frontage road. The Study Team observations were that vehicles were exceeding the posted 40-mph speed limit. Delays are created as vehicles slow down or come to a stop as they descend the ramp to make a right turn. Also, accidents occur due to the turning movements. (Table 4-2)

TxDOT's access management guidelines are followed, along with the Lubbock City Ordinance. The ordinance allows two driveways cut within the first 100-ft. and one for each 200 ft. thereafter. There is communication between TxDOT and city officials; the relationship is functional, but viewed as systematically imposed. There are no additional plans for this ramp location.

Table 4-2 Lubbock Accident Report Summary Loop 289 at Slide			
Year	*Yearly Totals*	*Year*	*Yearly Totals*
1998	24	1993	40
1997	49	1992	28
1996	25	1991	27
1995	48	1990	27
1994	44		

Source: City of Lubbock Traffic Engineering Department

Lessons Learned

The minimum distance from the base of the ramp to the right turn into the Post Office and the adjacent street is too short. This is particularly the case given the speeds traveled by vehicles along the frontage road. Other locales have doubled striped a length of roadway to discourage vehicles exiting the freeway from making such turns. In many areas, however, the striping is ignored. In such cases, TxDOT should construct raised curbing or another type of barrier to physically prohibit unsafe turning movements. In cases of new development, TxDOT will want to consider prohibitions against driveway access within a certain distance of egress ramps.

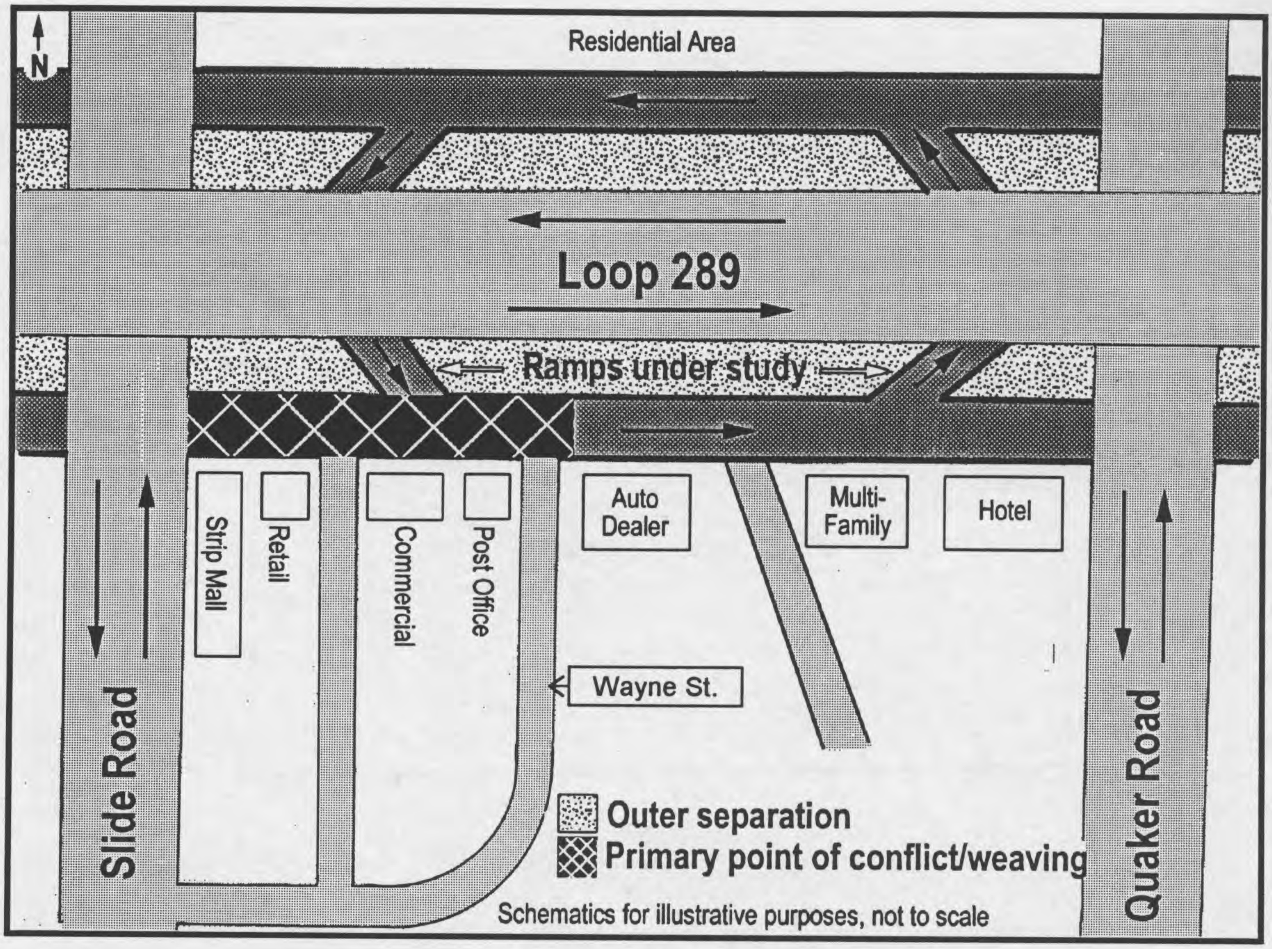

Figure 4-15. Lubbock Case Study Schematic

Figure 4-16a. Lubbock: Looking West
Loop 289/Slide Road, South of Highway, Eastbound Frontage Road

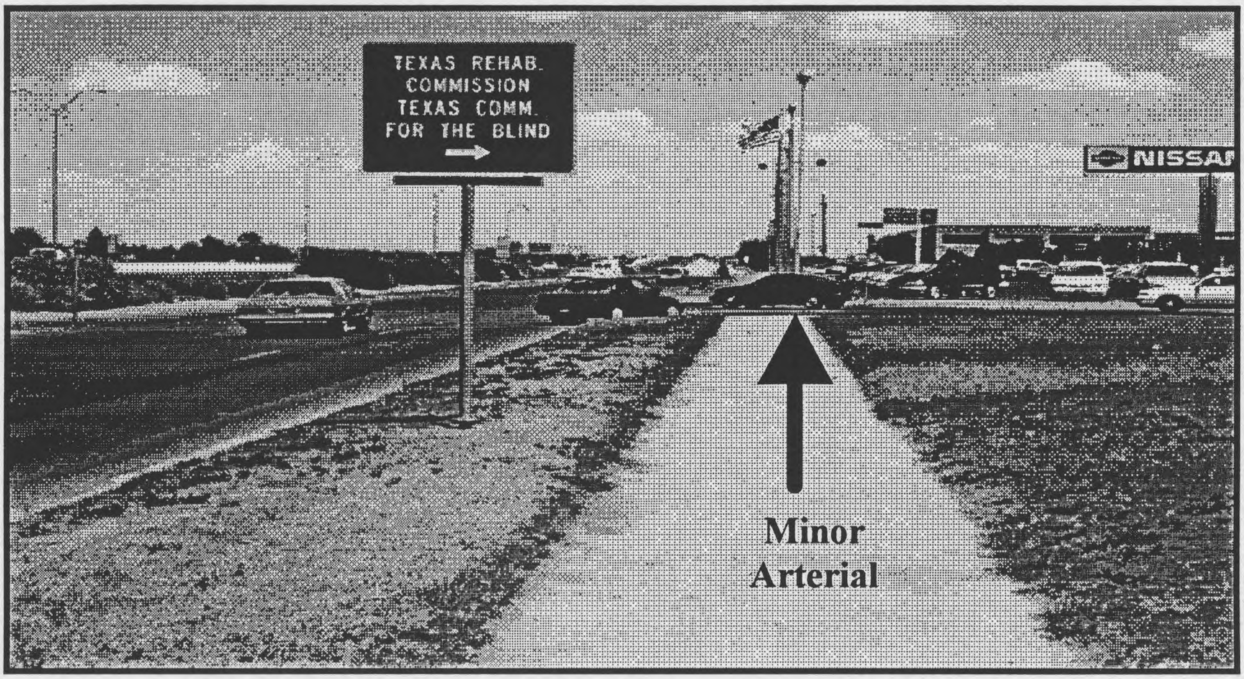

Figure 4-16b. Lubbock: Looking East

Marshall Case Study
Location: I-20 and U.S. 59, principal focus eastbound, after intersection

Introduction

The intersection of I.H. 20 and U.S. 59 became operational when that section of the interstate opened in the early to middle 1960s. The ramp is located at the far south end of the city, very near the city limits and proximate to rural areas. It is the only interstate access into Marshall. The convenience store oriented, commercial area that has developed there caters to through-traffic traveling the interstate, particularly truck traffic. The interchange is a typical diamond controlled by stop signs. The U.S. 59 is constructed over I.H. 20 and has a steep slope with the crown at the centerline of the interstate. Initially the bridge had only 2 lanes; at that time the level of citizen complaints was extremely high. The bridge was subsequently widened to 4 lanes, which reduced the level of automobile and truck conflicts.

Although Marshall is a small city by Texas standards, it is the largest in Harrison County and the seat of county government. In 1950, Marshall had 22,225 residents; by 1990 that figure was 23,682. During the 1980s, the population had been higher, but decreased 5% during the decade as the oil industry experienced a decline. Marshall's economy is now more diverse, based on industry, agriculture, and tourism.

Development in Ramp Vicinity

The land use at the intersection is light commercial including hotels and gas stations/convenience stores. There is a mobile home park behind the gas station on the northwest corner. Contiguous properties are sparsely developed and primarily rural, residential in nature. Prior to the interchange construction, the area was rural. Two-way frontage roads provide access to the properties fronting the interstate. The opening of the interstate providing access into Marshall did serve as an impetus for development at this location.

Marshall employs a zoning system and categorized the area near the ramp and intersection as commercial. The classification was a revision from the previous designation as rural.

Issues

This location is a major attraction to truck traffic traveling I.H. 20. When the trucks cross over I.H. 20 on U.S. 59, they often hinder the automobile flow because their acceleration and deceleration is slow after making the turn from the frontage road. Their movement is also affected by the slight incline in U.S. 59 as it crosses I.H. 20. This location has the highest number of accidents in Marshall (Table 4-3). Citizens still complain about the truck traffic, although the level of comments has decreased since the bridge was widened.

There are no existing plans or proposals to modify the design or operation at the I.H. 20/U.S. 59 intersection. The city of Marshall has asked TxDOT to conduct a study to determine whether signalization is needed at the location. The very long range thinking by TxDOT is that a new highway bypass constructed to minimize the through truck traffic on I.H. 20 would be desirable.

Lessons Learned

The location of major truck stops at critical locations serves to lower the speed and accessibility of other traffic. In this particular example, all access into Marshall is affected by the conditions at this location. Because this is principal route into Marshall, the commercial activity at this location is not unexpected.

Table 4-3

Marshall: Total Accidents Case Numbers*

Year	*Yearly Totals*
1997	40
1996	21
1995	21
1994	26
1993	44

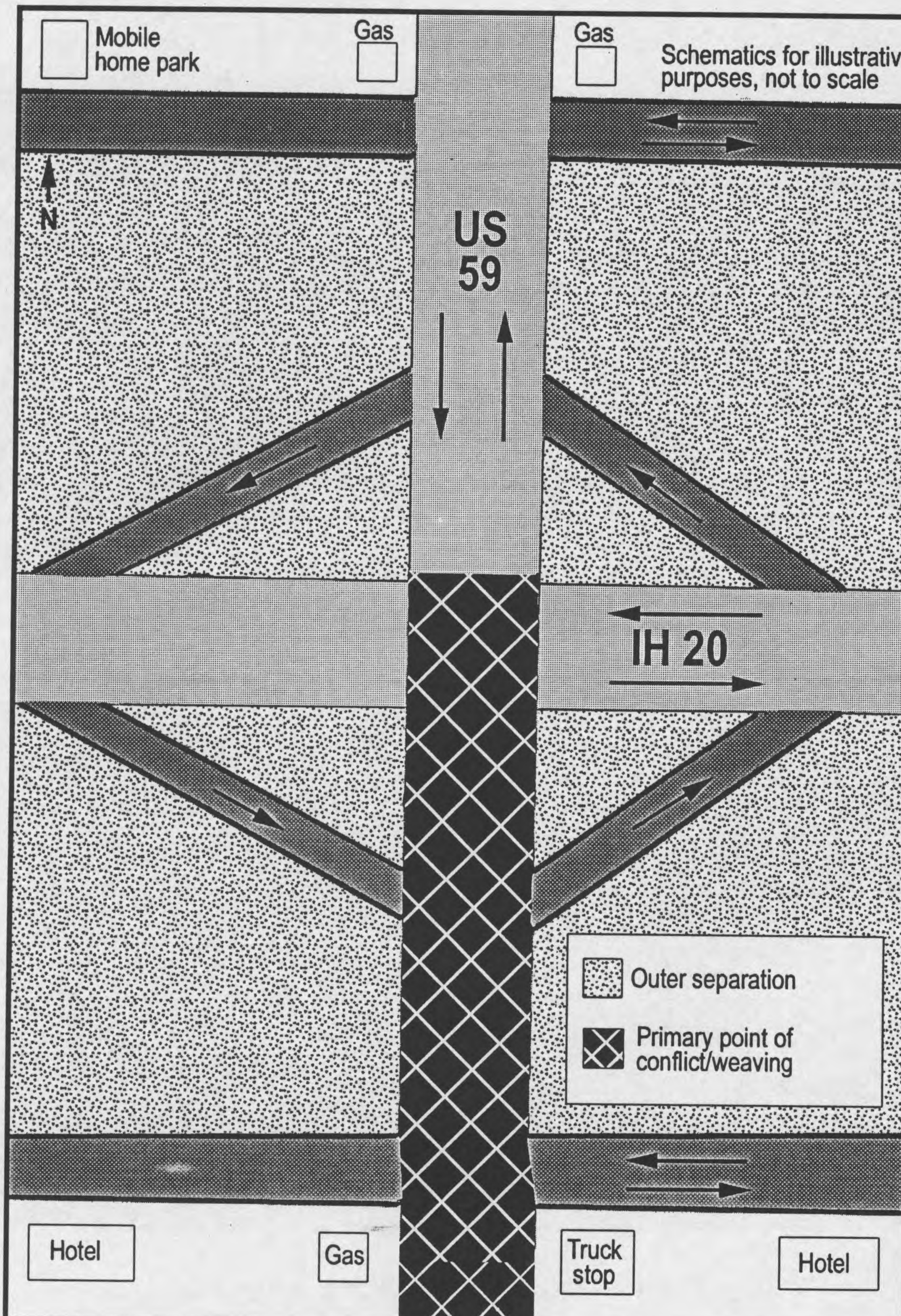

Figure 4-17. Marshall Case Study Schematic

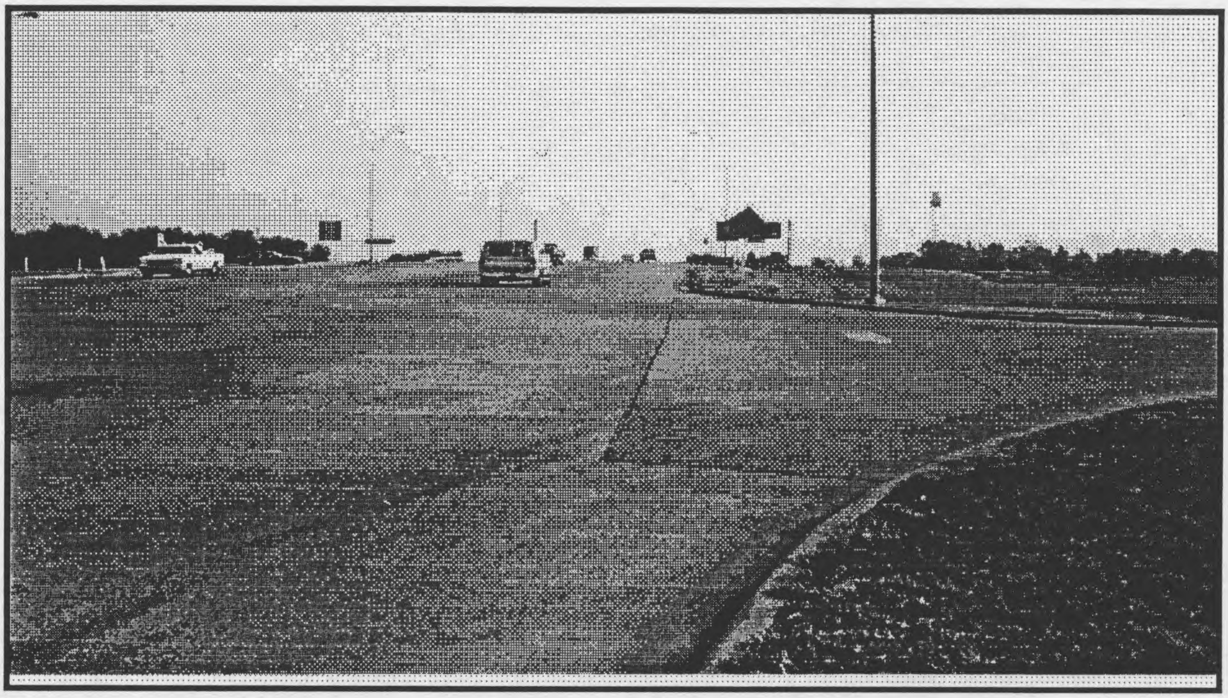

Figure 4-18a. Marshall: Looking North
IH-20 / U.S. 59

Figure 4-18b. Marshall: Looking West
IH-20 / U.S. 59

Midland Case Study
Location: I.H. 20 and S.H. 349, principal focus westbound.

Introduction

Located at the southern end of town, this exit is the primary entrance to the city of Midland. The ramp was first planned and completed in the 1960s. The first development occurred around the ramp in the 1980s. The area around the ramp has not changed much until the past three years. Currently, the city is contemplating renovating the ramp and its surroundings in order to draw in more motorists to the center of town. They have received ISTEA funding and will be holding a public hearing to decide how to use the funds.

I.H. 20 was built in the 1960s and 70s during the first wave of interstate technology and design criteria. Designed for rural conditions, the freeway used a side system of two-way frontage roads with button-hook ramps. These ramps require yields on the frontage road in both directions and a low exit speed so vehicles avoid running off the road; a minimal length is provided, for acceleration; this ramp design works best at low volumes of traffic. As the volume of traffic increased on I.H. 20, TxDOT added a lane on the frontage roads in this area to smooth the flow of traffic through the interchange. This system functions well in areas that remain largely rural. TxDOT's primary concerns with this system are threefold: 1) As the town grows, the volumes of traffic increase. 2) Outsiders are not used to these types of ramps and make serious mistakes, exiting too quickly or failing to yield. 3) NAFTA freight traffic will increase and the button-hook is an awkward ramp for the trucks.[69]

The population in the Midland MSA grew from 82,636 in 1980 to 106,611 by 1990, a 29.0% change.[70] Little of the City's recent growth has taken place along the I.H. 20 corridor, although a recent sewer line may spur new development. Most of the city's growth has occurred to the northwest.

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[69] Interview with Gary Law, Odessa District, TxDOT, September 1998.
[70] County and City Data Book 1994, US Department of Commerce: Bureau of the Census, Washington, DC: US Government Printing Office, 1994.

Development in Ramp Vicinity

This particular ramp gives access to S.H. 349, a main north/south arterial through town at the time the interstate was built. Although no development existed at this particular spot on the road, it was a natural junction to provide ramp access. At the time, communities were disinclined to have highway traffic stop in their cities, so I.H. 20 is located about two miles from the city center. The interstate was designed to skirt the city. The site has changed little in the past 20 years. The area was annexed to the city in 1964. In the vicinity of this ramp, the development is sporadic and strung along the frontage road and down the cross street. Many of the existing businesses were built in the last three years. Recent construction added a McDonald's, a Sonic drive-through restaurant, a Comfort Inn and a gas station to the existing Super 8 Motel.

Two key factors created this particular development pattern. The first is the distance from the city. Because the ramp was located far from the town center, relatively little has been developed around it. Some of the nearby uses have traditionally been pushed to the outskirts and considered undesirable neighbors for development. These include a single-room occupancy hotel and a piece of unannexed, unregulated residential development.

The second feature is the lack of utilities. However, the City recently put in a new water/sewage line to serve the airport, but with the intention of providing service to development along the highway as well. Until the new water/sewage line was completed, the number of hotels or restaurants that could be constructed was limited to those plots where a sewer line could be connected from a main line to the north.

Currently, the city is contemplating improvements to the ramp and its surroundings in order to draw in more motorists to the center of town. In the 1990s, the Interstate is seen as an economic resource, providing opportunities for hotel, restaurant and convenience store ventures. This ramp is seen as the future gateway to Midland. TxDOT is conducting a study for the I.H.20 corridor through Midland and Odessa to look for methods to improve safety and enhance mobility. There are plans to make the ramp more attractive through landscaping and sign control. The city reported that there is no resistance to their plans to further develop this area.[71]

[71] Interview with Becky Hamm, Planning Department, City of Midland, September 1998.

Currently zoned as an industrial park, the city has plans to change to a less restrictive zoning code (Business Park) in order to spur growth. Under the new code, more intensive uses, primarily commercial, would be allowed. There would be two zoning layers in this area. The first is the base layer, that of a business park district. This would allow all of the uses currently allowed and also include offices and outdoor storage facilities or warehouses. The only activities excluded would be pipeyards and oilfield equipment. Billboards and a proliferation of signs are also prohibited. Sexually oriented businesses are discouraged but allowed. The city is hoping for businesses like auto sales and is trying to guarantee new curb cuts to enable access for new businesses. The second layer is the I.H. 20 Corridor Overlay district. This district would cover 300 to 400 feet on either side of the highway and would regulate signs, landscaping, xeriscaping and setbacks as a part of a beautification program for the interchange area.[72]

Traffic Conditions in Ramp Vicinity

At this time, there have been few major problems with the ramp and its surroundings. With increased traffic however, the yield and button-hook configuration could cause problems for trucks and out of town visitors. Although city officials feel that overall the interchange works well, they are hoping for interchange improvements from TxDOT including an upgrade of the access along the Interstate.[73]

The TxDOT driveway manual notes that there are two ways to control access: by regulating site design and through right-of-way ownership. Access to the property along the frontage roads is strictly governed by this TxDOT district. As part of the design of I.H. 20 in the 1960s, TxDOT bought the access rights in this area giving the agency control of where people enter and exit the facility. Recently TxDOT sold the rights for one driveway in the area for more than $50,000.[74] However, a demand for access beyond that provided by existing ramps in the area shows up in the form of "Texas ramps," self-made exits. The newer neighborhoods located in other parts of the city do not have convenient ramps to serve them. Although it is relatively inexpensive to build more ramps in this region, the department has not been able to keep up with the demand.[75]

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[72] Hamm.
[73] Interview with Cameron Walker, Planning Department, City of Midland, September 1998.
[74] Law.
[75] Law.

Although the ramp is not operating anywhere near its capacity, TxDOT plans to change the intersection in two or three years to eliminate the two-way frontage road and the button hook configuration.[76] The primary options for future changes are the conversion of the frontage road to one-way and the creation of an X configuration instead of a diamond. These changes would be undertaken to make the ramp safer for the anticipated increase in use and to encourage economic development along a greater stretch of the frontage road. The modifications would allow longer access to frontage property, a longer amount of time to weave over to the right lane, and would take up less right-of-way. These changes would be fairly simple, would require little to no additional right-of-way, and would be relatively inexpensive at $4 million. If an overpass is involved, however, the complexity and the cost would both increase.[77]

Lessons Learned

Utilities can be a strong constraint on growth and offer one mechanism by which the city can control development, either encouraging or discouraging growth. It may be possible for cities to control the types of businesses and the design of commercial sites using zoning designations and overlays. Right-of-way acquisition can provide an effective way to manage access, but drivers may compensate for limited access by creating their own ramps.

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[76] Law.
[77] Law.

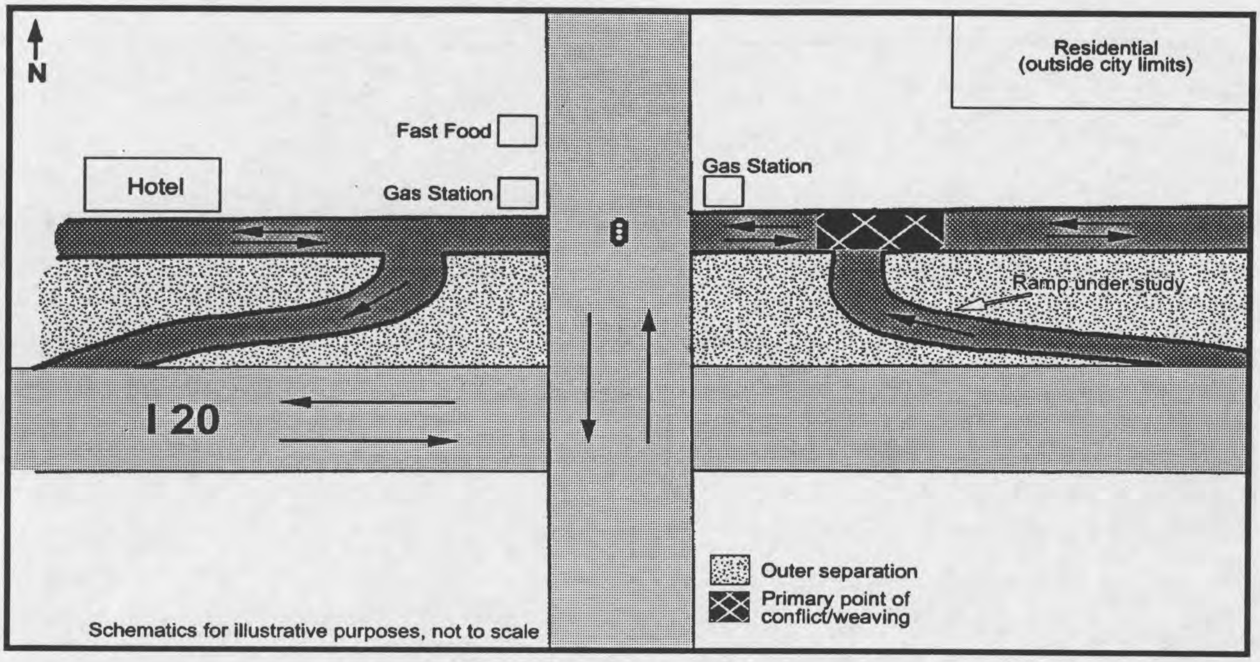

Figure 4-19. Midland Case Study Schematic

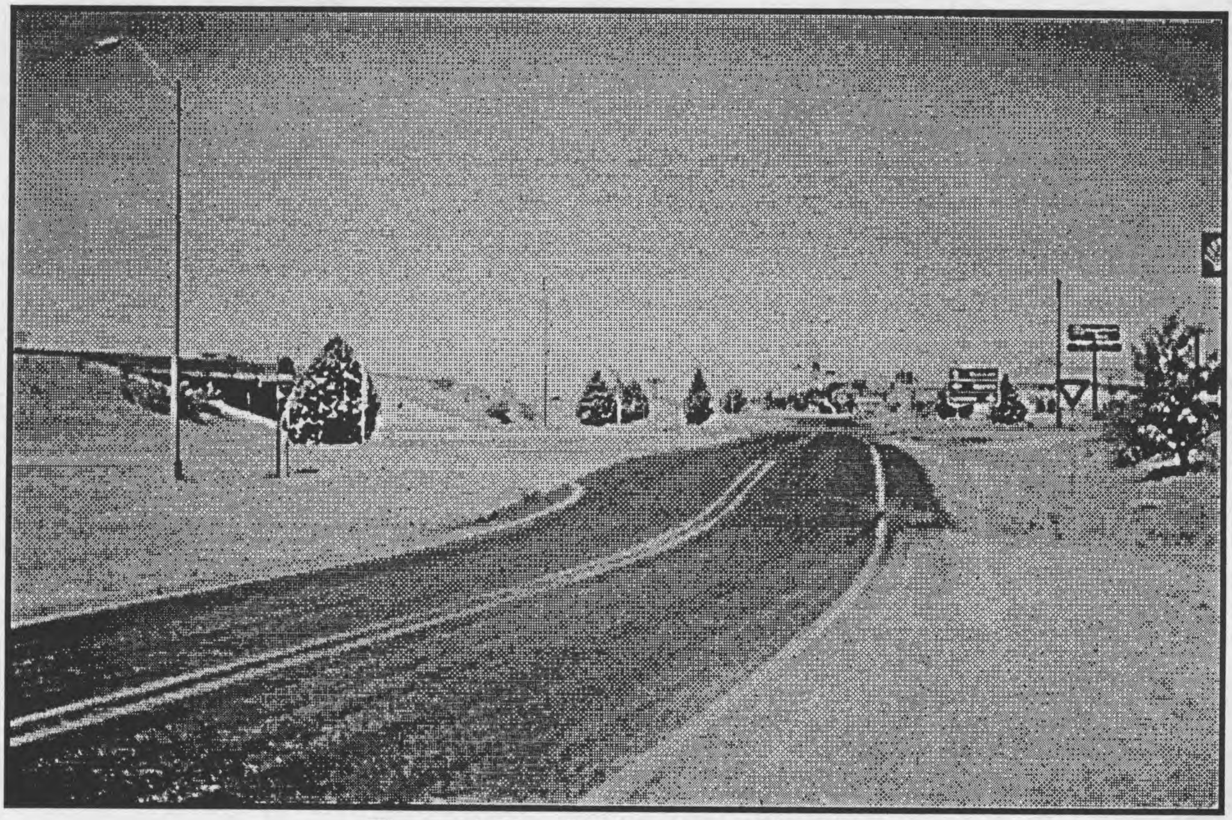

Figure 4-20a. Midland: Looking West

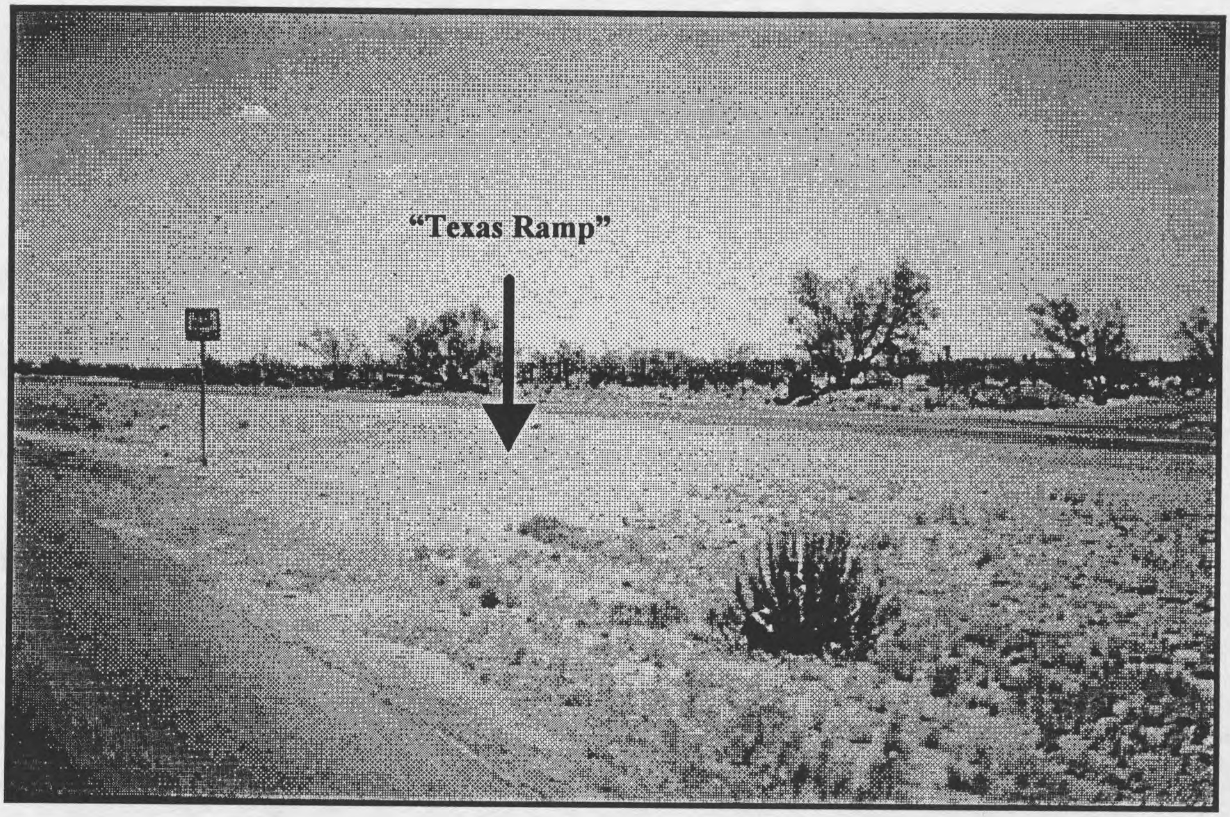

Figure 4-20b. Midland: "Texas Ramp"-- Unofficial Ramp Created by Motorists

Pecos Case Study
Location: I.H. 20 and U.S. 285, principal focus westbound.

Introduction

The population in Pecos has remained relatively stable at around 12,000 residents for the last 40 years. Located outside of town at the southern edge of the city limits, this exit primarily serves a truck stop although it also gives access to a north/south arterial. The ramp was planned and completed in the 1960s. This ramp is a modified button-hook leading onto a two-way frontage road that changes to a dirt road just beyond the ramp.

Interstate 20 was built in the 1960s and 70s during the first wave of Interstate construction and design criteria. Designed for rural conditions, the freeway uses a side system of two-way frontage roads with button-hook ramps. These ramps require yields on the frontage road in both directions and a low exit speed so vehicles avoid running off the road, and they provide a minimal area for acceleration; they work best at low volumes of traffic. This system functions well in areas that remain mostly rural. TxDOT's primary concerns are twofold: 1) Outsiders are not used to these types of ramps and make serious mistakes, exiting too quickly or failing to yield. 2) NAFTA freight traffic will increase and the button-hook is an awkward ramp for the trucks.[78]

Development in Ramp Vicinity

The area around the ramp has not changed substantially since the entry of the truck stop in the late 1980s. Currently development around the interchange consists of the truck stop, one gas station, a tire repair business and several empty or abandoned businesses. The development is sporadic and strung along the frontage road and down the cross street. Aside from the truck stop, the development has created little extra demand on the ramp and interchange.

Although no development existed at the time of the freeway construction at this particular spot on the road, it was a natural junction to give ramp access. At the time, communities were disinclined to have highway traffic stop in their cities, so I.H. 20 is located nearly a mile from the city center. Now the Interstate is seen as an economic resource, providing opportunities for hotel, restaurant and convenience store ventures, although not many have been successful in this location.

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[78] Interview with Gary Law, Odessa District, TxDOT, September 1998.

Two key factors created this development pattern, with businesses that serve mostly Interstate traffic rather than local customers. The first is the distance from the city combined with the stable population of the city. With a small and stable population, the city generates little demand for new businesses, and any new businesses serving the local population are likely to locate closer to the center of town. The second feature is the distance from the next city down the highway. The number of miles to the next stop (70 miles to the west or 40 miles to the east) means that the traffic through this interchange can support a truck stop and other traveler services.

The city reported that there is no interest in focusing efforts to further develop this area.[79] They believe the current businesses saturate the market, but are willing to work to keep the truck stop in the area. The city annexed the interchange as part of a development deal with the owners of the truck stop, but has no plans for new development.[80]

Issues

Trucks and vehicles exit the highway and come to a stop at the intersection. Most of the traffic is trucks headed for the truck stop on the frontage road on the northwest side of the intersection. At this time, there have been many problems with the ramp due to its design and the heavy use of the ramp by trucks. The high fills on the sides of the ramp create steep slopes. The steep slopes on the overpass create dangerous conditions for vehicles crossing U.S. 285 and short sight lines to the intersection with the frontage roads.[81] The steep slopes and limited sight lines have led several trucks to roll and have contributed to many accidents at the frontage road intersection with U.S. 285. Similar problems have occurred on the westbound on ramp, again due to the configuration of the ramp and its impact on trucks.

TxDOT has attempted to flatten the ramp a bit to keep the trucks from rolling if they take the exit too quickly and hopes that a planned new X configuration will alleviate these problems. Advantages of the X modification will include federal funding for the frontage road. The current configuration, a modified diamond, keeps the trucks off the frontage road, but the state is solely

[79] Kenneth Neal, City Manager
[80] Kenneth Neal
[81] Doug Eichorst, TxDOT Engineer, Pecos

responsible for its maintenance.[82] In addition, the new configuration will eliminate the current button-hook ramp which should alleviate some of the safety concerns.

Lessons Learned

A ramp will not induce new commercial development, if the population in the area is not growing. Trucks introduce their own problems and needs, especially in areas with a high number of trucks passing through. The entry of the truck stop on a ramp leads to its own set of special considerations.

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[82] Eichorst.

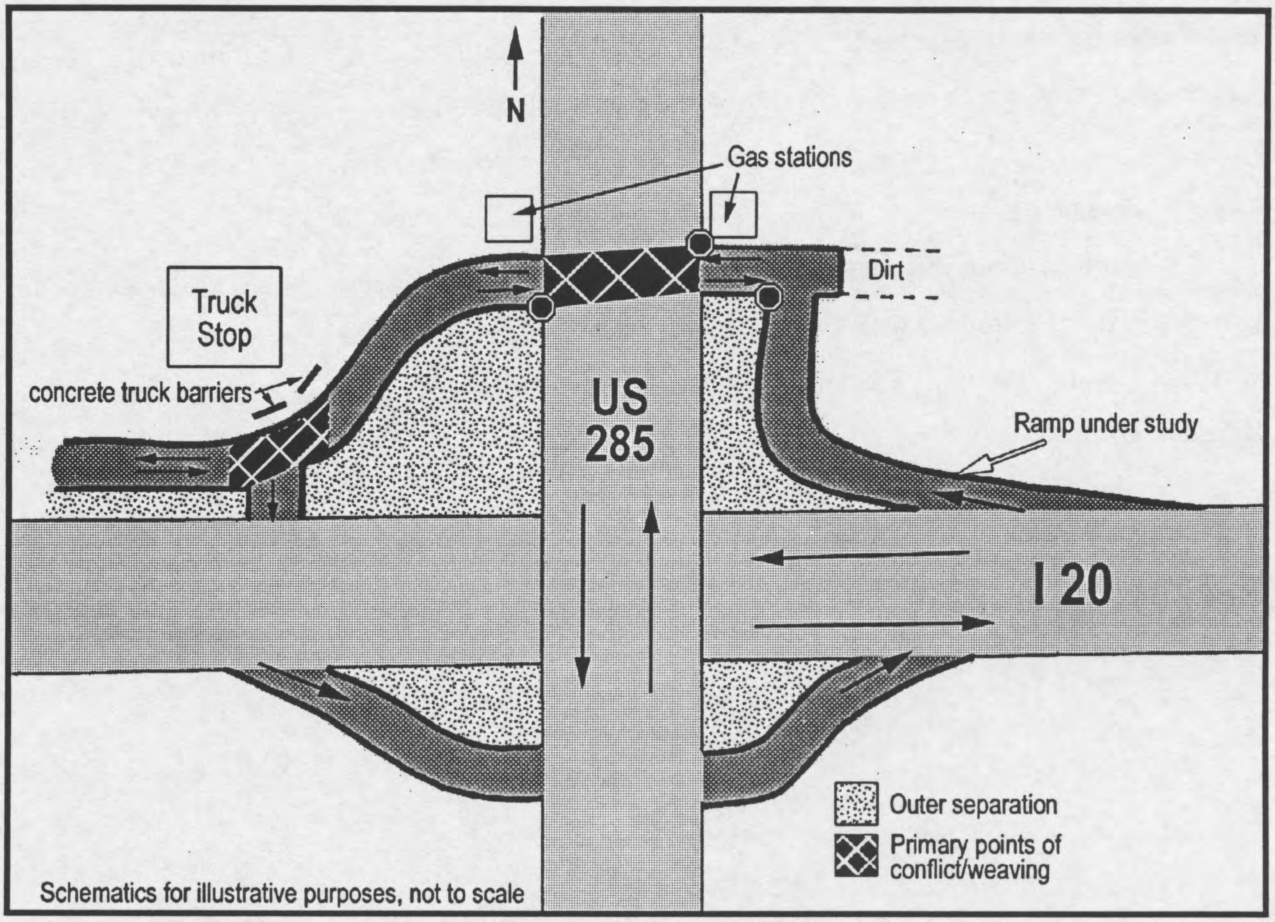

Figure 4-21a. Pecos Case Study Schematic

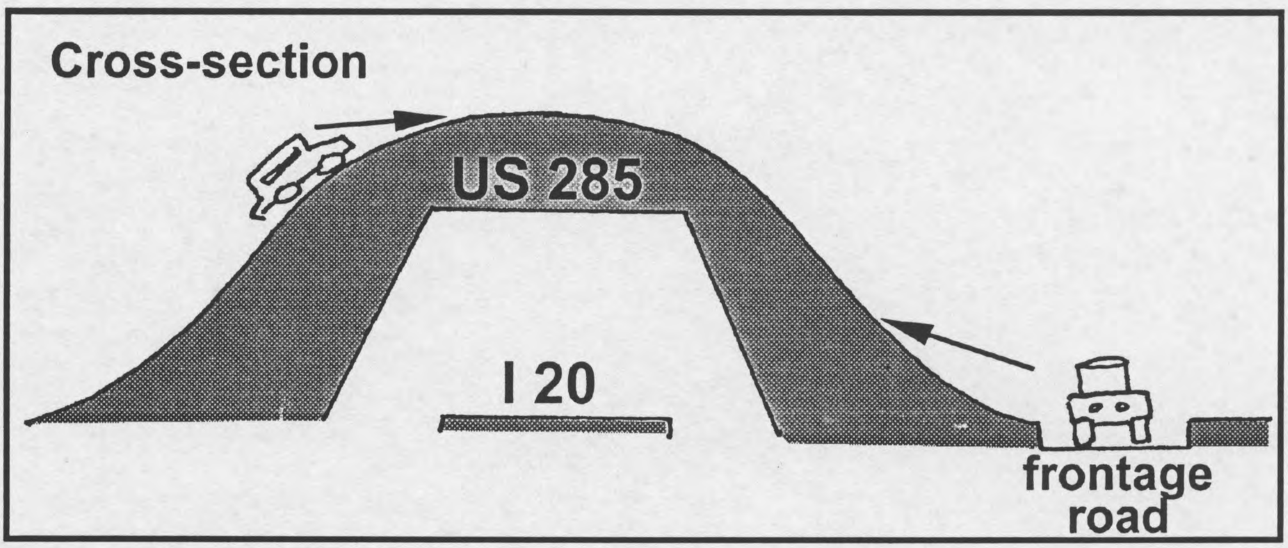

Figure 4-21b. Pecos Cross-Section

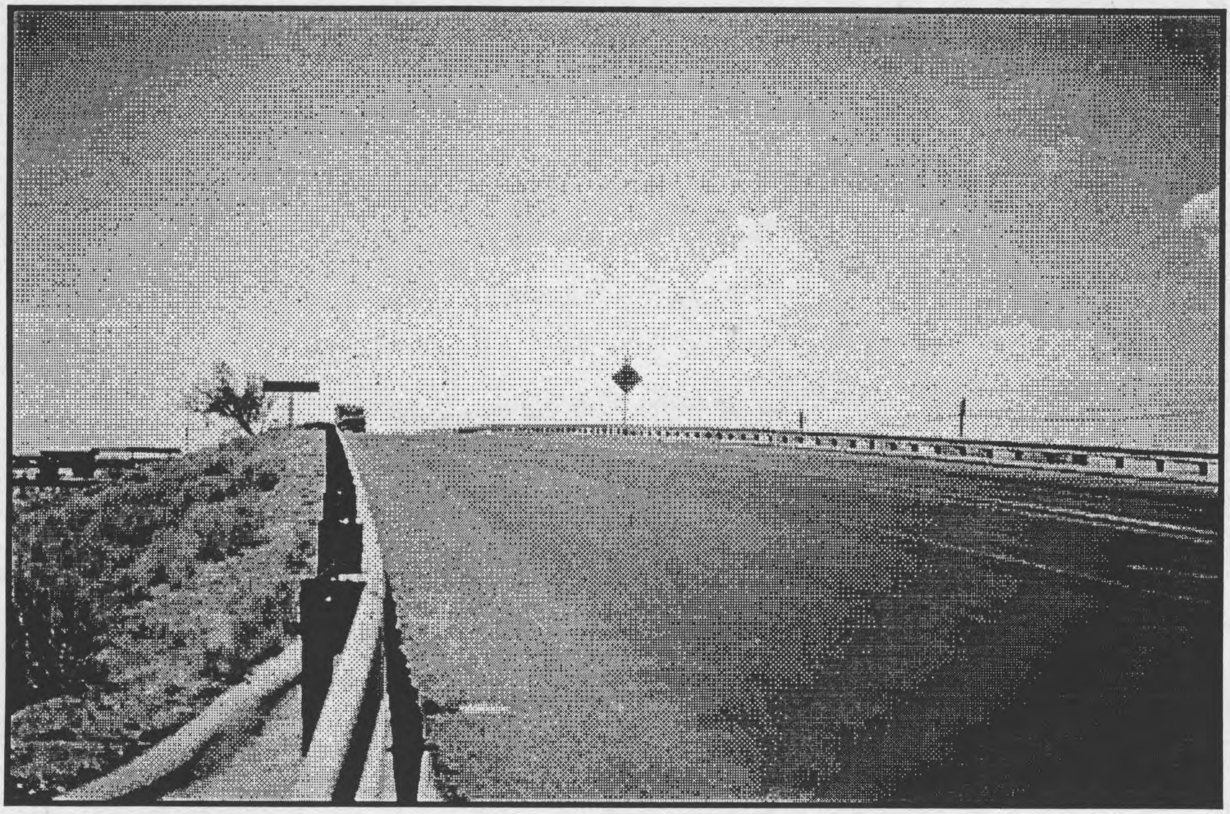

**Figure 4-22. Pecos: Looking South
Over Crown of Overpass**

San Antonio Case Study

Location: U.S. 281 and F.M. 1604, principal focus northbound, prior to intersection.

Introduction

This ramp provides access from U.S. 281 to F.M. 1604 in the absence of direct freeway-to-freeway ramps at this interchange. In addition, the ramp provides access to the frontage road along a strip of commercial development and, with a quick weaving maneuver, a street named Henderson Pass. The ramp was completed in July 1990. The first applications for development permits were filed in February 1992, and the first development occurred in December 1992.

Both of the intersecting highways were initially built outside the city limits without a wide right of way. When the city grew to encompass this interchange in the late 1980s, the lack of right-of-way created severe space constraints in which to develop the necessary on and off ramps. Normally an intersection of this type would use a parallel configuration rather than the current diamond. Under the current configuration the ramps serve double duty, providing access to the frontage road and the intersecting highway.[83]

The location of the ramp was partly determined by the distance from the upstream on-ramp and the need for a sufficient weaving distance between ramps. This requirement meant that the ramp could not have been located any farther south than it was, thus limiting the length of frontage road served by the ramp. Usually in San Antonio the frontage road yields to the ramp, but at this site, the Austin model was used: a double white line that channels traffic and eliminates the need for a yield and thus smoothes the flow of traffic on the frontage road past the ramp.

This ramp is located in a rapidly growing area of a rapidly growing metropolitan region. The population in the San Antonio MSA grew from 1,072,125 in 1980 to 1,302,099 by 1990, a 21.5% change.[84] Growth in this area consists mostly of middle and upper class residential development and commercial development that serves this population. This interchange is becoming a center for the suburban development occurring on San Antonio's northern edge. The site is part of the Edward's Aquifer Recharge Zone.

[83] Interview with Clay Smith, San Antonio District, TxDOT, June 1998.

[84] County and City Data Book 1994, US Department of Commerce: Bureau of the Census, Washington DC: US Government Printing Office, 1994.

Development in Ramp Vicinity

The property was first zoned for business in the early 1970s. Sometime in the early 1970s, the owners at the time had the property zoned B-3, business for a supermall. A referendum overturned the zoning, but the referendum was found illegal by a local court. However, the area went through the economic flux that hit all of the US during the early 1970s, and poor relations with the neighbors kept any development from occurring. The development at this site has occurred entirely since the early 1990s, after the opening of the ramp. Since no development existed at the time of construction, there was little to no developer pressure over the type and location of ramp.

The retail stores are of a wide variety primarily geared to the mid to upper end - Golf Inc., Radio Shack, Beauty First, DeMi - fine wines and liquors, Stein Mart, The Mattress Firm, Warehouse Pool Supply, Pier 1 Imports, Wolf Camera and Hollywood Video. There are also restaurants and service shops, Chili's, On the Border, Marbella Seafood, Starbucks, HEB, and Compass Bank. The design of the development is not friendly to pedestrians, although care was taken to preserve some trees and there are many new plantings as well. Public transit service to the site consists of a single bus line along the frontage road with an uncovered bench at the stop.

Two key factors made this particular development possible.[85] The first was the existence of the early 1970s commercial zoning category. Because this property had been rezoned for commercial use in the 1970s, later developers had an easier time getting through the regulatory process.

The second was the creation of the Encino Park Municipal Utility District (MUD) north of the site. The MUD created a sewer and water system that was essential to the development of this site. Encino Park MUD also created the residential base necessary to support retail and commercial development. When the area was first zoned for business, the small population in the area could not support much commercial activity. Only with the development in the late 1980s did the population in the vicinity begin to warrant further commercial growth.

The city believed that it made sense for the development to occur here because of the intersection of two main freeways. As in the Austin case study, if they were to deny permits for development here, then they would be forced to grant them somewhere where the city would become responsible for the transportation infrastructure.

[85] Interview with Alex Garcia, Planning Department, City of San Antonio, June 1998.

In this case, however, the development in the ramp area was closely regulated, with developers working with the city and TxDOT to limit the number of driveways to the sites. Here the agencies were able to base driveway limits on the length of the entire frontage rather than setting limits for each separate parcel. This new type of driveway restriction is based on a "1 foot control of access lines" where developers agree early in the planning process that they won't have as much access as they would under previous regulations; the agreement is enforced through deed restrictions. The new system is based on TxDOT's driveway manual, but involves the application of restrictions to an initial large parcel rather than to later subdivisions.

The city cooperated with TxDOT in this case by allowing only internal access for several sites. This approach allowed development to occur without each store or strip center having its own driveway (or more) to the frontage road. These efforts were aided by the fact that HEB, the supermarket chain, owned a large portion of the site, on the corner, and was amenable to working with the government agencies.[86] As a result, this stretch of development has one-half to one-third of the driveways that would be found in a standard development.

Traffic Conditions in Ramp Vicinity

Traffic in this area is extremely heavy. In 1996 there were 18,640 cars per day on the ramp.[87] Somewhere between 25% and 40% of traffic in the area is using these facilities to bypass other congested areas of the city, as shown by zip code surveys taken at the intersection.[88]

TxDOT considers the resulting traffic patterns problematic. Cars weave across a three-lane frontage road in order to reach the driveways for the commercial developments or to turn right on Henderson Pass. This weaving occurs in spite of lane striping and a "No Access" sign that makes it illegal to do so. In addition, traffic is so heavy during peak commuting hours that cars are unable to exit from the parking lots back onto the frontage road. The problem has gotten bad enough that a city police officer directs traffic during these times. In addition, the traffic backs up onto the freeway past the exit point, interfering with through traffic. Recent development has increased the congestion in the area, exacerbating the weaving problems in this area.

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[86] Smith.
[87] Interview with San Antonio Police Department.
[88] This study was conducted by TTI, Russel Henk and used by WalMart and HEB for their forecasts (90% response rate).

In order to alleviate some of the traffic congestion resulting from this situation, the city is working with TxDOT to create circulation routes around the interchange. These routes connect the four quadrants away from the highways so that local traffic can easily move from one side to the other without entering the freeway. However, the ramp placement, as dictated by the weaving distance from the previous ramp to the south, has led to conflicts with the circulation loop. For example, the bridge over the freeway at Henderson Pass was recently closed because of the high level of conflict. Other recent projects intended to relieve congestion include changes to signal timing and rounding off the left hand curve radii for faster left turns. An extended left-hand storage bay (lane) helps keep turning cars out of the main traffic lanes. These improvements bought five to ten years worth of time in terms of having adequate capacity to meet demand.[89] However, one TxDOT engineer says that what is really needed at this site is "a multidirectional interchange to separate through traffic from local traffic." This process is currently underway and will take five to ten years.[90]

Issues

Initially the city was not happy to participate in this unusual driveway arrangement. Officials read their codes as requiring public access to each property, but later reinterpreted their codes as allowing internal access instead. Internal access is now seen as not only acceptable but preferable. This reinterpretation occurred primarily in response to growing troubles in other areas of development. The city's role is critical: according to TxDOT, "As far as land use goes, we're not the controlling agency - it's the city. They're the ones who can actually make things happen and in the past they haven't been willing. Now the city has new people and they work with us."[91]

In the future, TxDOT would like the city to allow TxDOT to participate in the platting and Preliminary Overall Area Development Plan (POADP) process in much the same way that the utilities participate in the easement process. Currently the city sends TxDOT a copy of plans for review but they are not an integral part of the process. Of course this is only for cases that involve the state road system. Current coordination efforts are working because people in the

[89] Smith.
[90] Smith.
[91] Smith.

planning department are working voluntarily with TxDOT, but this could change with changes in personnel. The city recently asked for comments on their process, but large changes are unlikely without an internal champion or a planning commissioner who feels strongly about including other agencies in the process.[92]

According to one TxDOT engineer, this system should be continued in the future, but the internal access should be more carefully worked out. He feels the system is working pretty well, although it is still somewhat of an honor system. Some developers and their agents attempt to circumvent the restrictions by platting small sections of a lot at a time, but the city is working with TxDOT through their PODADP process to cut down on this practice.

Although the San Antonio case study represents a high level of cooperation, especially compared to other case studies, the agencies involved would have like more coordination. The city would prefer to have greater access for pedestrians between the various stores and possibly transit on the site. TxDOT would prefer more on site coordination so that less traffic would be forced onto the frontage roads when going from one development to the next. Changing this would require the city to create new policies governing the site plan development process for large scale (and small) development projects. TxDOT could probably encourage this type of policy in some way, either by recommending it to cities or by writing it into their driveway access policy.

Some of the developers and their consultants still challenge the ideas used in the driveway limitations, but TxDOT and the city are trying to let them know well in advance so that their development can be planned around this constraint. Being aware of the constraint early places the responsibility on the developers to subdivide their lots responsibly so that the first lots don't get all the access, making the later lots unsellable. One official lauded this approach as creating a need for earlier master planning.[93]

Lessons Learned

A cooperative relationship between TxDOT, city officials, and developers can enable a reduction in driveways that helps to control traffic problems in a highly congested area and contribute to a better balance between the competing goals of providing mobility and providing access. However, cooperative relationships depend on the specific individuals involved; because

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[92] Smith.

they are not institutionalized in planning and design processes or codes, these relationships may be temporary and fragile. Early and careful planning of internal circulation is essential for effectively reducing the number of driveways.

[93] Smith.

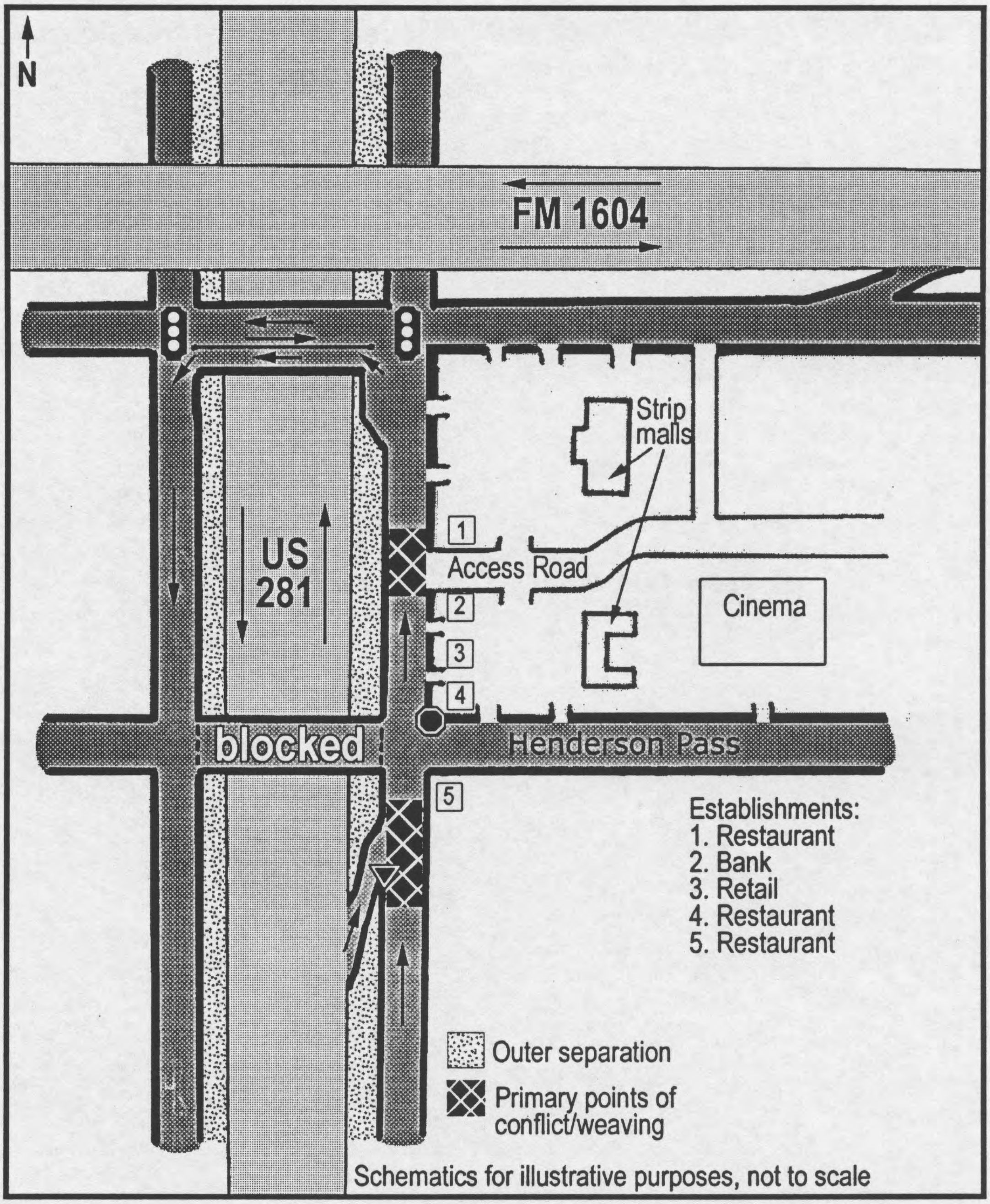

Figure 4-23. San Antonio Case Study Schematic

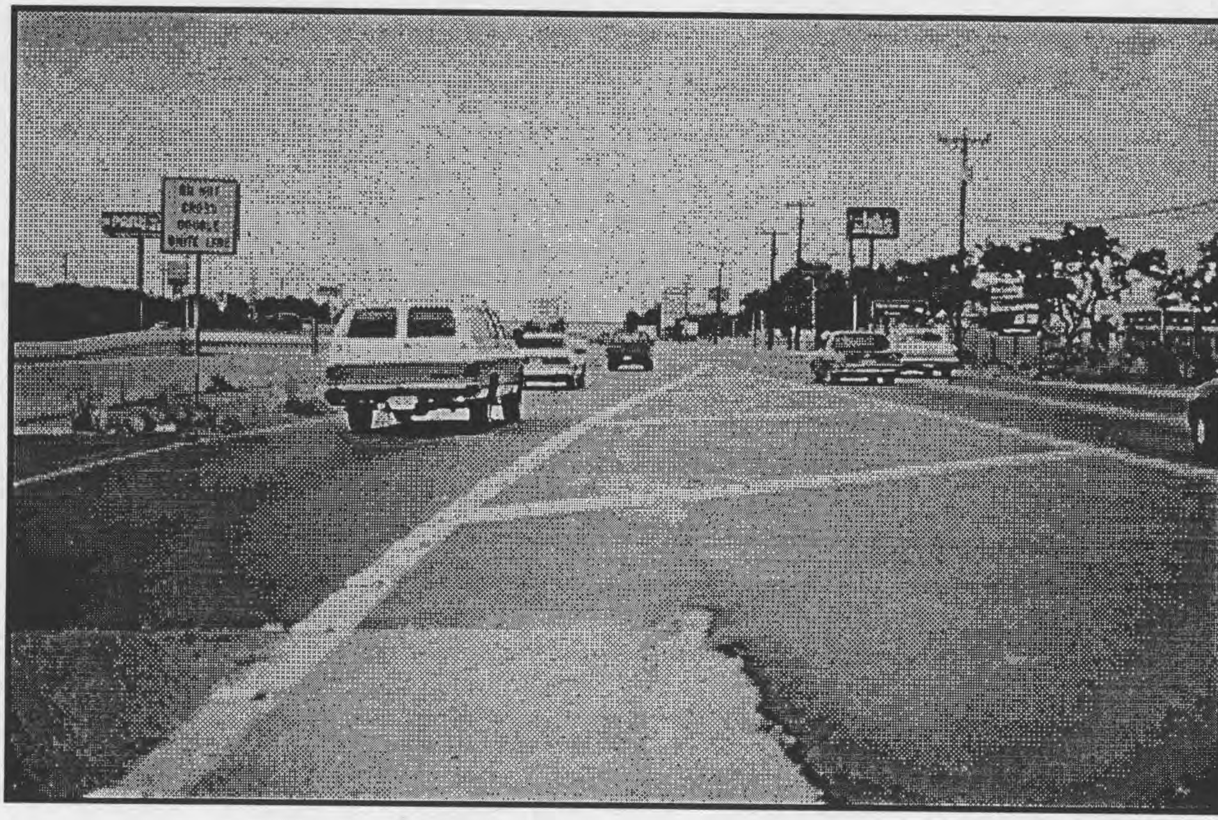

Figure 4-24a. Looking North with Transit Stop

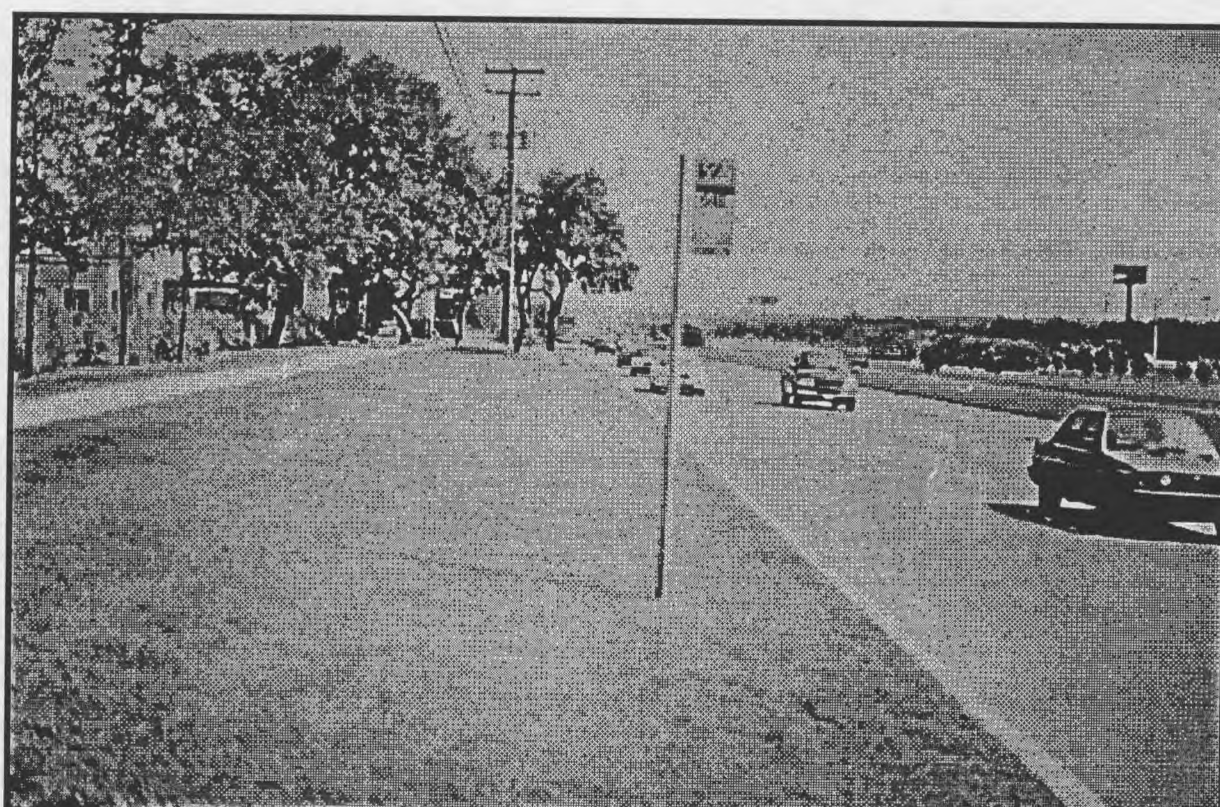

Figure 4-24b. Looking South with Transit Stop

Sugar Land Case Study
Location: U.S. 59 and Sweetwater, principal focus northbound, after intersection.

Introduction

The ramp(s) under study are in the city of Sugar Land between Sweet Water Blvd. and S.H. 6 along U.S. 59. This area is southwest of Houston in the Fort Bend County, one of the fastest growing counties in the country. Rapid housing development and the opening of a new indoor mall have precipitated growth in the area. Built in the 1950s to 1960s, the original ramps were configured in the typical 'Diamond' design. In 1996, TxDOT reconstructed the ramps into the 'X' configuration and added access ramps on both sides of U.S. 59.

U.S. 59 serves as the major access thoroughfare for the city of Sugar Land and Fort Bend County. The population in Fort Bend County has exploded since the 1980 US census. In that year (1980), the census indicated nearly 131,000 people residing in the county. By 1995, the figure had increased over 55 % to nearly 293,000 people. The number of employees in the county also experienced a significant increase, rising 18 % from 1993 to 1996.[94] In 1990, the US Census Bureau listed 24,549 residents in the City of Sugar Land. In January 1998, the population estimates indicate an increase of nearly 180 % from 1990 to 68,716 residents. The increase in residents has been accompanied by a dramatic increase in commercial and residential construction. In 1997, the City experienced $115.7 million in new commercial and residential construction.

In the general vicinity of the ramp, there has been significant growth and internal improvements. Considered a suburban area to the city of Houston, Sugar Land's residential population nevertheless demands increased infrastructure development. The frontage roads in the vicinity of the ramp have yet to be developed, except for the recently opened First Colony Mall. TxDOT and city officials commented that the construction of the frontage roads on both sides of U.S. 59 was in anticipation of commercial development. The city's current zoning is conducive to development along the frontage roads. It is uncertain when the undeveloped land will change land uses, but Fort Bend County and the City of Sugar Land are in a posture of encouraging as much commercial growth as possible. The only restriction on commercial development may be those placed on the adult entertainment businesses.

Development in Ramp Vicinity

The area under consideration is primarily undeveloped, except for a large retail mall. The redesign of the ramps and the recent construction of the frontage roads is in anticipation of future growth in the city and along the frontage roads in particular. The secondary areas near the ramp are primarily residential. The developmental patterns of the City of Sugar Land indicate that internal improvements are in place before residential development begins. These improvements include major streets, drainage and utilities.

Traffic Conditions in Ramp Vicinity

The major area of traffic concern is along U.S. 59. Officials from Fort Bend County routinely petition TxDOT and the State legislature for additional funds for improvements. The U.S. 59 corridor has been identified as a major thoroughfare for truck traffic between the US and Mexico, and local officials are encouraging efforts to designate the highway as I.H. 69. Fort Bend County officials and residents are concerned that the current capacity of U.S. 59 is not adequate enough to accommodate the anticipated increased truck and passenger car traffic.

Lessons Learned

Since the area near the ramp is basically undeveloped, there are no real hindrances or identified problems to discuss. City and County officials have taken a proactive approach to commercial development by encouraging TxDOT to modify the existing ramps and construct new frontage roads. The zoning in the area is also an attractive enticement for development, as well as the availability of land. The opportunity exists for the city planners to manage growth and land use design in the present to prevent congestion problems in the future.

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[94] The number of employees in Fort Bend County in 1993 was 50,837 and in 1996 that figure increased to 62,070.

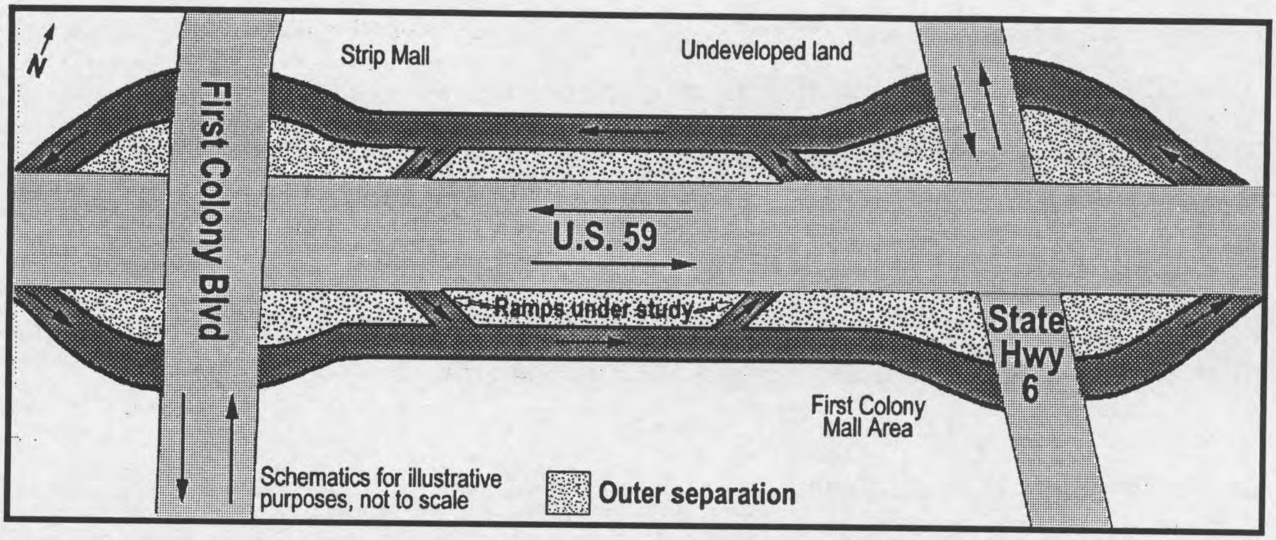

Figure 4-25. Sugarland Case Study Schematic

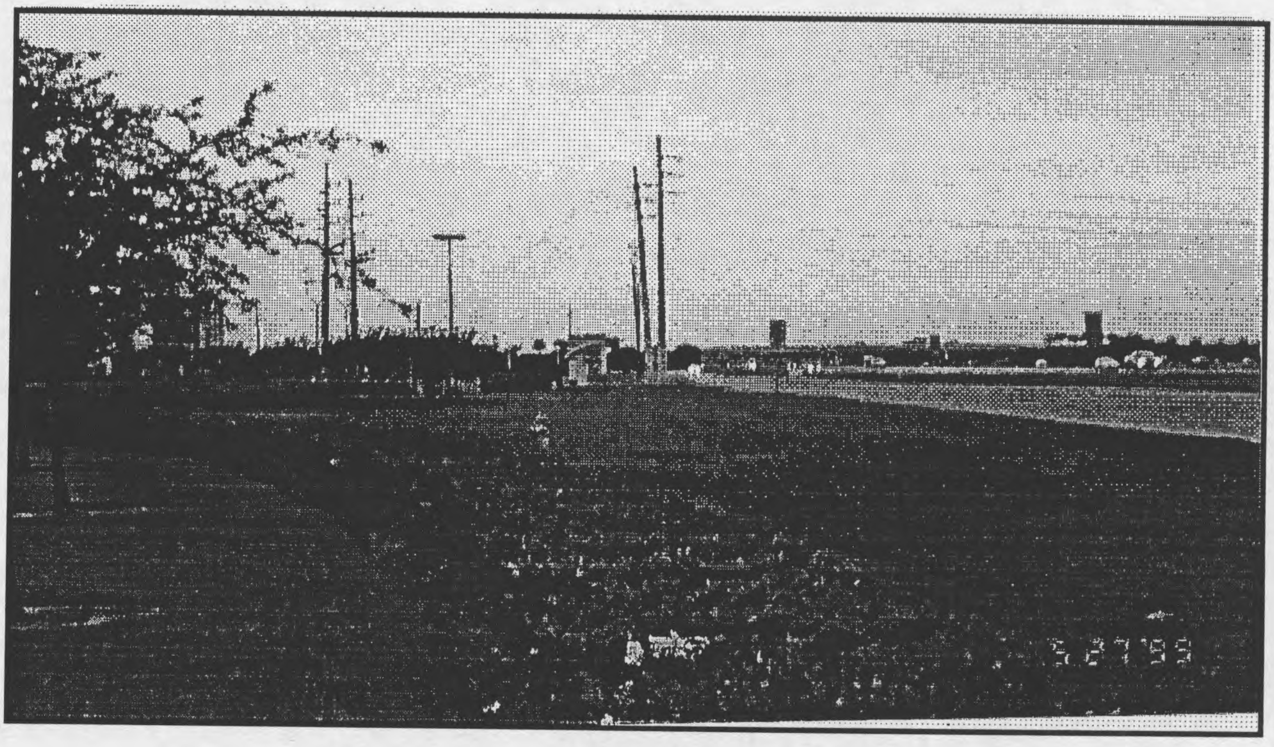

Figure 4-26a. Sugarland: Looking South
View facing South on the Southwest Freeway. Notice the shared use driveway on the left (AMC Theaters and First Colony Mall).

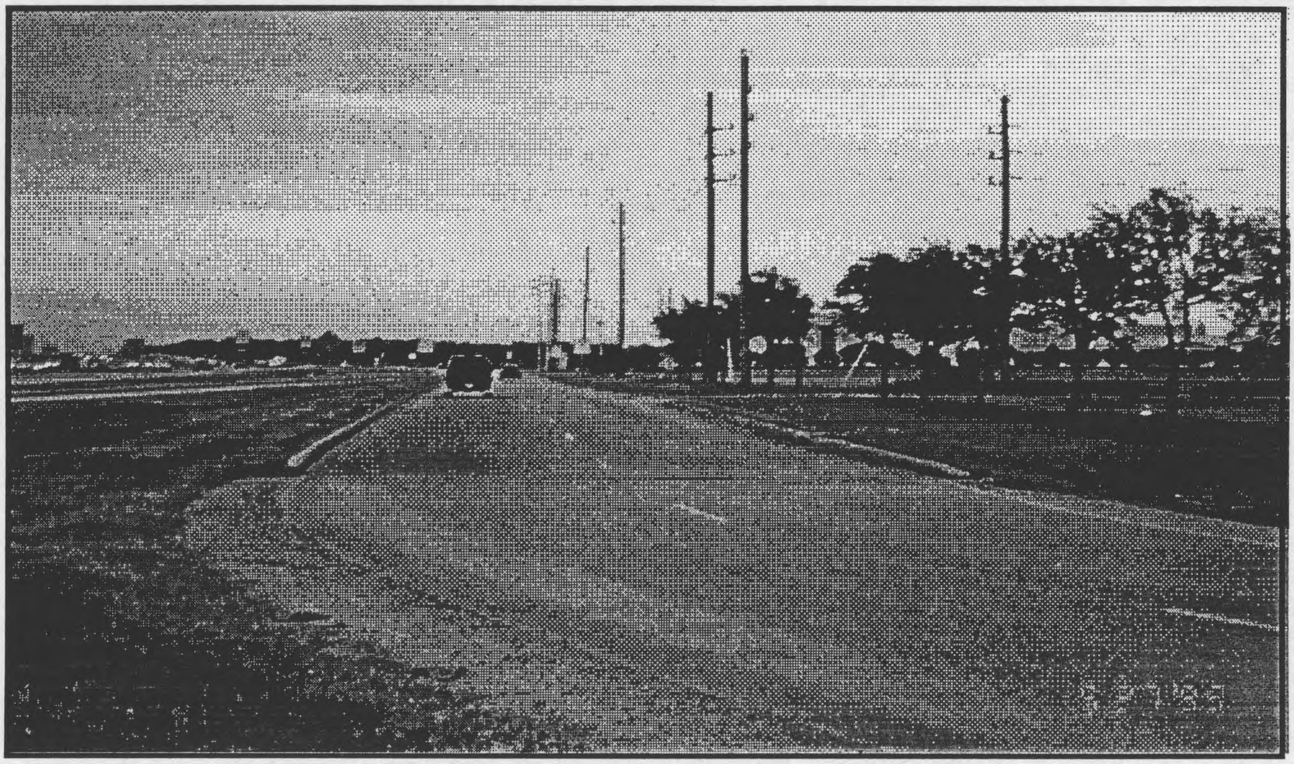

Figure 4-26b. Sugarland: Looking South.
View facing North on the Southwest Freeway. Notice the undeveloped land to the right.

Texarkana Case Study
Location: I.H. 30 between Richmond and Summerhill.

Introduction

Texarkana is one of a select number of cities in the US. The city straddles the borders of Texas and Arkansas, and while most consider Texarkana as a single city, it is in fact two cities: Texarkana, Texas, and Texarkana, Arkansas. Each city has its own governing bodies and character, but share the same history and legacy. Therefore, one may find the city listed as "Texarkana, USA". Texarkana, like many regions in Texas, has begun to address common problems on a regional basis rather than as individual cities. In 1990 the regional population measured 54,287, with 31,656 in Texas and 22,631 in Arkansas, the MSA total is 120,330.

The ramps identified for study in Texarkana are located along I.H. 30 and Summerhill and Richmond roads. This area is considered urban by local officials. Prior to 1964 the land use was considered basically undeveloped. Currently, there exists a mixed use of development which includes commercial development, office space, numerous fast food restaurants, a hospital, and a sizable indoor retail mall. Since the access to all development is from the two-way frontage, there is little delay moving from the major streets to the highways. There are no sidewalks in the area and none are planned for the future. The city of Texarkana does not have a public transit system, however, there are third party transportation providers primarily for the elderly and social programs. The area along the interchanges appears fairly well developed at present and the City does not foresee drastic changes in the land use characteristics, even though the City is proactive in promoting economic growth.

The ramps identified for observation in Texarkana are a part of a larger system of interchanges at I.H. 30 and Richmond, and I.H. 30 and Summerhill. The configurations of both are basically "diamond" interchanges with slight modifications, and built around 1964. The slight modifications include two-way frontage roads on the north and south sides of I.H. 30. However, these frontage roads do not connect to the ramps as seen in most diamond interchanges. This leaves the frontage road to act as collector roads rather than the typical frontage roads as found in other freeway designs.

Population growth has been constant in the area surrounding the interchanges resulting in both interchanges operating ineffectively due to intense congestion during the peak hours. At times this congestion may cause the delays to extend into the ramps and possibly onto the mainlanes of I.H. 30. The proximity of signal lights along the Richmond and Summerhill overpasses at I.H. 30 is perceived to be the cause of the excessive delays in the area. To relieve the congestion at both interchanges, an overpass (tentatively called the Cowhorn Overpass) is planned that will be located between, and parallel to, Richmond and Summerhill over I.H. 30. This bridge will not connect to I.H. 30 itself, but only to the two-way frontages to the north and south. Officials believe this will dramatically reduce the incidences of congestion at Richmond and Summerhill by providing another access point north and south of I.H. 30. Currently no plans are being considered to address the high number of traffic lights at the interchanges.

Neither TxDOT nor the City of Texarkana plan any major changes to the current number of traffic controls in the areas of I.H. 30 and Richmond and Summerhill roads, two north-south major arterials. The perception is that when the Cowhorn overpass, a planned north-south arterial, is completed the congestion along Richmond and Summerhill will be reduced significantly. There were no other observed incidences of a traffic nature along the two-way frontage roads, as most of the commuters appeared accustomed to the frequent delays caused by the frequent cycles of the traffic controls. The lack of sidewalks acts as a deterrent to pedestrians, many of whom could conceivable walk from one development to another.

Traffic in Ramp Vicinity

I.H. 30 is a heavily traveled corridor in the Texarkana region. Officials estimate daily traffic through the Summerhill/Richmond intersections at I.H. 30 to be over 51,000 vehicles.

Issues

Access from the current land uses to the frontage roads comply with both TxDOT and local requirements for the number of driveways and their location along the frontage road. Because of the unique configuration of the frontage roads to the ramps congestion occurs along the major thoroughfares on the overpasses to I.H. 30. Much attention has been focused on the concept of "building out of congestion", whereby new roads or increased capacity are constructed to alleviate congestion. Most studies indicate that within time the added capacity becomes congested and the whole process for combating congestion begins anew. However, this is exactly what appears to be underway in Texarkana. Officials believe that the construction of a new overpass over I.H. 30 will reduce the congestion along Richmond and Summerhill.

An alternative may be to change the frontage roads to one-way and redesign the ramps to intersect the frontage roads at a distance within TxDOT standards. This action would automatically reduce the number of traffic controls at the major intersections. By using synchronization the traffic controls could then facilitate the increased movement through the area at timed intervals. Granted, there may be geographical considerations in the redesigning of the ramps, but this option deserves consideration before additional capacity is built that will only increase the number of autos in the area within five years. It may also require time for the commuters who pass through the area to become accustomed to the changes, but the presence of uniformed police officers directing traffic in the peak hours would help facilitate the orderly transition within a limited time.

Lessons Learned

The original geometric design of the ramps and frontage roads may not have been a significant traffic issue when first designed. However, as this region continues to grow, this design appears to no longer be functional. Local officials have recognized this, but the idea of building a new transportation facility (highway overpass) is an outdated strategy of combating congestion. History shows that a region cannot build its way out of congestion. In this particular instance officials should consider some form of modification to the ramp/frontage road design. Given the existing geometric constraints, modifications may not be possible, or may be more costly than a new overpass. Still, both alternatives should be evaluated to determine the advantages and disadvantages of each.

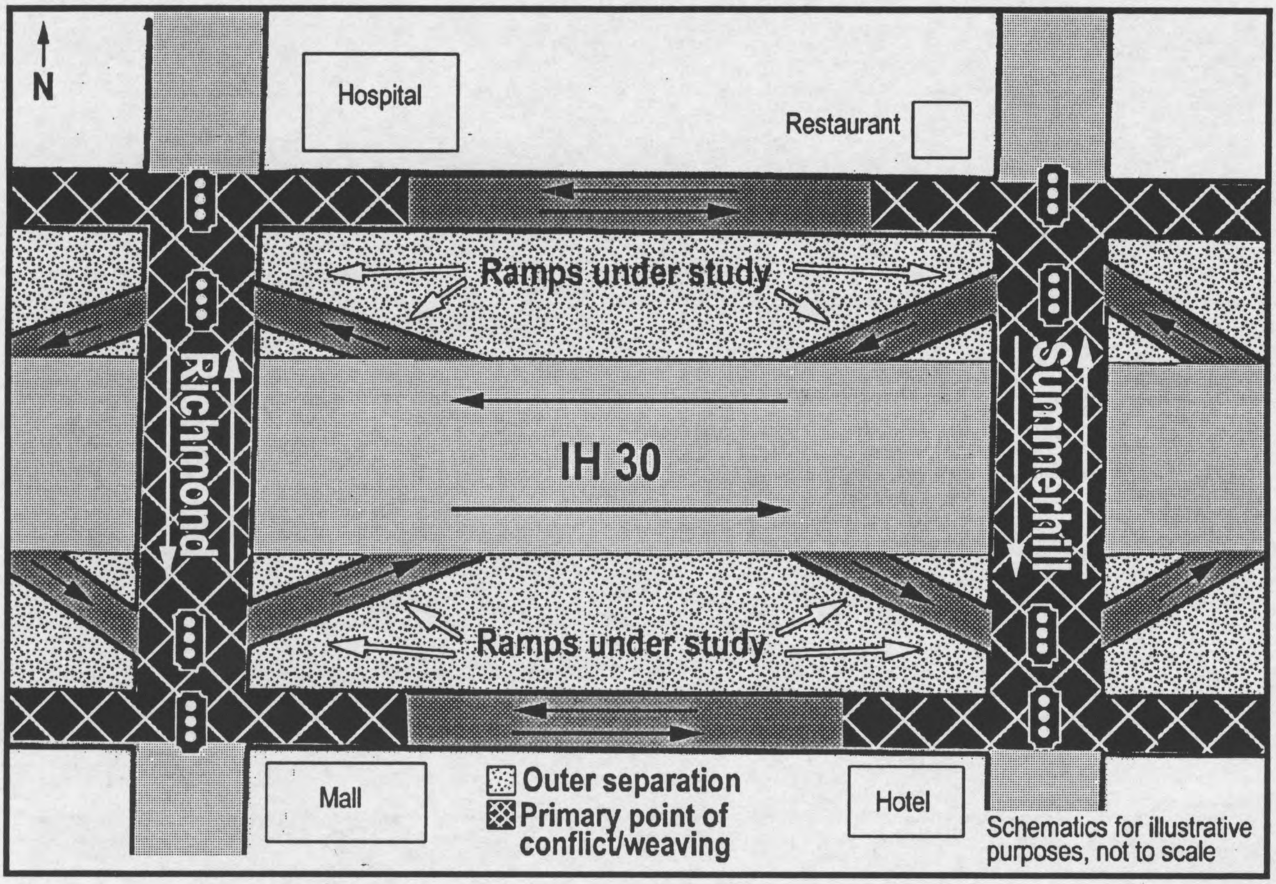

Figure 4-27. Texarkana Case Study Schematic

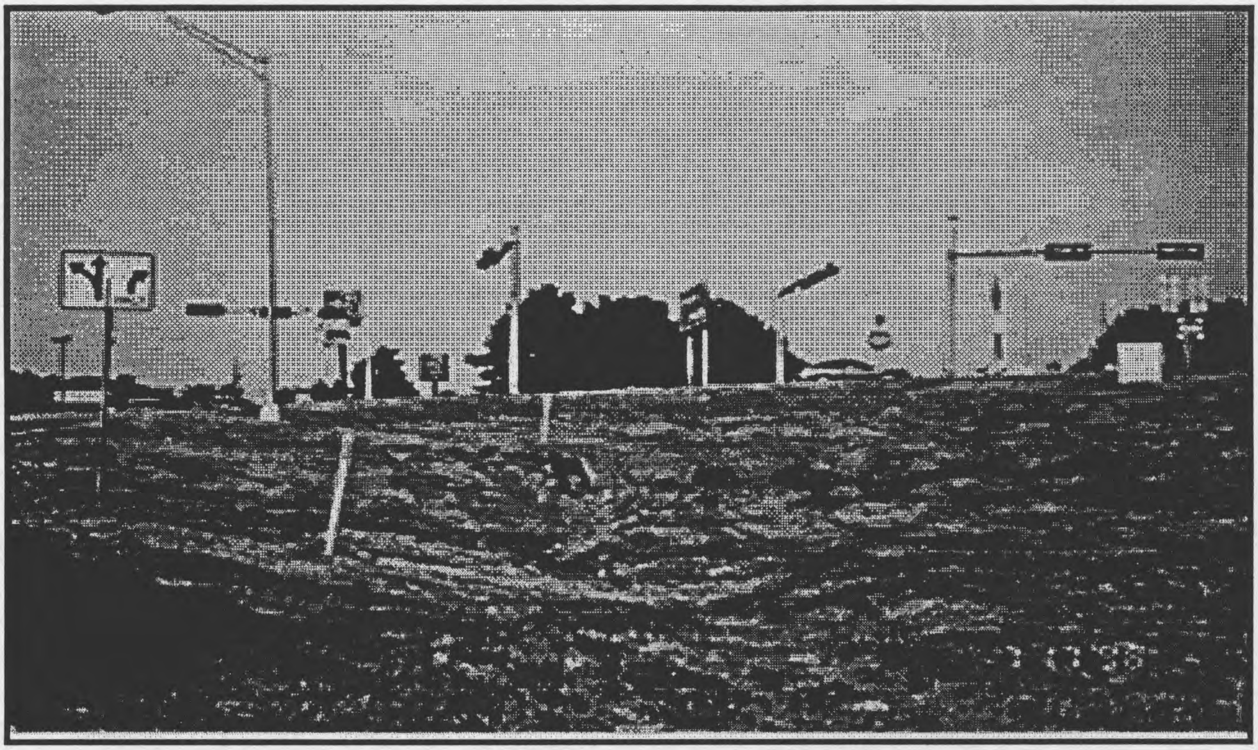

Figure 4-28a. Texarkana: Looking East
View Facing East to the Intersections of Summerhill and I.H. 30. Notice the Proximity of the Entrance/Exit Ramps to I.H. 30.

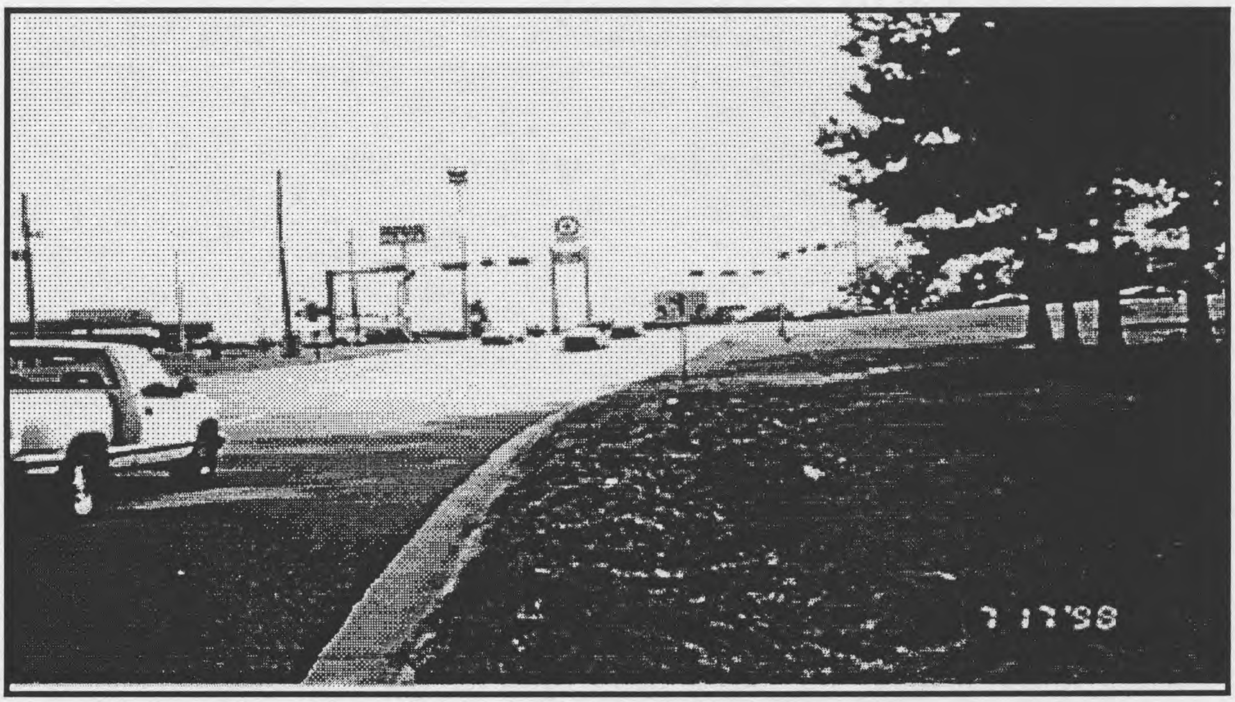

Figure 4-28b. Texarkana: Looking West
View Facing West Towards the Intersection of Richmond and the I.H. 30 Frontage Road. Notice the Two-Way Frontage Roads and the Various Land Uses.

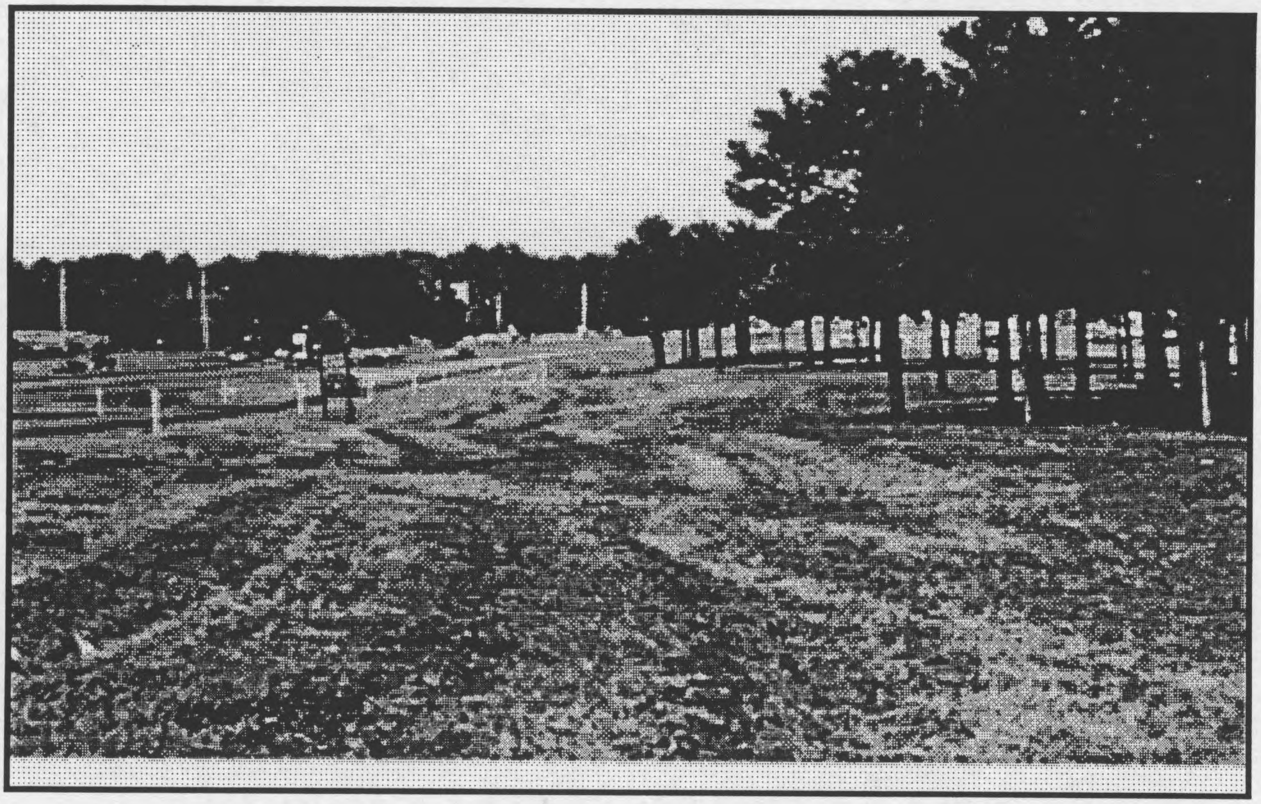

Figure 4-28c. Texarkana: Looking East
View Facing East from the On Ramp to I.H. 30 from Richmond.
Notice the Two-Way Frontage Road on the Right Behind the Trees

Chapter 5: Summary of Case Study Findings

The fourteen case studies represent a wide range of situations, from urban to rural locations, from complicated X-interchanges to simple button-hook off-ramps. Although each case study is unique in many ways and the number of case studies is too small to statistically test the research findings, several clear patterns emerge. The case studies provide important findings about two interrelated issues:

- The contribution of ramps to land development around interchanges, and
- The contribution of land development to traffic problems around interchanges.

Land Development Impacts

The access provided by freeway ramps clearly contributes to land development, although many other factors also influence the amount and type of development (Figure 5-1 and Table 5-1 and 5-2). Ramps are a necessary but not sufficient condition for development. Other important factors include growth pressures in the area, as influenced by the size of the community, whether or not the community as a whole is growing, and the type of development currently in the ramp area. The local community's attitude towards development is another important factor and may be reflected in plans for development and the zoning designation of the area around the ramp, whether or not the area is served by utilities, watershed policies, and regulations about site access. Finally, the volume of traffic passing by on the freeway will influence the potential for development in the ramp area.

For ramps located in growing communities, in areas with commercial zoning and already served by utilities, development is virtually inevitable; the Austin and San Antonio case studies are the most extreme examples in this category, but the College Station, El Paso, Houston, and Sugarland case studies also fall into this category. Even in communities that are showing moderate growth, intensive development may occur in the ramp vicinity, as was found in the Beaumont, Lubbock, Marshall and Texarkana case studies. The proposed ramp in the Dallas case study could be expected to trigger development similar to what occurred in these cases unless more restrictive policies are adopted.

The lack of any one of these factors, however, may limit the development that occurs. In the Midland case study, for example, the lack of utilities limited development around the interchange, and in the Pecos case study, the stability of the community meant little development around the interchange. The importance of a ramp in supporting economic activity can also be seen in the negative: in the Gregory case study, the movement of the ramp farther upstream from the commercial development may have contributed to the decline of local businesses.

Little evidence was found of attempts on the part of local communities to limit the amount of development in the vicinity of interchanges. In fact, the opposite was true in many cases: cities see the interchange area as the most appropriate (and most likely) place for intensive commercial development and have thus been willing to provide the zoning and utilities necessary for intensive development. The high level of access provided by interchanges makes them ideal locations for commercial development from the perspective of both city officials and developers. At the same time, little evidence was found of attempts on the part of local communities to control the type of development, either specific land uses or the design of commercial sites. An interesting exception was the use of the I.H. 20 Corridor Overlay zone in Midland. The rarity of such efforts suggests a missed opportunity on the part of local communities to ensure that the development that occurs around the interchange is consistent with community goals.

Traffic Impacts

Although the primary purpose of ramps is to facilitate traffic flow, TxDOT generally plans and designs ramps and frontage roads so as to enable development of the adjacent land. However, the development that occurs often generates levels and patterns of traffic that conflict with the goal of safe and efficient traffic flow. Traffic problems on frontage roads created by the development of adjacent land may spillover to the ramp or even the freeway itself. Several different traffic problems seem to be generated by the development that occurs in the vicinity of ramps and, more specifically, by a mismatch between the amount and type of development and the design of ramps and frontage roads:

First, intensive development, especially of the kind found in rapidly growing suburban areas, can lead to levels of traffic that simply overwhelm the capacity of the ramp and frontage roads during peak hours. This problem was found in the Austin and San Antonio case studies.

Second, even moderate growth and development can lead to congestion depending on the design of the transportation facilities, including the geometry of the interchange, the number of lanes on the frontage road, and traffic controls at the ramp and at the intersection of the frontage road with the cross street. This problem was most obvious in the Texarkana case study.

Third, commercial driveways along three-lane or wider frontage roads lead to dangerous weaving movements from the ramp over to the driveways and from the driveways across to left-turn lanes; the Austin and San Antonio case studies demonstrate this problem.

Fourth, driveways in the ramp gore area (sometimes located there before the ramp was opened, sometimes after) can also lead to dangerous and even illegal weaving movements from the ramp over to the driveways; the Lubbock case study demonstrates this problem.

Fifth, commercial activity that draws truck traffic may lead to dangerous conditions for the trucks themselves, as was found in the Pecos case study, or to a dangerous and inefficient mixing of truck traffic with automobile traffic, as was found in the El Paso, Marshall, and Beaumont case studies.

Sixth, development that occurs in areas less easily and directly accessed from the ramp can lead to circuitous routes to get to the development and/or back on the freeway and to dangerous and even illegal shortcuts; this problem was observed in the Austin and Beaumont case studies.

The TxDOT driveway policy seems to be the only policy being used to guide access management in the vicinity of freeway ramps. San Antonio and El Paso provide the only such exception among the case studies. As a result, the driveway policy serves as both the minimum standard and the maximum standard, since few cities have chosen to regulate access management beyond this policy. In San Antonio, the city worked with TxDOT to implement more stringent access controls; in El Paso city officials indicate their policies are more stringent. It is not entirely clear that the driveway policy always serves as the minimum standard, however; there seems to be some question about how strictly it is enforced from district to district and project to project. In the Lubbock case study, for example, the location of the driveway for the Post Office close to the ramp lead to dangerous and illegal shortcutting; in this case the problem emerged when the interchange was redesigned and the ramp was located so as to place the driveway within the restricted ramp gore area.

TxDOT policy on interchange design also plays an important role. In general, interchanges are designed for existing development conditions or in anticipation of likely development. If development conditions change significantly over time, then TxDOT redesigns and rebuilds the interchange to better suit the new conditions. In several case studies, traffic problems stemmed from the fact that development conditions had changed but the interchange had not yet been redesigned. In other case studies, TxDOT had spent considerable sums to rebuild interchanges where development conditions had changed (most commonly converting a "diamond" interchange to an "X" interchange through the reversal of ramps). In some of these cases, the relocation of ramps or the conversion of frontage roads improved overall conditions but created new conflicts for specific businesses.

Challenges

The case studies suggest two important challenges for TxDOT in designing safe, operationally-effective, and cost-efficient interchanges and thus in maximizing the benefits from the State's investment in these facilities.

First, the more accurately that TxDOT staff can predict the likely future development patterns, the better job they can do at designing the interchange appropriately from the start. The case studies suggest some of the factors that will influence future development, but each situation is unique to some degree and the factors that influence development can change substantially over time. TxDOT must also decide how far into the future to look in deciding on the appropriate design for today.

Second, to the degree that TxDOT can work more closely with local communities to manage the intensity and design of development in the interchange area, fewer traffic problems are likely to arise and the initial interchange design is likely to work for a longer period of time. Site design that provides for internal access linking commercial sites, for example, can effectively increase the capacity of the frontage roads, thus contributing to the goal of enhancing both mobility and access. A cyclical and interactive relationship exists between the land development impacts and traffic impacts. As can be seen in the case studies, TxDOT, local communities, and developers all benefit from better coordination between development and facility design and thus have an incentive to work towards better coordination.

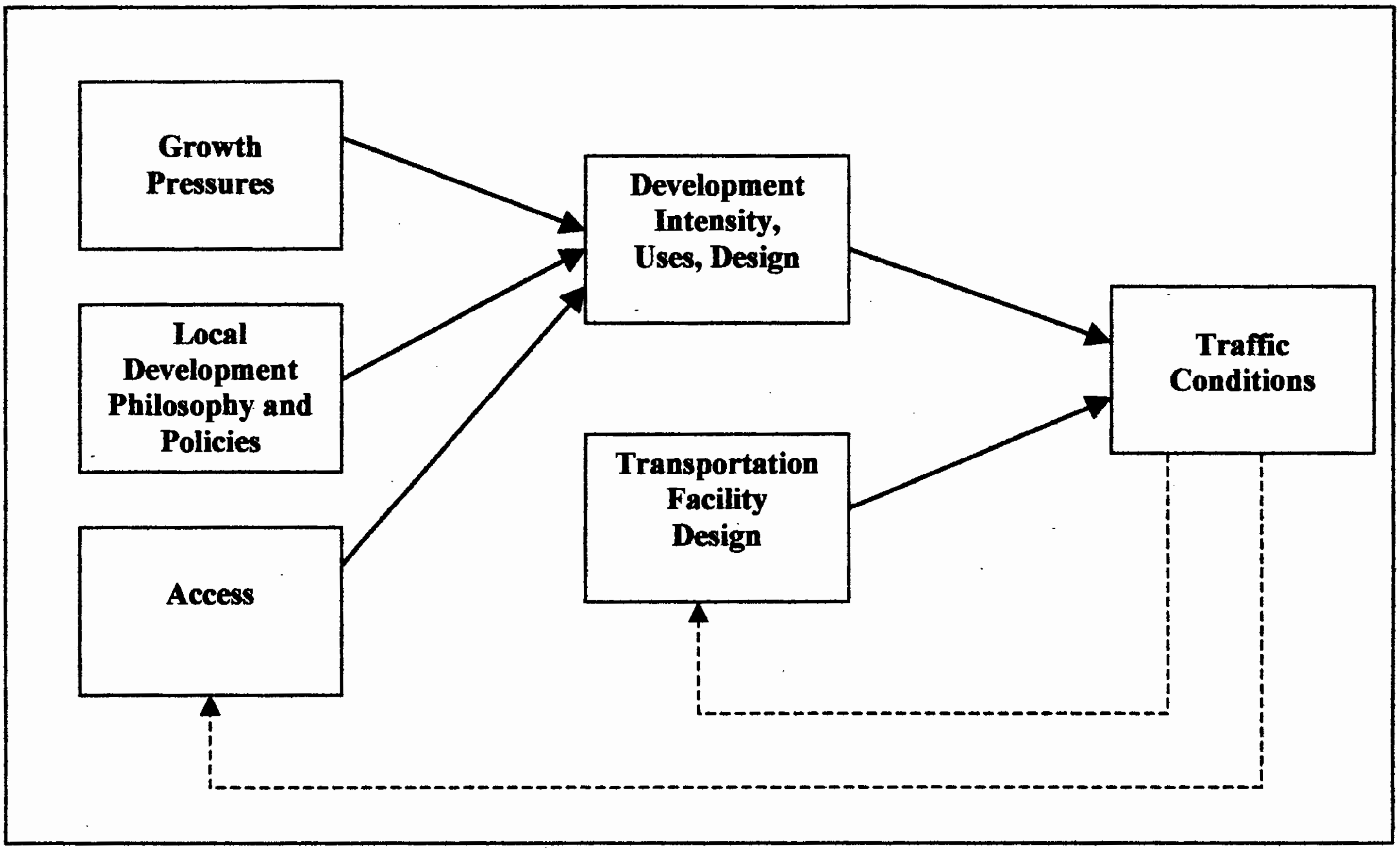

Figure 5-1. Summary of Relationships

Table 5-1. Factors Contributing to Development in Ramp Vicinity

Ramp site	Growth Pressures			Local Development Policies						Subsequent development
	City size (1990)*	City growth rate**	Pre-existing development	City plans for development	Zoning policy	Availability of utilities	Watershed policy	Access regulations	Freeway ADT	
Austin	781,572	46%	undeveloped	N	commercial highway w/overlay restrictions	Y	urban	N	NP	intensive suburban commercial
Beaumont	114,323	-3%	undeveloped	Y	retail / commercial	Y	N	N	NP	intensive commercial
College Station	52,456	30%	undeveloped	Y	commercial	Y	N	N	19,200	intensive suburban commercial
Dallas	1,007,618	30%	undeveloped	Y	commercial	Y	N	N	NP	planned commercial
El Paso	650,000	23%	undeveloped	N	commercial	Y	N	Y	15,000	commercial
Gregory	2,500	0%	small commercial	Y	none	Y	N	N	NP	decline
Houston	1,600,000	21%	undeveloped	Y	none	Y	N	N	NP	commercial / institutional
Lubbock	196,679	5%	undeveloped	N	commercial	Y	N	N	72,000	commercial
Marshall	23,682	7%	rural		commercial	Y	N	N	2,100	commercial
Midland	106,611	29%	undeveloped	Y	commercial w/ overlay restrictions	N	N	N	16,000	motorist services
Pecos	12,000	0%	undeveloped	N	none	Y	N	N	6,800	truck stop
San Antonio	1,302,099	22%	undeveloped	N	commercial	Y	urban	Y	66,000	intensive suburban commercial
Sugar Land	24,549	42%	commercial / retail	Y	commercial	Y	N	N	NP	commercial
Texarkana	31,656	9%	undeveloped	Y	commercial / institutional	Y	N	N	51,000	commercial / institutional

* Source: County & City Data Book, US Department of the Census, 1994.

** 1980-1990 Source: County & City Data Book, 1994.

NP-Not Provided By District

Table 5-2. Factors Contributing to Traffic Conditions in Ramp Vicinity

Ramp site	Subsequent development	Recent growth in area	Geometry	Lanes on frontage roads	1 or 2 way frontage roads	Traffic control at ramp	Traffic control at next inter-section	Ramp ADT	Public transit	Does it work?	TXDOT plans to change it
Austin	intensive suburban commercial	heavy	X	3	1	merge	signal light	16,197	N	congestion, weaving	Y
Beaumont	retail / commercial	moderate	standard diamond	2	1	yield	signage	n/a	N	heavy truck traffic	Y
College Station	commercial	heavy	modified diamond	2	2	merge	signal light	19,200	N	ramp design, 2 way frontage	Y
Dallas	planned commercial	-	planned X	future 1 way	planned 1-way	-	-	-	-	-	currently under construction
El Paso	commercial / retail	moderate	diamond	2	1	yield	signal light	n/a	N	congestion @ intersection	N
Gregory	decline	decline	X	2	1	yield	none	168	N	Y	N
Houston	commercial / institutional	moderate	modified X	3	1	merge	signal light	n/a	N	Y	N
Lubbock	commercial / retail	moderate	modified X	3	1	yield	signal light	n/a	N	congestion near P.O.	N
Marshall	light commercial	stable	diamond	1	2	none	signage	n/a	N	hampered by truck traffic	N
Midland	motorist services	stable	button hook	2	2	yield	signage	10,260	N	Y	Y
Pecos	truck stop	stable	button hook	2	2	yield	signage	4,650	N	dangerous for trucks	Y
San Antonio	commercial	heavy	X	3	1	merge	signal light	19,350	Y	congestion, weaving	Y
Sugar Land	commercial / institutional	light	modified X	3	1	yield	signal light	n/a	N	Y	N
Texarkana	commercial / institutional	moderate	modified diamond	2	1	light	signal light	51,000	N	congestion @ lights	N

Chapter 6: Recommendations and Implementation

One of the most important aspects of research is the potential to advance the state-of-the-industry as a result of study findings. The lessons learned through the examples provided by the case studies in this research offer several opportunities to improve operations, travel speeds, and safety for the locations analyzed. Additional opportunities exist to refine standard operating practices that can be applied to future projects.

Recommendations Based on Lessons Learned

Several locations reviewed for this research are candidates for modifications that would result in improved safety and more efficient operation. In some cases, the demands of patrons utilizing the subsequent development have outgrown the original roadway capacity or other parameters of the design. In other cases, the mix of personal use vehicles and heavy trucks has varied from that anticipated. For both examples, traffic flow is compromised. Specific recommendations are an outcome of the lessons learned regarding new construction and ramp reversals and modifications. Also, a truck related concept is advanced for TxDOT to consider on new highways, especially those traversing the state and connecting to interstate roadways, as well as suggestions for non-motorized transportation. The recommendations are as follows:

New Construction

1. Review current policy on driveway restrictions in ramp gore area for a given length of frontage. In the meantime, strictly enforce existing policies.

2. If diamond interchange is being constructed, locate the on-ramp as far from the intersection as practical and appropriate, given design standards and geographic parameters. This is particularly important where frontage roads dead-end or are discontinuous.

3. Consider purchase of driveway access or purchase adjacent property as another mechanism to control the number of driveways from the frontage road. (The agency could take a proactive position and provide shared access between businesses in order to improve mobility on the frontage road).

4. Increase proactive liaisons between local officials and TxDOT.
    - Consider developing shared access guidelines
    - Encourage cities to require developers to provide internal circulation, so travelers are not forced back onto the frontage road to patronize adjacent businesses
    - Work with city/county officials to direct growth through provision of utilities and other strategies designed to keep development from outpacing original ramp design, and
    - Explore designs that allow for pedestrians and non-motorized transportation, particularly for key urban locations. Work with MPOs and local communities to ensure that realistic demographic forecasts are used in the project design specific studies.

5. Require developers of large parcels with multiple driveways to use signage to direct customers to those exit driveways that will cause the fewest conflicts on the frontage road.

6. Increase the utilization of signs that inform drivers of services and businesses that are located at the upcoming exit. This strategy would partially address the lessons learned in Lubbock and Gregory.

Ramp Reversals and Modifications

7. If existing driveway access no longer meets minimum criteria, TxDOT should prohibit dangerous turns into property using barriers, striping, or signage. Where striping or signage is chosen, enforcement must be a priority. The case study in Lubbock with the turning movements into the post office illustrate the type of location where this recommendation should be applied.

Implement "Truck Zones"

8. In upcoming TxDOT plans, implement "truck stop" zones designed to concentrate trucking activities in desired locations and away from through and local mixed traffic. These "truck zones" could have hotels, diesel fueling capabilities, eateries, and Intelligent Transportation System (ITS) weighing, tracking and other conveniences to attract truckers to these locations. The objective would be to minimize the mixing of high volumes of through and interstate trucks with local traffic.

Non-motorized Transportation

9. For new construction or modifications, explore designs that allow for pedestrians and non-motorized transportation, particularly for key urban locations.

Implementation Strategies

An initial task for this study was to document the procedures and policies currently guiding ramp access in Texas. Engineers throughout the state apply three key documents in guiding design of ramps and frontage roads and to determine acceptable driveway access distances (See Chapter 3). Officials from 13 of the 14 locations reported that these guidelines are the most important component in their driveway decision making process. Only officials from the City of El Paso indicated that their driveway location standards are more stringent than TxDOT's. The established guidelines recognize the importance of roadway accessibility as a variable in economic vitality. Therefore, the guidelines are fairly liberal in granting developers access to frontage roads and freeways. In most cases, it is likely that city officials and TxDOT engineers allow as many driveways as the policies permit. However, the case study from San Antonio shows a different approach as TxDOT, the city, and developers collaborated to reduce the number of driveways that the guidelines would have allowed.

The implications of the findings have interesting ramifications for future development and traffic that occur at freeway ramps. Many communities wish to encourage economic development and growth. The prevailing practice is to allow each developer an individual driveway or allow more than one driveway per property. The field observation at some of the locations studied for this research show access points outside the bounds of the guidelines. For each of these examples, there was undoubtedly an overriding consideration that led to the decision.

But when there is a need or desire to limit access, the cities tend to rely on the TxDOT policy to set the limits. One official stated, "It's better for us to make TxDOT have the heavy hand." Ideally, the communities and TxDOT would establish strong working relationships so that the decisions are mutually beneficial to both entities, as in the case in San Antonio. Thus, the land use and highway ramp and access decisions would be compatible, reflecting the goals and desired performance standards of the agencies and the community-at-large.

In the locations studied, land development whether the original land use or changed land use, affects the traffic operation of the ramp, frontage road, and nearest intersection. As the number of trips per property increases, the traffic on the frontage road increases, as well. It would be easy to accept growth and subsequent facility modification as the normal course of business. The question is whether that approach is the most efficient or whether some other strategy should be considered. In some cases, an appropriate modification may be expensive and difficult to implement. This research has found that changes in TxDOT's standard operating practice would be beneficial. Specific strategies to implement the recommendations are as follows:

- Develop a brochure that provides examples of successful shared access arrangements and explains the disbenefits of the lack of coordination. The brochure will include tools that will help improve the level of frequency of communication with city and county planners.

- Develop a training session for TxDOT design engineers that raises awareness of the kinds of problems identified in this report and presents approaches for addressing those problems. The training session would emphasize several topics to include the importance of informal, on-going communication with city and county officials and a list of considerations when allowing waivers to the existing policies and guidelines.

- Based on this study and on access management studies underway by other researchers in separate TxDOT projects, revise formal procedures and planning and design guidelines.

The above recommendations are advanced in order to prolong the viable utility of TxDOT facilities, to reduce consumer complaints regarding congestion, and to improve safety. In addition, the goals of improved mobility will be addressed. Greater financial responsibility will be placed on developers to thoughtfully design their driveway locations and throughways to provide access to interior parcels. A greater degree of internal circulation will occur on the property instead of on the frontage road. The recommendations from this study will assist TxDOT in meeting fiscal and operational objectives.

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APPENDICES

APPENDIX A-1

TEXAS SOUTHERN UNIVERSITY
3100 CLEBURNE AVENUE • HOUSTON, TEXAS 77004
(713) 313-7011

CENTER FOR TRANSPORTATION
TRAINING AND RESEARCH
OFFICE: (713) 313-1925; FAX: (713) 313-7924
FAX: (713) 313-1923

November 13, 1997

Dear TxDOT District Engineer:

Researchers at Texas Southern University and the University of Texas at Austin are conducting a TxDOT sponsored project (TxDOT 0-1762) examining the effects of highway or freeway ramp locations on land use. The purpose of this study is to examine the relationship between freeway ramp construction and development, given a variety of land use policies. Our objective is to describe land uses that are appropriate with various ramp configurations and the mechanisms or incentives that facilitate such development. The study will also be sensitive to land uses near ramps that have increased weaving manuevers, or otherwise encourage less than desirable traffic operational conditions. We are asking you to identify 1 to 10 highway or freeway ramp locations within your district for possible inclusion in the study. The study team will review the submitted locations and narrow the number to be studied to 15 locations around the state. We are seeking ramp locations in urban, suburban and rural environments. The following questions may be used as a guideline to assist you in thinking about ramps in your district.

- Has an abundance of development occurred at a ramp since it was opened? Is there a particularly busy ramp location with traffic volumes beyond expectations that you suspect has been impacted by adjacent development?
- Do you have locations near ramps with higher than anticipated accident rates?
- Is there an area where traffic maneuvers have been affected because of development built after ramp construction?
- Is there a ramp where you would have expected more development to occur, but where city policies or unknown factors diminshed the amount and/or type of development?
- Do you have bus stops or a high volume of pedestrian movements near a ramp?
- Did adajacent land owners express a desire for a ramp in a particular location to encourage or support development?
- Do you have a ramp that was placed in a specific location in response to development activities?

Please complete a separate survey form for each ramp location you submit. The survey may be copied, if additional forms are needed. We would also appreciate a diagram of the development in the vicinity of ramps you submit. A stamped self-addressed envelope is enclosed for your convenience.

Sincerely,

Carol A. Lewis	Susan Handy
Study Supervisor	Study Supervisor

APPENDIX A-2

District ____________ Contact Person ________________

1. Ramp number and city/county where located____________
2. Name and Number of Highway ___________
   (example: IH30, SH71)
3. What is the grade of the highway at the ramp location?
   Elevated___ At Grade___ Depressed___
4. Approximate date ramp became operational _________
5. Has this ramp ever been modified?_____
   If yes, when__________
6. In what type of area is this ramp located?
   Urban___ Suburban___ Rural___
7. Are any of the following present near the frontage road near the ramp:
   pedestrian activity___ bus stops___ bicycle travel___
8. What types of land uses are near the ramp? (check all that apply)
   commercial___ single-family residential___
   multi-family residential___ institutional (school/church)___
   park/recreation___ other___
9. Number of lanes on adjacent frontage road?___
10. ADT near ramp location.: (as available)
    a. ADT on freeway ______
    b. ADT on frontage road _______
    c. ramp ADT ________

1. Ramp number and city/county where located____________
2. Name and Number of Highway ___________
   (example: IH30, SH71)
3. What is the grade of the highway at the ramp location?
   Elevated___ At Grade___ Depressed___
4. Approximate date ramp became operational _________
5. Has this ramp ever been modified?_____
   If yes, when__________
6. In what type of area is this ramp located?
   Urban___ Suburban___ Rural___
7. Are any of the following present near the frontage road near the ramp:
   pedestrian activity___ bus stops___ bicycle travel___
8. What types of land uses are near the ramp? (check all that apply)
   commercial___ single-family residential___
   multi-family residential___ institutional (school/church)___
   park/recreation___ other___
9. Number of lanes on adjacent frontage road?___
10. ADT near ramp location.: (as available)
    a. ADT on freeway ______
    b. ADT on frontage road _______
    c. ramp ADT ________

Thank you for responding to this survey! Please return to:
Center for Transportation Training and Research
Texas Southern University, 3100 Cleburne
Houston, Texas 77004
ATTN: Carol A. Lewis

TxDOT Research 0-1762
Texas Southern University/University of Texas at Austin

APPENDIX A-3

DATA COLLECTION AND OBSERVATION LIST

Observation List:
(Detail depends on what's useful, time available; have base maps in hand before doing observations)

Business names/types
Sidewalks
Driveways
Signage
Visual notes about approach
Driver's experience of the ramp
General impressions (cleanliness, part of town, vacancy rate for businesses, etc.)
Pedestrian / transit counts
Conflicts at ramp
Pavement quality
Pedestrian environment
Bus stops
Street furniture

Photos:
(take color slides)

Elevation photos of each business
Driver perspective form ramp (if possible)
Perspective of frontage businesses
Panorama of area
Unusual site specific features

Appendix A-5

Submitted ramp locations (Districts) throughout the state:

Abilene	Laredo
Atlanta	Lubbock
Beaumont	Odessa
Bryan	Paris
Childress	San Antonio
Corpus Christi	Tyler
Dallas	Waco
El Paso	Wichita Falls
Houston	Yoakum

Selected ramp locations (cities) throughout the state:

Beaumont	Lubbock
Bryan	Marshall
Corpus Christi	Midland
Dallas	Odessa
El Paso	Pecos
Houston	San Antonio
Killeen	Texarkana
Laredo	Tyler

APPENDIX A-6

INSTRUMENTS FOR INTERVIEWING TXDOT AND CITY OFFICIALS

Businesses

1. Was your business located here before the ramp?

2. Did you want the ramp constructed? Why or Why Not?

3. How well does the ramp's location serve your business?

4. Are there conflicts between your customers and people exiting/entering the ramp?

5. Are there problems with the ramp?

6. What could be done to solve these problems?

7. Do you know if other business owners feel the same way about the ramp and its location?

8. Is safety an issue?

TxDOT

1. Why was this ramp constructed? (designed to solve current problems, in place to serve future needs, etc.)
2. Why was the location chosen?
3. Was there any pressure to construct this ramp? (from what source?)
4. Was there any opposition to it? (from what source?)
5. Why was this configuration used?
6. If it were built today, what configuration would be used?
7. What existed at the site before the ramp was built?
8. Do you have documentation of the changes that have occurred since then?
9. Are there any technical problems unique to this location?

City Planners

1. Why was this ramp constructed? (designed to solve current problems, in place to serve future needs, etc.)
2. Why was the location chosen?
3. Was there any pressure to construct this ramp? (from what source)
4. Was there any opposition to it? (from what source)
5. Why was this configuration used?

6. What existed at the site before the ramp was built?
7. Do you have documentation of the changes that have occurred since then?
8. What zoning policies existed before the surrounding land uses?
9. Were there any changes in reaction to its presence?
10. How systematic were these changes? Were these changes planned or given as variances?
11. What types of policies govern the surrounding land uses?
12. Of these, how many are specific to this location? To this type of interchange?
13. How does this area fit into the overall city plan?
14. Is this area creating a problem?
15. How well does the ramp and the surrounding uses fit into the areas beyond this immediate vicinity?
16. What is planned for this location in the future?