

Sonora Relief Route Investigative Study

Final Report

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Appendix A consists of an annotated copy of the survey conducted by the Transportation Committee during the early public contact period. While the number of responses was not sufficient to constitute statistical significance, this survey and personal contact with the people of Sonora contributed significantly to specific points of judgment expressed in this report. In particular, the feelings of people who responded about their land, the homes of others, and the prospect of increased traffic along their streets lent some credibility to what would otherwise be conjecture on my part.

George R. Herrmann, P.E.

Disclaimer:

This study, although undertaken by an employee of the Texas Department of Transportation (TxDOT) under the auspices of that agency, does not represent TxDOT policy or an official TxDOT position with regard to any issue under discussion. The intent of this document is to articulate the facts in evidence and the opinions and conclusions reached by the analyst in the context of professional practice. The author of this report has no authority to create, interpret, or state policy, commitment, or institutional position for the agency.

Chapter 1- Introduction

This study has been undertaken by the San Angelo District of the Texas Department of Transportation (TxDOT) in order to address concerns of the citizens of Sonora and Sutton County with regard to the future of north-south traffic on U.S. Highway 277 (US 277) through the community.

A. Situation

The city of Sonora is located at the intersection of Interstate Highway 10 (I 10) and US 277 in Sutton County, Texas (Figure 1). Both of these highways are relatively important arterials for travel through this area.

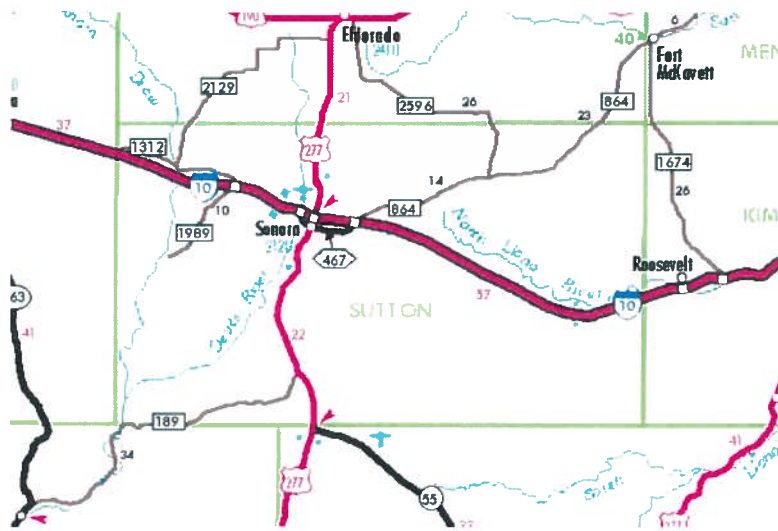


Figure 1.1; Location of Sonora with respect to US 277 and I 10

I 10 is a four-lane divided, controlled access facility that was constructed under the auspices of the Interstate System that began during the Eisenhower administration. When constructed, it was a completely new alignment through this area. It passes Sonora along the northern edge of town, with access points at three locations. This interstate is a major east-west route, although it does not carry as much coast-to-coast traffic through central Texas as I 20 to the north does. I 10 provides a connection primarily between the west coast and the Texas, Louisiana, and Mississippi gulf coasts, while the interstates further north (I 20 and I 40) are more direct connections between the west coast points further north and east. I 20 merges with I 10 in the trans-Pecos area and continues west as I 10.

US 277 begins at the Texas-Mexico border crossing between Del Rio, Texas and Ciudad Acuna, Coahuila, Mexico. Sonora is the first sizeable town north of Del Rio, being roughly 90 miles distant. From Sonora, US 277 continues through a number of small

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towns as well as the major towns of San Angelo, Abilene, and Wichita Falls in Texas, and points north. It intersects with US 87 in San Angelo, which continues north to Big Spring and Lubbock, where US 87 intersects with I 27 to Amarillo. From Amarillo, there are numerous major routes northeast and northwest.

US 277 from San Angelo south has been designated as a segment of the “Ports to Plains Trade Corridor”, advocating upgrade of these segments to a standard similar to Interstate roadways in order to provide a high speed, high traffic connection from the Texas coast and Texas-Mexico border into the central US and Canada (as envisioned by the North American Free Trade Agreement- NAFTA). There exists, therefore, political and physical potential for large volumes of high-speed commercial traffic (truck traffic) to develop along US 277 in the foreseeable future. It is worth noting that other than I 27, which connects Lubbock and Amarillo and goes neither north of Amarillo or south of Lubbock, there exists no north-south route of Interstate Highway standard between I 35 through the center of Texas, and I 25 through the center of New Mexico.

At this time, US 277 traverses Sonora through the heart of the town, down several city streets, and includes four signalized intersections, two with right-angle turns. It passes through both residential and commercial zones of the town. Posted speed limits are low (30 mph). These factors are all considered undesirable or inconsistent with high speed, high volume traffic, particularly truck traffic, from the point of view of the traffic.

B. Mission

The intent of the San Angelo District personnel in undertaking this study is to identify, isolate, examine, clarify, and articulate all factors influencing the decision-making process regarding a potential relief route for north-south traffic traveling US 277 to negotiate the Sonora area. Due largely to the fact that no source of funding for a relief route now exists, this document will present, discuss, and compare alternatives according to various criteria, but will not recommend a preferred route. The current state of funding indicates that right-of-way acquisition and subsequent construction are not in the near future. The recommendation of a preferred route at this time would be based on conditions as they exist at this time; conditions that could change with time and invalidate current assumptions. Facts, preferences, alternatives, and analyses will be presented in a manner such that they will hopefully hold their value for an extended period of time, and contribute to a refined decision-making process when the time is right.

While the lack of a specific recommendation for a single, distinct route may be seen by the citizens of Sonora as indecisive, there are certain advantages to this course of action. An agency such as TxDOT must represent the population of the State of Texas, and by adherence to Federal law and policy, that of the Nation as a whole. Agents of TxDOT are bound by fiduciary responsibility to make decisions on that basis. It is not uncommon in such cases that the larger interests of the State and Nation are perceived by local people to conflict with their own interests and desires. Since no decision is currently being made, the author of this report is free to present, discuss, and articulate all interests represented as objectively as possible.

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The mission of this report is to provide information that may be used to guide future actions by all interested parties. Barring unforeseen dramatic change in transportation technology or demographics, it is taken as a bounding assumption for this study that facilitating the passage of large volumes of truck traffic through the Sonora area will, at some point in the future, become necessary. The “no-build option” often mentioned in engineering discourse will be referenced on occasion as a condition of comparison. However, should that option be a viable permanent one, the need for a study such as this disappears.

It is considered axiomatic that at some value of traffic volume, continuing to carry the through traffic stream on a city street becomes untenable. The actual traffic volume number associated with the breakdown of satisfactory performance of the street is probably subjective, and will not be addressed.

Chapter 2- Goals of the Study

a. Influencing Factors and Relative Importance

The overall goals and intentions of this study are to document, compare, contrast, and articulate all pertinent influencing factors regarding the conduct of north-south traffic through the immediate Sonora area. An attempt will be made to represent several major points of view. As many influencing factors will be identified as possible. Core issues will be designated and used as landmarks for comparison of points of view and influences.

The relative importance of core issues will be discussed, once again from various points of view as understood by the author. It is inherent that relative importance is a very subjective and contextual issue- different stakeholders would certainly assign different relative importance to various issues. For the purposes of discussion, stakeholder categories will be identified, and those categories will be consistently referenced throughout the study. Some categories listed as “stakeholders” do not directly consist of persons, but may exhibit a constraining interest that must be acknowledged. That list of stakeholder categories and their descriptions is as follows:

- **TxDOT-** the Texas Department of Transportation, as represented by the San Angelo District. The agency responsible for the design, construction, and management of the statewide roadway system in Texas and all decisions related to it.
- **The City of Sonora-** the incorporated entity of Sonora as represented by the city government, with the legal obligations, planning and zoning authority, taxing powers, and police powers that accompany that status. Revenue participation, taxation to support that participation, zoning and regulation, and public support all depend on the city government.
- **Sutton County-** the entity of Sutton County as represented by the county government, with the legal obligations, authorities, taxing powers, and police powers that accompany that status
- **Local Citizens-** Those persons who live and work in Sonora and/or Sutton County, use the streets and roads, patronize the businesses, and generate a personal income. This is a broad and encompassing category, many members of which will also be members of other categories. However, the majority of the members of this category are assumed to be persons who do not have an interest in another category or categories that would override their interest as a local citizen. Homeowners, residents, shoppers, churchgoers, and public school students **that would not be subject to property acquisition for a roadway facility** are all sub-classes of this category.

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- **Surrounding Landowners-** Those persons who own undeveloped land in the immediate vicinity of the City of Sonora, and who might be directly affected by right-of-way acquisition and/or access management.
- **Commercial Businesses-** Those businesses in Sonora that deal with the public at large, such as convenience stores, gas stations, etc. that might be adversely affected by diversion of traffic away from their location, positively affected by an increase of traffic, and directly harmed by minor right-of-way acquisition, access management, or traffic management. (Minor right of way acquisition in this context is considered that which does not bisect a building)
- **Other Businesses-** Those businesses that do not deal with the public at large and would not be directly adversely affected by a diversion of traffic, might be inconvenienced by an increase in traffic, might be inconvenienced or adversely affected by minor right-of-way acquisition, access management, or traffic management. Owners of real property within the city and along the existing route may be considered members of this category if their dominant interests are not covered under “Commercial Businesses”.
- **Petroleum Industry Stakeholders-** Those businesses that own and operate oil and gas wells and the necessary facilities and appurtenances for the collection and sale of these commodities. These interests are separate and distinct from those of the landowners on whose land the wells are located. The principal interest of these stakeholders is an investment in wells and hardware, and in real property rights acquired by lease from the landowners.
- **Public at Large-** The citizens of Texas and the United States. This is an all-encompassing category. In reality this category includes all of the others named here. For the purposes of this study the specific interests of the other categories will be considered to potentially conflict with those of the Public at Large, and therefore the interests of the Public at Large will be considered separate and distinct from local interests. While all other interests fall within this category, membership in other categories may be considered to have vested interests that may conflict with and override the interests they hold as members of the Public at Large. The interests of each individual member of the Public at Large is very dilute, whereas the interests an individual member may hold in one or more other categories might be significant in the context of those categories.
- **Directly Affected Businesses-** Businesses that might be affected by right-of-way acquisition to a degree that required complete relocation of the business to another site.
- **Directly Affected Homes-** Homeowners or residents that might be affected by right-of-way acquisition to a degree that required complete acquisition of the home site and possible relocation of the resident to another site.

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In addition to the stakeholders mentioned above, there are other interested groups or sub-groups of people or features that bear mention and consideration as distinct entities:

- **Utilities and Ancillary Features-** Physical assets that exhibit hardware with definite monetary value, as well as possible property rights through easement or fee title. Drainage facilities or natural drainageways can, under certain circumstances, fall into this category. There may be access limitations or physical limitations, such as connections to adjacent property for water, gas, and electric service or gravity flow of sewer lines.
- **Public and Private Schools-** features that require access, and yet are considered by the nature of the clientele to warrant an extraordinarily high level of protection from hazardous materials, high-speed traffic, and other threats to life and health. School districts are also taxing entities, with taxes based all or partly on appraised property value.
- **Existing Transportation Features-** Streets and roads that now carry traffic. These are an important consideration because at each there must be a decision to provide or deny a connection to a new roadway, the manner of a connection or separation, and the potential to sever existing facilities.
- **Local Traffic-** Vehicular traffic that originates and/or terminates within the immediate Sonora area. It consists of all of the vehicles and trips that support a community as it goes about daily life. As compared with through traffic, local traffic would contain a larger fraction of elderly or young drivers, family units with small children, local services such as mail delivery or utility metering, trips to school or work, and shopping trips. Local traffic will tend to make more turning movements, cross traffic to park at businesses, and travel both directions along an arterial route multiple trips in a day. It is logical to assume that drivers of local traffic might be more distracted from the tasks of driving by cell phones, radios, passengers, or navigation to a desired destination than the drivers of through traffic. Local traffic can be thought of as “white noise” in the traffic stream when considering long-distance movements. Yet, because of persistent exposure, local traffic is most affected by particular conditions along a specific roadway. If there is an incident along a particular roadway, the infamous “law of large numbers” implies that local traffic is likely to be involved in or affected by such an incident than is through traffic.
- **General Through Traffic-** For the purposes of this study, traffic of interest is that traveling US 277 from the north or south and departing. It may continue south or north respectively, or turn east or west. General Through Traffic consists of vehicles not constrained by commercial scheduling or planning. It might be thought of as primarily passenger traffic of various types, although it might also consist of some types of unscheduled trucking.

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- **Commercial Through Traffic-** Traffic of interest, probably mostly truck borne, that is scheduled and managed by some dispatching process that limits operator decision making ability and for whom travel time is a critical, managed commodity. For the purposes of this study, traffic in this category will be considered to be carrying non-hazardous cargo.
- **Special Through Trucks-** Truck traffic that is either subject to permit by virtue of being oversize/overweight, or that is carrying hazardous material. Some Special Through Trucks may otherwise be considered commercial, but are discussed separately by virtue of carrying hazardous cargo.

b. Identify and Compare Alternatives

The core activity of this study will be to identify and compare alternatives for the general location of a relief route. In theory, there are an infinite number of possible locations. However, there are a limited number of classes or groups into which most, if not all, of the practical options fall by basic similarity. Each of these groups was extensively examined using a specialized computer procedure known as “Quantm” in order to identify alignments that are optimal from the standpoint of cost. This process allows extensive and diverse constraint mapping for consideration in the optimization process. The Quantm system and process will be discussed in more detail later in the report. The results of those analyses will be presented as alternatives or options, examined, compared, and discussed.

c. Estimate Costs Associated with Various Alternatives

As part of the comparison process, estimated costs were developed. Cost is the primary vehicle of optimization for Quantm, and is a consideration of driving interest to all parties. An effort was made to be thorough and comprehensive in the development of cost inputs to Quantm, but it must be stated that absolute cost information is time-sensitive and volatile. Absolute costs as developed here appear to experienced engineers to be in line with expectations at this time, but will no doubt change in the future. Comparative cost information, however, should be much less time sensitive. Regardless of the state of construction costs in the future, there is no reason to believe that the relative positions of options in a hierarchy ranked on cost information will change.

Cost information was developed in mid-2007 for this comparison, based on recent projects of significant magnitude in this area. Between that time and the completion of this report, construction costs have already fluctuated significantly due to large fluctuations in the costs of fuel and related materials (asphalt), as well as by the economic state of the nation. No attempt has been made to “keep up” with those changes by altering cost information in the analysis; this was considered both futile and unnecessary.

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d. Identify Impacts of Various Alternatives

Equally or more important than cost for many of the stakeholders are other impacts that can be anticipated to issue from the construction of a relief route. This study will identify the major impacts of concern, discuss them as they relate to the various stakeholders, and discuss them in the context of each of the major alternatives.

It is in this subject matter that the extremes of competing interests exist, and where there is certain to be disagreement among parties. The author will attempt to represent all interests and articulate all points of view objectively.

Chapter 3- Background Information

a. Historical Concerns

An examination of the post-World War II development of the United States would be incomplete without a discussion of transportation. Between the mid-nineteenth century and the end of World War II, railroads dominated land transportation in this country. Today, railroads have waned considerably in their influence and prominence, replaced by the increased convenience of truck transportation for freight, by automobile for personal general transportation, and by air travel for long-distance personal transportation. The prominence of truck and automobile transportation has developed largely parallel with, and interdependent upon, the development of an extensive network of US highways. At the pinnacle of the development of these facilities is the US system of Interstate Highways. The Interstate Highway system is a network of high-speed, controlled access, divided roadways with grade-separated crossings (over/underpasses). The overriding concept of Interstate roadways is of continuous movement unimpeded by crossing traffic, intersecting roadways, traffic signals, pedestrian traffic, or large differences in speed between vehicles. Many Interstate roadways have posted minimum speeds, to prevent the impediment of movement. The Interstate system is considered by many to be one of the most important engineering accomplishments of the twentieth century.

This convenience has not come without social cost. Because of the conditions necessary to accomplish an environment of unimpeded movement, Interstate roadways were routed around most small towns. Many of those towns had once seen benefit from transient traffic through them by way of sales and services. It is now considered a historical truth in our society that “bypassing” small towns adversely impacts the economic viability of those towns. Such impacts are nearly impossible to quantify objectively. However, there is a large body of literature that discusses these impacts qualitatively. Specific examples have gained iconic status in some areas; the most prominent being the conversion of US 66 to I 40 through Oklahoma, the Texas Panhandle, and New Mexico, and the effects of that conversion on many small towns in those states.

It is not possible for this study to quantify the potential effects of a relief route for north-south traffic on the economic vitality of Sonora, but it is necessary and prudent to recognize that concerns for adverse effects exist as axioms in our society, that there are concrete examples, and thus that these concerns have foundation in recent history.

Sonora has been affected by this phenomenon in the past. US 290 became IH 10 through this area during the years of Interstate construction. Interstate 10 passes through the north edge of Sonora. Relatively speaking, Sonora was spared major economic harm by the proximity of IH 10 to the town, access provided to the town by the intersection of US 277 and IH 10, and the fortune of terrain that provides physical conditions conducive to the placement of IH 10 in a convenient place. However, there were some displacements, and many of the people of Sonora have personal recollections of the process surrounding the construction of such a high-speed roadway in their “back yard”.



Figure 3.1

Overhead image of Sonora, showing the relative position of I 10 and the majority of the town. US 277 runs from the lower left to the upper right.

B. Public Safety Concerns

As US 277 exists, all traffic traveling along it from the south must travel along one of the major arterial streets through the entire city. Local traffic mixes with through traffic, forming a heterogeneous traffic stream and higher traffic volumes than on the open road approaching town. Through traffic must slow to 30 mph, and stop at several traffic signals. Each component of the traffic stream (local and through traffic) approaches driving with different priorities; the preponderance of local traffic has a task and local destination in mind for the immediate future whereas most of the through traffic has the priority of traversing town and returning to a higher speed. Some fraction of the local traffic is exiting town for a longer trip, and some fraction of through traffic is inclined to make a temporary stop, usually for a commercial purpose (to patronize a business). On an uncontrolled street such as this, there are many potential “conflict points”, places at which traffic crosses paths. Street intersections, business and residential driveways, and parking lots all propagate conflict points. The mixing of two fundamentally different

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traffic streams, increased traffic volume, the presence of pedestrians, and a large number of conflict points invariably increases the likelihood of traffic incidents such as vehicular or pedestrian collisions. Such a situation is obviously a public safety concern.

A more visible public safety concern is that of hazardous material. Many tons of materials of varying degrees of health hazard are moved along the highway system every year. In a situation such as that in Sonora, there is currently little choice but for whatever material is being moved to move through the heart of the town. The actual chance of a hazardous material spill occurring at a given point on a roadway is very, very small, but the consequences of a spill of many hazardous materials in a commercial or residential area such as that surrounding US 277 in Sonora are dire. The chance of such an occurrence with the mixed traffic stream and multitude of conflict points mentioned above is obviously higher than elsewhere on the roadway. For most engineering purposes, "risk" is considered to be the product of the chance of occurrence (probability) and the cost or consequences of an occurrence. Hazardous materials traveling through town as they currently must on US 277 undergo a considerable increase in attendant risk-both probability of an accident and the consequences of a spill increase several times over as compared to the approaching roadway.

Occurrences of hazardous material spills that result in major health threats are comparatively rare nation wide. It is difficult to assign a useful probability to such an occurrence, and more difficult to assign consequences, being that consequences are very dependent on the material spilled. Useful quantification of the risk is therefore not forthcoming, but it can be said with some certainty that risk is tangible and real, and that it increases several times over as loads enter the town as compared to the open road. Unfortunately, we do not possess the ability to force risk out of existence; some risk is always present and must be tolerated. It is possible to talk generically about relative magnitude of risk, but even that is subjective in many cases.

Although we may be able to assign preference to one option over another with respect to the risk of a hazardous spill, the actual risk is always very small, but it is never non-existent. In the large context, there are locations where risk is known to be much greater than the average; locations that correlate access to large manufacturing or handling facilities and/or present specific difficulties in negotiation for transport vehicles. No such locations of an extraordinary nature are in immediate evidence in Sonora.

C. Concerns of Commerce

As noted earlier in this report, there is a considerable body of history that indicates that some commercial businesses have been in the past adversely impacted by the routing of traffic around small towns rather than through them. It is understandable that business owners in Sonora are concerned over the prospect of such impacts.

The concept underlying these concerns is the level of dependence of some businesses on patronage by transient through traffic. As previously mentioned, some fraction of through traffic will want to stop temporarily and patronize local businesses. Some

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businesses may be highly dependent on this transient patronage, others less so. Different components of the through traffic stream probably have different degrees of influence on the local economy, and may influence different segments. However, all business that is conducted by transient patrons results in a net inflow of cash to the local economy- it brings money into the community from outside. In that way, transient business has some impact on the local economy as a whole, not just on those businesses that are directly patronized.

Many business owners perceive that access to their businesses is crucial to success. From their point of view, completely unimpeded access to their doors is desirable. If their particular business is difficult to access, or even appears difficult to access, potential patrons are thought to be likely to continue on to the next, similar business along the road. As traffic volume increases, access becomes more and more difficult regardless of the presence or absence of specific access management, simply because of spacing between vehicles in the traffic stream. In that sense, traffic can be seen as having dual and disparate implications- more traffic means more potential patrons, but more traffic also means more difficulty gaining access, and the possibility of a higher percentage of potential patrons lost for that reason. Along existing streets with traditional design, there are comparatively few innovations available to enhance access to a business.

When speaking of a new roadway such as a relief route, a further concern of existing businesses is competition from new businesses that may develop along a new route. New businesses are often able to optimize access relatively freely, locate adjacent to a new roadway, and directly compete with established businesses on terms advantageous to the new businesses. In cases where an old business is inside of the corporate limits of a city and a new route is outside, the tax base of the city might even be affected. Money will still flow into the local economy from outside, but there may be other economic hardships incurred.

In virtually any context, the interests of established local businesses dependent on transient patronage conflict with the interests of the traffic management/transportation engineering features and procedures necessary to accommodate increasing traffic volume. It has been stated previously as an axiom that traffic volume through town and past existing businesses can become so large as to be untenable. It is understandable that existing businesses choose not to acknowledge that axiom until it becomes apparent in their individual situations. The choices are to divert traffic to another location or to restrict access to adjacent lands, neither of which is in the interests of existing roadside businesses.

D. Nuisance Issues

An increase in the volume of through traffic invariably brings with it issues that may not affect the health and safety of nearby residents and workers, but that may affect their quality of life through persistent, unpleasant irritations. Both traffic noise and exhaust fumes can present hazards to health and safety if they occur at sufficiently high levels. However, even if they are at levels considered acceptable according to federal and state

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standards, they might well be considered nuisances. This is particularly true in rural areas and small towns like Sonora, as compared with major metropolitan areas. The local populace of Sonora is accustomed to a quiet, sedate atmosphere with the clean air that is one of the attractive aspects of life in west Texas. It is reasonable to assume that people in Sonora will be less tolerant of traffic noise and exhaust fumes than people would be in a major metropolitan area such as Houston or Dallas.

Nuisances normally play a small role in the process for making decisions about such things, but they can be of great importance to the affected people. If considered early enough in the process, and acknowledged as valid concerns, nuisance issues might be addressed satisfactorily without compromising other interests.

E. Local Geography

Sonora is located in a very advantageous position from the standpoint of regional transportation development. There are no other towns in the immediate vicinity that would be considered competing for the development of transportation-related businesses, or the sustenance of existing businesses by new patrons. The nearest neighbor to the south along US 277 is Del Rio, which is 90 miles away. San Angelo is 60 miles to the north, and there are only two small towns between. Junction to the east and Ozona to the west along IH 10 are also small towns of the same order as Sonora, and each lies at a considerable distance in terms of the transportation system as a whole.

Topographically, Sonora is somewhat challenged with regard to development. The town lies along the valley terraces of an ephemeral stream known locally as Dry Devils River, at the confluence with Lowrey Draw. Being located at a bend in the Dry Devils River, the town appears visually to be surrounded on 3 sides by rocky hills typical of the Edwards Plateau area of Texas. The town virtually fills the valley from east to west. To the southwest and to the north, the valley of the Dry Devils River continues at a reasonably gentle slope.

From east to west, I 10 traverses the north edge of town. Interestingly, the IH 10 main lanes are screened from most of the town for visibility and for noise nuisance by the peculiarities of terrain. Approaching from the east, Sonora is screened from view by a hilltop until very close, then is visible for a short period of time as I 10 crosses Lowrey Draw, then is screened again by another hilltop and a large rock cut. Sonora becomes visible again as the interstate approaches the intersection with US 277. The town is visible for approximately one mile, after which it is screened again by hills. Whether or not this screening was conscious on the part of the designers of IH 10 is not clear. However, the net result is that the citizens of Sonora are largely protected from potential nuisance noise due to interstate traffic because of the location of I 10 with respect to local geography.

The alignment of US 277 as it approaches Sonora from the south predominantly follows the valley of the Dry Devil's River for several miles. It lies along the side of the valley approximately at the break point between the valley floor and the bounding hillside. The

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valley exhibits several gentle meanders south of Sonora. This results in the visual screening of the town from US 277 traffic approaching from the south until it is approximately 3 miles distant from the south edge of town. The town is then visible intermittently until approximately 1 1/2 miles from the south edge, after which it is visible.

Approaching from the north, US 277 also follows the valley of the Dry Devil's River for approximately 3 miles, although along the east side of the valley. Again, the roadway is located at the breakpoint between valley floor and adjacent hillside. With the exception of the Sutton County Airport, very little of Sonora is visible from this direction until traffic is very close, within approximately 1/2 mile of the intersection of US 277 with IH 10.

The town of Sonora itself lies primarily on the valley floor of the Dry Devil's River, and extends partway up the adjacent hillsides. As its name implies, the Dry Devil's River is an ephemeral stream that runs through the heart of Sonora. The US 277 alignment crosses the main channel three times as it traverses the town. Because of the close proximity of the main channel of this stream to many commercial and residential areas of town, there exists some threat of flooding. This area is known for and prone to severe flash flood generation. Many communities in the area, such as Del Rio and Ozona, have experienced catastrophic floods in the past. Sonora appears to have been largely spared this experience to date. However, as a result of the obvious threat, there exist numerous small reservoirs in the vicinity of town that were constructed in the late 1950s and early 1960s as flood control efforts. While these reservoirs are dry except for short times after large rainfall events, they nonetheless are presented as obstacles to be avoided in the construction of a relief route.

Upon viewing any recent overhead imagery of the town and surrounding area, one of the most obvious aspects is the very large number of natural gas and/or oil well sites. Wells are present in every direction from town. The lowest density appears to be in a sector roughly between the bearings of N 30° E and S 85° E of town. There appear to be literally hundreds of wells present within a few miles of Sonora.

By nature, the general terrain in which Sonora lies exerts considerable influence over the practicality and cost of relief route construction. While there does not appear to exist a widely accepted metric of terrain severity, it is apparent from examination of USGS topographic maps and GIS digital elevation maps that Sonora lies at a particularly difficult point along US 277 with respect to terrain severity. South of Sonora, the Dry Devil's River valley widens and flattens. The surrounding hills have been eroded more extensively due to the lateral migration of the stream itself over a longer time, and the accumulation of greater quantities of alluvial material. The net result is a decrease in the elevation change of the surrounding hills, and greater separation of them from one another, than in the immediate Sonora area.

Conversely, as US 277 proceeds north, it exits the Dry Devil's River valley within a few miles and proceeds north along high ground until it reaches the watershed of the South

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Concho River. After US 277 separates with it, the Dry Devil's River valley narrows and the stream channel itself ascends to the drainage divide between it and adjacent watersheds of the San Saba and South Concho rivers. Again, the net result is a decrease in the relative elevation change between the stream valley and the adjacent surrounding terrain. Thus, qualitatively, Sonora appears to be located in an area of particularly difficult terrain when compared to other terrain within a few miles north or south.

f. Background and Desires of the Local Populace

At least some portion of the local populace of Sonora and Sutton County are familiar with the particulars of the upgrade of an existing roadway to that of a controlled access, major rural arterial. Several decades past, they witnessed this process first hand during the planning and construction of I 10 through this area. As is the norm in such cases, there appears to be a wide range of personal feelings on this subject. As is also the norm in such cases, it is very difficult to assess what the feelings of the majority of the local citizens are on this matter. Information appears to be readily available primarily from those citizens who hold a strong interest, while the majority remains relatively silent.

What information that exists from the local populace appears as would be expected. There is concern for general public safety due to traffic and hazardous material; there is concern for the inconvenience of additional truck traffic; and there is concern for the proximity of the current route to public facilities such as schools. There also appears to be concern for the health of local businesses, and for the growth of the local economy.

There also appears to be some fatalism or feeling that "TxDOT will do what it wants", regardless of local concerns; i.e. that local citizens have very little input into the process.

A questionnaire was available to the people of the area at two public meetings, but only 38 of them were returned. Due largely to the (statistically) insignificant size of sample opinions (there is no implication of insignificant value of opinions) it is impossible to quantify these concerns, or even to rank them in importance at this time. Therefore, at this time the true nature of the desires of the local populace remains largely unknown. Some speculation about those desires will be necessary for future discussion, but speculation will be restricted to the articulation of possible options.

Chapter 4- Constraints and Assumptions

In real-world situations, we are never presented with comprehensive, complete information on any specific aspect of an issue, much less on all of them. In order to undertake a study such as this one, it is necessary to limit the study to reasonable pathways and to make reasonable and sound assumptions regarding unknown or poorly understood quantities. This chapter will present and discuss both limiting constraints and assumptions applied in the analysis of this situation.

a. Roadway Configuration

The basic concept of a relief route is to provide unimpeded, high-speed travel around an area of congestion. For the purposes of this study, the ideal configuration and specifications for such a route will be as follows: Four or more lanes, divided, controlled access, with no at-grade crossing roadways. This type of facility is best suited for all of the purposes and values in consideration. In order that the study have some breadth and not be overly constrained, relaxation of the ideal configuration will be considered for some of the options presented.

Current TxDOT policy is that the right of direct access from adjacent lands to a relief route roadway will be denied, and frontage roads will not be provided. This “right of access” is considered a real interest in the adjacent property, and the acquisition of that right is by purchasing it from the landowner at a fair market value for that interest. Local participation and desires can be brought to bear to modify that situation if desired by including frontage roads and some access to them. The logic behind denial of access and the absence of frontage roads is to prevent the propagation of businesses along a new route, which are considered to injure the existing businesses in town, and in the case of larger towns, to prevent the congestion that accompanies development. However, the purchase of the right and the denial of access cannot result in any property becoming “landlocked” such that access by owners is impossible. Alternative routes to access must be provided if existing routes are severed. This can be accomplished in many ways. In the case of a new roadway alignment that divides an existing contiguous tract, some indirect access to both parcels must be made available to the landowner. The point of access management is to control points of entry onto the main lanes of a roadway; entry must be at ramps or intersections. No private or commercial driveways will connect directly to the main lanes.

Due to the underlying purpose of this study, it is taken as axiom that a relief route departs from the existing US 277 alignment on one side of town and rejoins it on the other side of town. The vast majority of the existing physical features of concern lie south of I 10. For that reason, the only configurations that were considered were those that remove traffic from the current US 277 alignment from no further south than the I 10/US 277 interchange, and take it to a point near the south edge of town. Some configurations were considered that use I 10, and others that remove traffic from US 277 north of town and

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north of I 10. None were considered that do not circumvent the part of town south of I 10.

b. Terrain

From an engineer's standpoint, the first and most noticeable issue regarding a relief route in the Sonora vicinity is the terrain. The general nature of the terrain has been described previously. When considered in the context of roadway construction, the terrain surrounding Sonora presents a formidable challenge. There is no pathway around Sonora in the north-south direction that does not involve at least two changes in elevation measured in hundreds of feet- from the valley floor to the surrounding hilltops and back down. In and of itself, such a change in elevation requires considerable roadway length to accomplish at a tolerable grade (rate of change of elevation with distance). Once the elevation increase is achieved, further undulations of elevation may be required to cross streams and crossing roadways, or achieve connection with other roadways.

Complicating change in elevation and construction is the fact that the surrounding hills are almost exclusively composed of durable rock. The local geology is dominated by massive limestone beds. There are both advantages and disadvantages to this composition. Durable rock, such as the massive limestone of this area, is invariably more expensive to excavate than other earth materials such as alluvium, colluvium, soil, or deteriorated rock. Excavation of durable rock requires considerable use of explosives to accomplish. However, cuts with vertical faces can be made and maintained as opposed to battered slopes that are required on cuts in less durable materials. Typically, this reduces the width of right-of-way required in cut sections. It also provides excellent material for other roadway uses.

c. Existing Features

When possible, it is considered best to minimize the impact that new roadway alignments exert on existing features, both modern and historical. Modern features are typically subject to acquisition at fair market value through right-of-way processes, but common sense dictates that all other things being equal, it is preferable to avoid impacting them. Exceptions to this rule are facilities such as cemeteries, parks, hospitals, and schools. While it is technically possible to acquire such places for roadways, the cost and process are long and arduous, and should be avoided for reasons of cost and expediency if at all practical.

Historical features present similar problems. Historical buildings, archeological sites, etc. can be acquired and mitigated if there is no other option, but to do so is very difficult and typically very expensive- and it must be demonstrated that there is no other option.

In the case of Sonora, there are no significant, currently known historical or archeological features that would be in danger due to a relief route as studied in this report. There are existing features that could have some risk of acquisition should certain options be chosen. Among those are a small number of homes and businesses, a radio station

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transmitter tower, numerous gas wells and the attendant pipelines and equipment. There is some potential for the existence of habitat for one or more federally endangered species; however that determination cannot be made until an option is chosen and the final selection of a route is eminent.

As a fundamental assumption for this report, the consideration given to private property will be that it always resides in the possession of the person or organization who perceives its value as the greatest. Consider a contrived example:

John owns a piece of land. Henry wants that land, values it at \$10,000, and offers to buy it from John. If John values it at less than \$10,000, he will sell it to Henry. Henry now owns it because he placed a greater value on it than John did. However, if John values the land at \$12,000, he will refuse Henry's \$10,000 offer, and the property will remain in his possession, because he placed a greater value on it than Henry did.

From this logic springs the assumption that the current owner of property places the highest value on it, or it would change hands into the hands of the person who places the highest value on it.

The process by which land is acquired for public rights-of-way is intended to place an objectively determined, fair market value on that land and all existing improvements, assuming it were offered for sale by the owner in the market of the time. Almost without exception, those persons from whom land is being acquired for right-of-way consider it under-valued in the acquisition process. Given the above logic, that is understandable- in general, it has not been "offered for sale". However, public agencies such as TxDOT are expected to represent the interests of the public at large. The interest of the public at large is to pay fair market value as if the land were offered for sale, and no more.

Often, the extra value placed on land by owners has root in something other than money, such as heritage and sentiment. In this area, much of the land has been handed down through families for generations. In many cases, what remains of once large ranches are fragments in the hands of many family members, each of whom feels a very close attachment to the land holdings that they consider a birthright from their ancestors. Such land may be, in the eyes of the owners, virtually beyond price; they simply do not want to part with it. Value of that kind is attached to specific pieces of land by certain individuals because of their feelings, family history, and their individual rights rather than being an appraisable value intrinsic to the land itself. The process of acquiring land for public use has been contrived to be deliberately blind to such attachments, and to treat all private land equally- as a commercial commodity. This is because the primary fiduciary responsibility of an agency like TxDOT is to obtain land for the good of the public at large in a manner that is fair and business-like. To the agency, it is a business transaction; to the individual, it is an emotional event involving the loss of free choice. Quite often, the net results are hard feelings on the part of the landowner from whom right-of-way has been acquired, an antagonism toward the agency and its employees, and a feeling that they have been dealt with arbitrarily, impersonally, or unfairly.

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In spite of the philosophy underlying the right of way acquisition process, for the purposes of this report there will be discussion of a hierarchy of preference of taking based on use rather than ownership. All other things being equal, it will be considered preferable to acquire undeveloped land over developed land, industrial property over commercial property, and commercial property over residential property. This hierarchy is based on the author's perception of basic social mores and values. The value of undeveloped land and land used for industrial and commercial uses lies primarily in the fact that they are vehicles for the generation of income. For some commercial endeavors, location may have an impact on return, but the intrinsic use of industrial or commercial land is to make money, and any similar tract of land will serve equally well. If fair market value and compensation for relocation is offered, it is reasonable to assume that it can be viewed as a purely business transaction. Acquisition of industrial property over commercial property issues from the possibility that location is more critical for commerce than for industry.

Of privately owned property in which the public has no historical or other preservation interest, private residences hold the highest social value. While public entities like TxDOT must, at times, act as if they are blind to such attachments, the existence of these social values can be acknowledged early in the planning process, even if there can be no quantification. It is reasonable to assume that the public at large would tolerate or encourage the expenditure of a reasonable sum of additional money for the acquisition of other lands as an alternative to the acquisition of personal residences. The definition of "reasonable sum" is an individual value judgment and will not be quantified in this report. This is assumed to be a societal value rather than an individual one. This is not to say that homes cannot or will not be acquired, but is to imply that all other things being equal, society considers homes to be vested with personal attachment by the homeowner that invites the greatest amount of sympathy, and for that reason society favors sparing homes over other types of real property.

d. Cost

For the purposes of comparison among options the primary quantitative basis will be, of course, dollar cost. Overall cost is a composite of many individual costs. For the most part, those have been lumped together to the greatest extent possible. In some cases, such as gas well sites, an attempt to reflect a much higher cost for individual small tracts has been made. Some areas have been designated as "off limits", i.e. under no circumstances are they to be considered as part of the route. These areas are primarily the currently developed areas of Sonora. This is a result of two fundamental assumptions that bear discussion:

- Because of the assumption, outlined previously, in Chapter 1 section B, the "no build option" of conducting traffic through town on the current alignment, even if it were improved, is not considered a viable long-term strategy; it is necessary to consider alternative alignments.

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- An alternative alignment that requires acquisition of right-of-way and construction completely through the existing developed areas of town, and carries high-speed truck traffic through the middle of town, would have virtually no additional benefits when compared to routing around town, and would be very injurious to the town in many ways.

For these reasons, this study will focus on alternative alignments that primarily would take traffic around the developed areas of town, with as little direct impact on existing facilities, businesses, and homes as possible.

On the basis of the results of many trials, the outward appearance is that the direct cost of individual facilities such as gas wells exerts little influence on the particular choice of alignment. For most of the options investigated, other geometric influences such as terrain or the tolerable extrema of roadway geometric factors such as horizontal and vertical curvature and grade are the factors that drive costs. Original speculation was that there may be considerable difference in cost of various options due to the presence or absence of wells and the ability to avoid them. This has not proven to be significant.

As might be suspected if all other things were equal, simple length is the cost variable with the greatest impact on the overall comparative cost of various options. The cost of right of way is significant, and is relatively invariant with factors other than length. The cost of earthwork is also significant. Due to the constraints of terrain mentioned previously, considerable cut and fill is necessary regardless of what option might be chosen.

e. Connections

The entire purpose of this exercise is to examine the viability of various options for routing traffic traveling US 277 between the north and south edges of Sonora. It is obvious that a relief route must make a connection to US 277 at each end. For some options, there are other roads that intersect this route that may warrant connections. Whether or not connections are warranted, grade-separated crossings will be necessary at crossing roadways, or they will be severed.

Grade separated interchanges at each end of the route are anticipated. The possibility of connections to other roadways is under the influence of local people.

With a single exception, all of the options examined involve new interchanges between the relief route and I 10. In some cases, I 10 is considered to serve as part of the relief route, which may require upgrade of the existing connection between the US 277 and I 10.

f. Visibility

Considerable concern exists among many parties regarding the impact of a relief route on the economy of Sonora. As noted previously, many examples exist of towns that were

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adversely impacted by relief routes in the past. Anecdotal evidence is that the visibility of a town affects the degree to which it may be adversely impacted; i.e. that towns that are more visible attract more transient patronage than those that are visually screened or otherwise concealed from passing traffic. Effects like this are nearly impossible to quantify in any useful way, but their existence or perception of existence is strong among American society since the interstate building boom of the 1950s, 60s, and 70s. This report will acknowledge the existence of this effect, and attempt to evaluate the effect of various alternatives relative to one another and to other factors, rather than attempting to quantify the effect.

There exist several important considerations when discussing the visibility of Sonora with respect to a relief route. The first is that Sonora does not currently exhibit good visibility from any substantial distance from any direction of approach (Figure). This is primarily due to the terrain as discussed earlier. Improvement of the already relatively poor visibility of Sonora is not a reasonable goal. However, as traffic now traverses town, the town does get good exposure from close in. Obviously, diverting traffic from the current US 277 route through town will alter the visual experience of transient traffic in the Sonora vicinity.

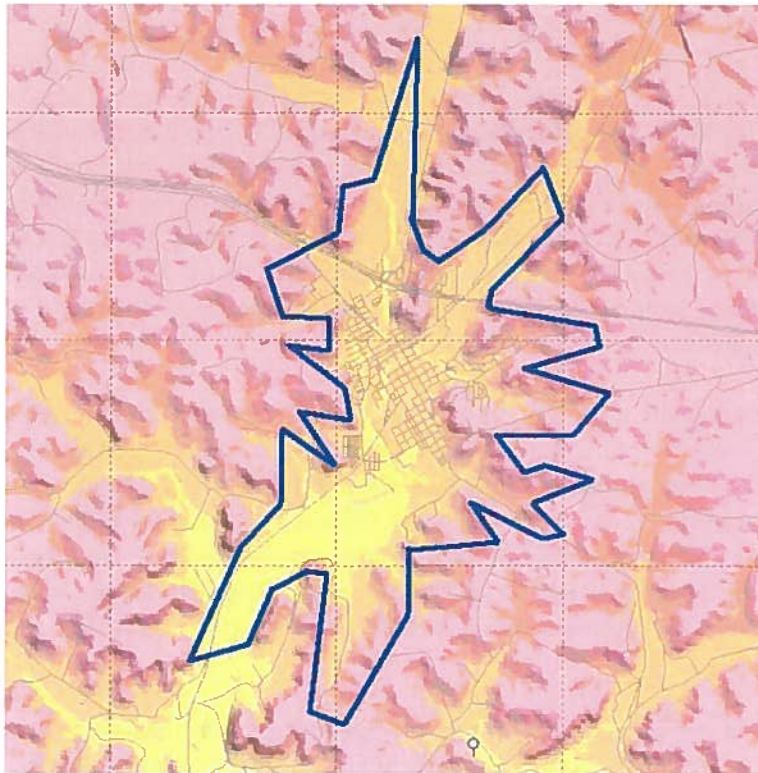


Figure 4-1; Approximate Limits of Visibility
The solid blue line represents the limit beyond which Sonora is concealed from view by terrain. Inside of the blue line visibility may also be limited by particular features.

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As stated earlier, the model for such a relief route is controlled access with no frontage roads and limited connections to town. Thus, the value of maintaining visibility of the town from the relief route itself can be thought of as limited. Transient traffic spotting a business from the relief route and desiring to patronize that business would have to return to town at or after having negotiated the relief route downstream connection to the existing US 277 alignment. Arguments in favor of this potential are that the next opportunity for food or merchandise of any diversity along the US 277 route are approximately 60 miles to the north and 90 miles to the south.

If, however, the town and businesses are visible to traffic prior to their departure from the existing alignment, the opportunity exists for potential patrons to elect to go through town on the existing US 277 alignment, giving them access to businesses. For that reason, visibility of town from the points of departure from the existing alignment will be considered of significantly greater value than visibility of town from the relief route alignment itself. For that reason if no other, the selection of points of departure is of paramount importance in the overall management of economic impacts to Sonora. The ideal is to locate them such that traffic has sufficient decision time prior to commitment to either the relief route or the existing route.

g. Noise

The issue of visibility is, to some degree, counterbalanced by the potential for nuisance noise. Noise levels due to traffic on a relief route would almost certainly not reach levels that would be considered unacceptable from a hygiene or environmental standard, but could conceivably become a chronic nuisance for the local populace. As stated earlier, Sonora is relatively well screened from noise generated by IH 10 traffic. Relatively poor visual access to Sonora from IH 10 is the price of that screening. However, Sonora is visible from the departure points from IH 10.

Due primarily to the terrain, a US 277 relief route would involve considerable change in elevation, from the valley floor to the hilltops surrounding Sonora. This change will involve significantly steep grades on both ends. Truck traffic in particular will be generating high amplitude noise pulling upward grades, and many will incur the use of engine braking on downward grades. If these grades can be screened from Sonora by terrain or roadway cuts, as the corresponding grades on I 10 now are, nuisance noise levels due to them should be minimized. However, screening for noise also means screening for visibility.

In the case of Sonora, nuisance noise protection and visibility are largely mutually exclusive; if you have visibility, you will probably have nuisance noise. The primary reason for this dichotomy is that Sonora is not visible from any direction for a distance sufficient to attenuate noise.

h. Hazardous Material and Oversize Loads

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The potential for a hazardous material spill along the existing US 277 route within the city of Sonora appears to be a relatively universal concern among the involved parties. All other things being equal, the probability of a spill along any given arbitrary length of roadway is very small. However, that probability increases in the presence of intersections with other streets and roadways, the presence of local traffic, traffic signals, pedestrians, and right-angle turns. The consequences of a spill range from minor inconvenience to catastrophic loss of lives and property. The possible severity of consequences makes even the small probability of such an incident an issue of concern to those who live and work near a roadway where hazardous materials may be transported.

For the purposes of this study, hazardous materials of concern will be considered to possess some mobility if released. Gases with densities higher than air, liquids with high vapor pressures and noxious vapors, and water-soluble solids all fall into this category. Many of these materials fall into the category of Toxic Inhalation Hazards (TIH). Historically, TIH spills occur most often during loading or unloading activities rather than due to on-road accidents. Many flammable materials and those subject to deflagration (rapid, violent combustion) present TIH hazards in addition to their flammability hazard, but the flammability hazards dominate the hazard they present. Substances that, when released, might disperse by wind or gravity and present an affected area that increases with time, remain in proximity to the ground, and present a hazard in that form appear to represent the most insidious case to expect. The prevailing winds are presumed to be out of the southeastern to northwestern half of the compass; i.e. southeast and southwest during the temperate and hot months, and northwest in the late fall and winter.

However, according to a study by Argonne National Labs, "Gasoline.... has been responsible for more transportation-related fatalities than any other hazardous material*". The flammability hazard presented by gasoline and other flammable, deflagrating, or explosive materials is typically physically confined to a distance from the accident that is much smaller than that presented by gaseous TIH hazards.

At this time, there exists no alternative but for US 277 traffic to traverse the town of Sonora. The public is at risk of immediate, close-proximity exposure to either TIH hazards or to flammability hazards presented by whatever substances are moving along that route. While small and virtually unquantifiable, that risk is nonetheless finite and real. The only way to reduce it is to provide an alternate route for traffic. The hazard presented by such flammables as gasoline is reduced very rapidly by distance, whereas the risk from the release of a TIH is reduced less rapidly. However, since the hazard due to flammables is much greater to begin with, reducing that hazard significantly reduces overall hazard due to spills.

Oversize loads also present issues in this case. Typically, oversize loads are permitted and carefully managed so as to present as little danger as possible to the public, but they can at times present considerable inconvenience. For many years, oilfield equipment has been a constant example of oversize loads that had to negotiate areas like this. More recently, components for wind-driven power generation facilities have presented very

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large loads that find the two right angle turns in Sonora difficult to negotiate. Once again, they have no alternative but to traverse the town.

While it is not necessarily assumed that a relief route would be designated as a hazardous material route, it will be assumed that the vast majority of trucks carrying hazardous material, as well as permitted loads, would use a relief route as opposed to traversing town. This assumption is based on simple convenience and level of effort.

i. Access

The current design criteria for relief routes does not include continuous frontage roads along the route, and involves the acquisition of right of access to adjacent lands for the purposes of management of development. These criteria can be modified by local desire and participation.

Access to crossing roadways on the state system will be assumed. Because of the design configuration, the assumption is for grade-separations and ramps as the connecting elements. City streets or county roads may not be provided with grade separations and thus may be severed, but discontinuous frontage roads may be necessary to prevent land-locking of property.

Local desire and participation, both in the decision-making processes and financially, allow for the basic conditions to be adapted to some degree. Frontage roads could be constructed and access provided under circumstances of shared costs and local benefit. In general, the tradeoff from the standpoint of the local economy is that new businesses that develop along a new route do so at the expense of patronization of existing businesses. The immediate and visible effects of that are obvious. However, sufficient foresight and planning by the local government and people could benefit the involved parties over an extended time period.

For the purposes of this study, the assumption will be that continuous frontage roads are not constructed and thus development of adjacent land is not a factor. No property will be land-locked, but connections will be provided to roadways on the state system. Development of property adjacent to crossing roadways will be assumed appropriately managed by the City for local benefit and satisfaction.

j. Local Commerce

There is considerable concern for the impact of the diversion of traffic from the existing US 277 alignment through town to a route that circumvents the commercial areas of town. There is a conflict of interests with respect to commercial businesses for which there does not seem to be a ready solution. A relief route is intended to accomplish the goal of providing a route for through traffic that is fast and convenient, physically separates through traffic from local traffic so that local traffic congestion is not affected by through traffic, and moves the majority of hazardous materials away from the

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populated areas to reduce potential exposures. That series of goals is in direct conflict with the idea of keeping through traffic traveling past existing businesses as it now is.

Ultimately, this question must be resolved one way or the other. As stated in the final paragraph of Chapter 1, it is considered axiomatic that at some value of traffic volume, continuing to carry the through traffic stream on a city street becomes untenable. Upon the determination that such a threshold has been reached, the diversion of traffic away from the existing businesses would become necessary.

If it is the intent of community leaders of Sonora to encourage growth in through traffic by supporting such initiatives as the Ports to Plains coalition, or if it is the opinion of community leaders that traffic will grow regardless of the position taken by Sonora, it ultimately becomes necessary to acknowledge that at some point in the future, diversion of traffic and the attendant impact on businesses will be necessary. That point does not appear to be on the horizon at this time, giving the community the ability to plan and manage in order to minimize adverse impacts on businesses.

Situations such as this manifest themselves such that local interests conflict with the interests of the public at large. As stated earlier, TxDOT personnel must consider the public at large to be their primary client and fiduciary responsibility. Actions by TxDOT will be governed by that responsibility.

The actual economic impact on local businesses is very difficult to measure. Research along these lines has indicated that there is substantial impact in some cases, and in others there is not. This may be due in large part to variation in research methods or to variations in situation. For the purposes of this report, the assumption will be that adverse impacts will occur to an unquantifiable degree, but that prior planning and management by the community can mitigate and minimize these adverse impacts. It will further be assumed that TxDOT will act in the interests of the public at large.

k. Regional Commerce

The issue of regional commerce is the principle driving force for the current discussion. Major, direct, high-speed roadway transportation routes in a north-south direction through Texas are uncommon, the main one being I 35, which transits 4 of the 5 major metropolitan areas of the state. These are all “non-attainment areas” for air quality, which limits further capacity enhancement on this route.

Other than I 35, there are no north-south freeway-type facilities. This study will assume that there will be an increasing need for such a route, that such a need will be particularly acute in the area west of I 35, and that there will be particular need for such a route that serves the US-Mexico border area at the southern end, and the Midwest/great plains area to the north. The US 277/Ports to Plains corridor meets all of these criteria. Without the implication of any commitment by TxDOT, it will be assumed for the purposes of this study that this corridor will develop into a major route with traffic continually increasing, and that the development of traffic along the route will be accompanied by new

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commercial and industrial development along the route as well, a “bootstrap” effect of development giving rise and impetus to even further development.

The implication of this “bootstrap” effect is that property values along the corridor may increase. Opportunities for industry and commerce that do not currently exist may present themselves. Being located at the crossing of the Ports to Plains corridor and I 10 should give Sonora and Sutton County a very desirable advantage in the competition for new industry. For the purposes of this study, it will be assumed that, regardless of adverse effects of traffic diversion on existing businesses, the overall economic effects of the development of the corridor into a major route will be a considerable net increase in economic opportunity.

That there will be the development of a major north-south roadway facility in the future appears inevitable. That it will be along US 277 through Sutton County appears likely. These assumptions are based on critical analysis of the situation by the author and are a professional opinion. They do not represent an agency stand by TxDOT.

I. Traffic Volume and Composition

The previous section discussed regional drivers for the development of a north-south high-speed route in this region. Such an assumption explicitly means a considerable increase in traffic. Truck traffic in particular is the object of concern, although the development of a major truck route is invariably accompanied by an increase in passenger vehicle traffic.

Passenger vehicle traffic presents substantially fewer problems than does truck traffic from the standpoint of many of the physical issues related earlier. Noise, congestion, hazardous materials, and hazards presented by increase in vehicle numbers are all of less concern for passenger vehicles than for trucks. However, passenger vehicles may imply a considerable increase in the likelihood of transient commerce to the local area.

Some of the issues mentioned above are of considerably more concern to passenger vehicles than to trucks. In particular, easy access and visibility are more likely to enhance the chances of transient business.

In any case, the stream of vehicles will be mixed between trucks and passenger vehicles. Regional commerce concerns are focused on truck traffic and the ease of passage along the corridor. Local concerns do not neglect truck traffic, but are more subject to influence by passenger vehicles. Currently, a mixed stream traverses the existing alignment. When, as is assumed, traffic volume increases to the point that this situation is untenable, it is the diversion of through truck traffic that will be the ultimate goal. Through passenger traffic that is not interested in stopping also will be best served by diversion. However, passenger traffic that may be interested in patronizing local businesses should ideally have ample information and opportunity to make that decision and do so. Through traffic that would not stop would not contribute to the local economy; diverting it harms no one and reduces congestion. Traffic that is actively

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seeking a specific business will find it, and is unaffected by a relief route. Traffic that may be swayed by the opportunity to stop is the group of concern to local businesses.

At this time, the exact nature and composition of the traffic stream is unknown, but can be assumed consistent with other, similar roadways. Traffic arriving from the south will have traveled 90 miles since the last significant opportunity to stop. From the north, it has been 60 miles since San Angelo and 20 miles since Eldorado. Sonora is in a very good geographic position to take advantage of transient patronage. People arriving there with a need to stop will have a strong motivation to do so, if the facilities are evident and convenient.

Chapter 5- Method of Analysis (Quantm)

This chapter is intended to outline the technical methods used to compare the anticipated dollar cost of alternatives from a purely construction standpoint. From the standpoint of the public at large, cost is the ruler by which all other interests are measured. Anticipated cost of construction includes “loaded” right-of-way acquisition cost, which in turn includes an averaged relocation and utility adjustment cost. It also includes the cost of materials, labor, and equipment for the actual construction process. Cost rates were developed from recent construction projects on Texas Trunk System projects in the San Angelo District, and from statewide averages. Such rates are always fluid, and the actual numbers used may have been valid only for a short time. However, the comparative ranking of one alternative relative to another is insensitive to detailed cost; those comparisons should remain valid indefinitely.

Quantm

For this study, the author utilized a special-purpose software tool known as “Quantm”. This system was available to TxDOT users through a contract between the vendor and the TxDOT Design Division.

The core code of Quantm is proprietary and is held private by the vendor. The base company is Australian, and the actual software kernel resides on an advanced computing platform located in Sydney. From the Quantm literature and discussions with the corporate representatives, it is apparent that the core code of Quantm is a highly advanced multivariate optimization routine.

Input files are generated on the user’s computer by the use of an input pre-processing graphical interface known as “Quantm Integrator”. Once these files are generated, they are sent by e-mail to Australia, where they are processed by the core program. Output is reviewed by the operator there, and then returned to the user by e-mail with operator comments. The format of the files returned is such that output is viewed using the same interface program. Complete cycle time from the time the user sends an e-mail until results are returned is highly variable, depending largely on the time difference between Australia and the user. The advertised standard is that if a user in the US sends a run at close of business one day, the results are waiting the next day. However, if an operator is on shift at the time an e-mail is sent, results may be returned in as little as 20 minutes.

Input information to Quantm is significant. Topographic data from a GIS Digital Elevation Model, cost information for land and construction items, roadway and right-of-way geometry constraints, beginning and ending geometric conditions, and information about areas that are “off limits” is all input by the user.

As understood by the author, the Quantm core program performs an exhaustive search for approximate alignments that meet the constraints specified by the user. It calculates a cost for each potential simulation of the alignment, and returns to the user the 50 least-

cost simulations. The “Integrator” program then allows the user to examine each of those simulations in many ways, both graphically and by tables.

The version of Quantm used in this project produces an alignment approximation using a type of curve known as a three-dimensional spline. This curve can reasonably approximate roadway alignments, but is constrained in one unusual way. Whereas actual roadway alignments are composed of circular curves joined by straight-line segments in the horizontal plane, and parabolic curves joined by straight grade segments in the vertical plane, a three-dimensional spline can possess no true straight segments. Straight “tangents” and straight grades must be approximated by segments of very slight curvature (large radius of curvature). The net result is not especially problematic, but leads to simulations that are unusual in appearance in some cases.

As far as user input, of particular interest are those parameters that exert geometric control over potential alignments. The user specifies minimum curvature values, maximum vertical grade values, locates “guideposts” between which the alignment is constrained to pass, specifies areas to be completely avoided, and specifies the location, direction of travel, and grade of the beginning and ending points of the alignment. In confined areas, these specifications can become very constraining, leading to a large number of very similar simulated alignments being returned. With more freedom, simulated alignments can vary dramatically in character.

As the process developed of refining potential alignments using Quantm, the analyst also began to observe characteristics of the various simulations that are cognizant, as opposed to being physically quantifiable. These are such things as visibility, accessibility, nuisance noise potential, proximity to existing homes, businesses, churches, schools, and other facilities, and others. These issues will be discussed and presented along with cost figures for various simulated alignments, as points or counterpoints to be used in the process deciding among options. They will be framed in the context of the situation, constraints, and assumptions previously discussed.

Chapter 6- Discussion of Alternatives

This chapter will be devoted to the discussion of alternatives for the general location of a relief route around Sonora. The “no build” option will not be discussed for reasons mentioned previously.

Initially, alignments departing from the existing US 277 alignment as far as 5 miles north and south of Sonora were given consideration, in order to avoid overly constraining the problem from the outset and overlooking alternative that might offer some hidden benefit. No such benefits were discovered, and the problem rapidly contracted into five basic options.

Other alternatives, including various ways of traversing through town, were given enough consideration to conclude that they were at best inferior to the five basic options already under consideration, and they were therefore rejected and given no further consideration. It is the author’s contention that at some time, every option that could be conceived was at least given sufficient consideration that it could be further investigated or rejected for reason, rather than arbitrarily.

The five basic options that will be discussed are as follows:

Option 1- From existing US 277 south of town, west around town, rejoining US 277 north of town, crossing IH-10 (Figure 6.1);

Option 2- From existing US 277 south of town, east around town, rejoining US 277 north of town, crossing IH-10(Figure 6.2) ;

Option 3- From existing US 277 south of town, west around town, connecting with I 10 west of town, following I 10 east until reconnecting with US 277 at the existing interchange (Figure 6.3);

Option 4- From existing US 277 south of town, east around town, connecting with I 10 east of town, following I 10 west until reconnecting with US 277 at the existing interchange (Figure 6.4); and

Option 5- From existing US 277 south of town, west around town to a point roughly in line with the projection of the existing US 277 alignment immediately south of the crossing of I 10, then descending to connect to that roadway, including a large bridge over existing Crockett Street as it intersects with existing US 277 . (Figure 6.5)

Within each of these options, there are a multitude of variations on the actual alignment. For the most part, within each option cost is relatively insensitive to specific alignment details. With the exception of areas near the points of departure from the existing alignment, the avoidance of any particular feature of high value should be attainable. High value features such as gas wells do not appear to dramatically affect cost, simply

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because costs are relatively high to begin with. Clusters of wells make it very difficult to avoid all of them, but avoidance of the majority should be possible.

As stated earlier, the location of the points of departure from the existing US 277 alignment are very important for visibility. In the immediate vicinity of those points of departure, any new alignment is, of course, very geometrically constrained. Those constraints relax with distance from the existing roadway. Not only is location important, but the compass direction and the vertical grade of the roadway present constraints. It is likely that an interchange of some sort will be needed at each of the departure points.

No underlying implications should be inferred from the numerical order of the options examined- the order was chosen by chance. For instance, simply because the general conditions referenced in this report as “option 1” are presented first does not mean that this is the preferred option.

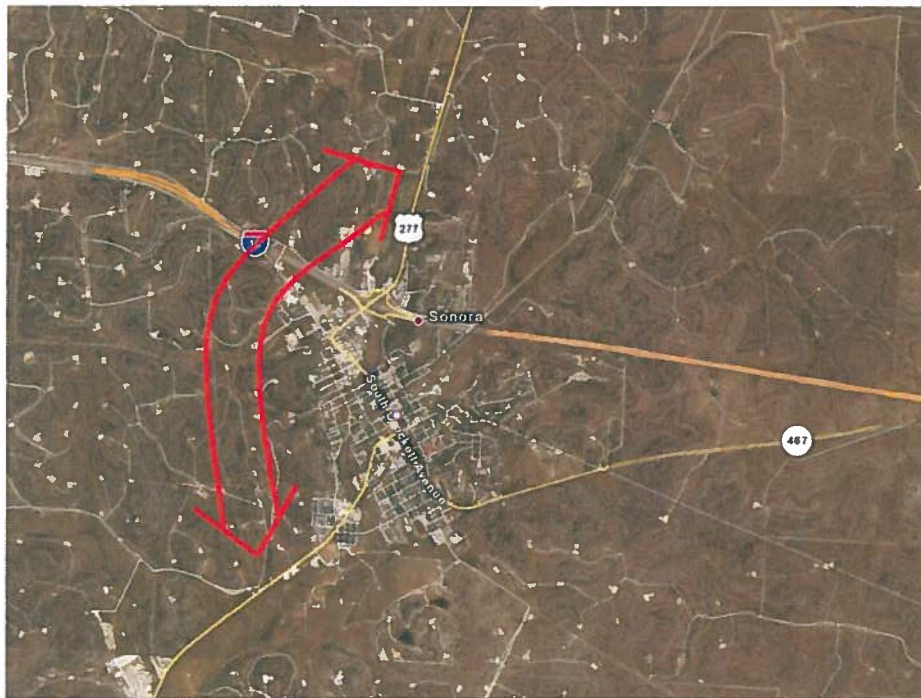


Figure 6.1

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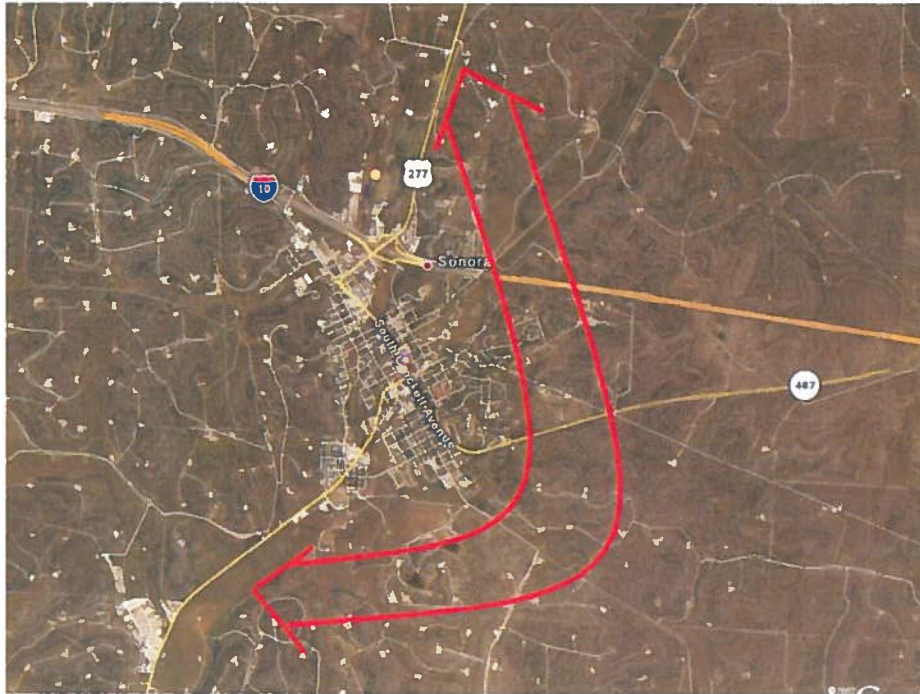


Figure 6.2

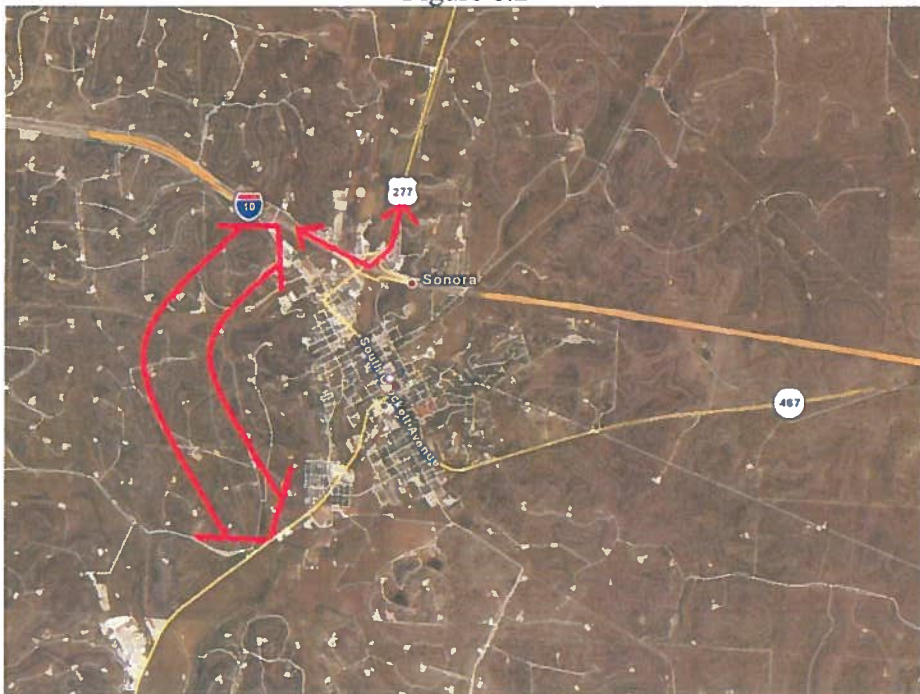


Figure 6.3

Ch. 6- Discussion of Alternatives

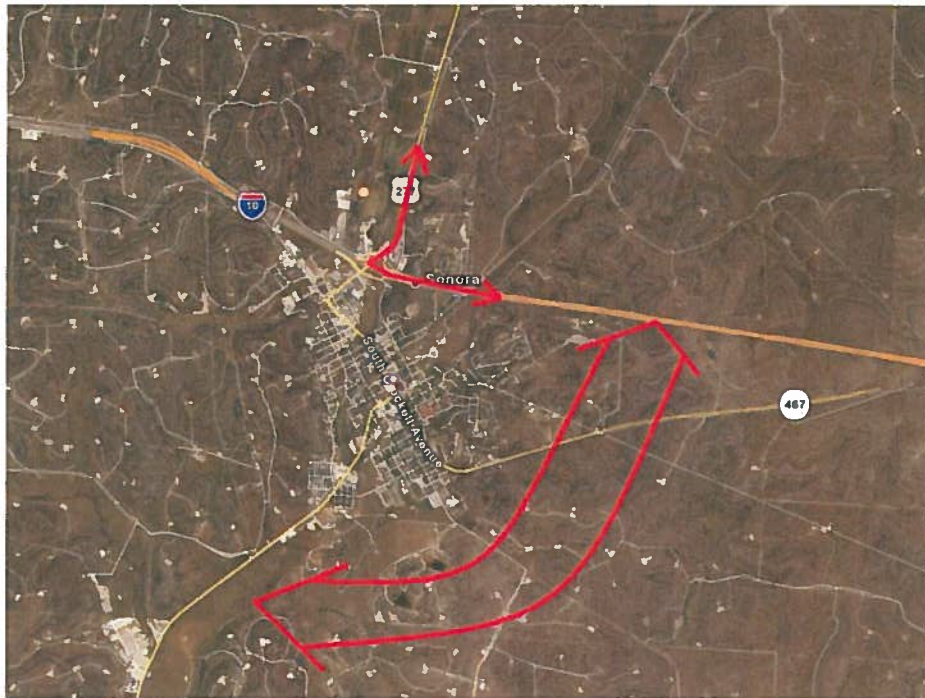


Figure 6.4

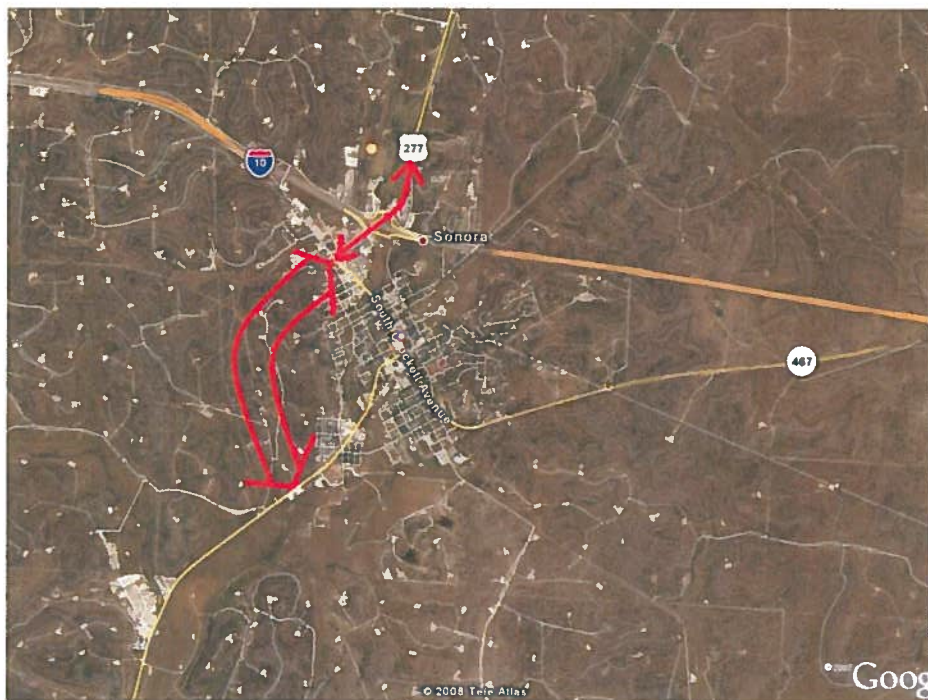


Figure 6.5

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Option 1- From existing US 277 south of town, west around town, rejoining US 277 north of town, crossing I 10;

Comparative cost: \$31.8M

This set of conditions appears intuitively as a consideration simply from a map of the Sonora area. Because of the locations and directions of the US 277 alignments to the south and north of town, a larger portion of the town exists to the east side of US 277 than to the west. It would appear from a map that this would be the shortest route around Sonora in a north-south direction.

The US 277 alignment as it approaches from the south is along the west side of the Dry Devil's River valley, which puts it in proximity to the hill slopes on the south edge of town. As it approaches from the north, the US 277 alignment is along the east side of the valley. Thus, any relief route alignment that completely traverses Sonora in the north-south direction, connecting with the existing alignment with new interchanges must immediately climb the hill slopes at one end, a geometrically challenging accomplishment, and must cross the valley completely at the other end. Crossing the valley would involve a substantial bridge over the streambed. However, it would allow flexibility between optimizing the departure point and choosing a route to climb the hill slopes on the other side.

Certain physical barriers present themselves when considering the portion of a potential option 1 alignment north of I 10. The Sonora airport, the Sonora golf course, and several flood control reservoirs are present in the immediate area and are all considered as fixed avoidance areas; under no circumstances will a route through them be considered. All are public use facilities that would be difficult if not impossible to acquire as right-of-way.

In order to minimize the length of roadway built, and thus costs, the departure points must be as close to town as possible yet still allow the geometric criteria to be met. This also serves to optimize visibility of town from the departure points. In all five of the options considered, the south departure point is relatively invariant. It falls southwest of the first major cross-drainage culvert on US 277 southwest of the city proper, in the vicinity of a private access drive leading to the KHOS radio station. Avoidance of the radio station and nearby private structures should be possible.

The north departure point for this option must be located such that the proposed route can cross the valley north of the Airport, and climb the hillslope between the airport and a large flood-control dam. If the north departure point is located 1.7 miles north of the US 277/IH-10 intersection, all of these goals can be accomplished. However, visibility of town from that point is poor; the majority of the town other than the airport is screened from view at the actual departure point. Sonora would become visible from the route alignment as it crossed the valley and climbed the hillside, but would be reduced again after the roadway leveled out on the hilltop.

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This option crosses IH-10 at or near the existing west overpass, where Crockett Street meets I 10. Some form of interchange with I 10 would be necessary, such as a diamond interchange as a minimum, and could possibly use the existing bridge. Traffic arriving at the I 10 interchange would have some visibility of town and could exit the relief route to patronize businesses if desired. The visibility of town would be reasonably good for a short stretch either side of I 10, more so for southbound traffic than for north bound.

The Quantm system returns the 50 least expensive options that it computed during an optimization run. Of these, the 5 least expensive are shown in Figure 6.6. Among these 5, cost varies by less than 1%, among the least expensive 10, by less than 2.5%, and among the top 20, less than 5%. The implications of these facts are that if a general corridor indicated by the top 5 Quantm –produced alignments were chosen, costs would be reasonably fixed and not subject to great variation due to specific alignment features.

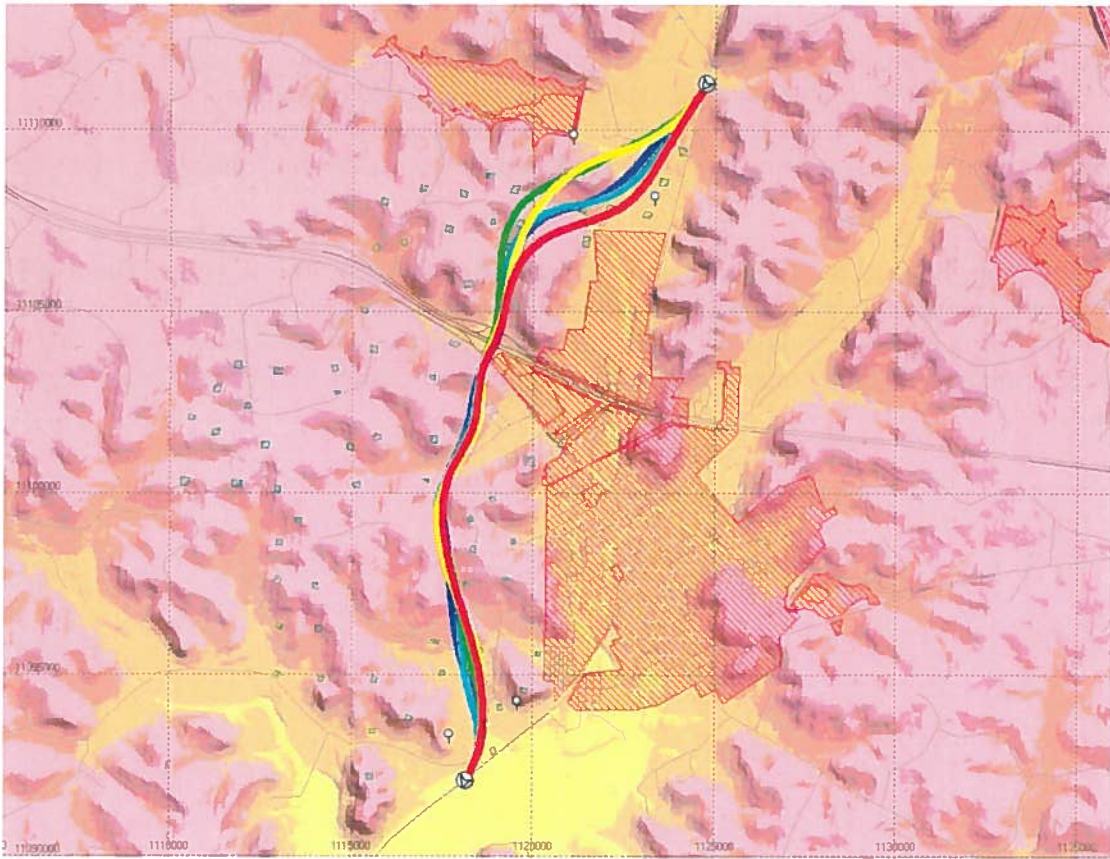


Figure 6.6; Option 1
Five least cost alignments
Order of cost- Red, yellow, green, cyan, blue.
Red hatched areas are avoidance areas.
Small grey hatched polygons are well locations.

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If this option were chosen, in order to make the grade change between IH-10 and the hilltops to the south, a mobile home park south of the west interchange would be affected. It is not known if the lots in this park are individually owned or are rented, but the extreme southwest end of the street would coincide with needed right-of-way.

The top 5 alignments are all very similar, except in how they climb from the valley floor to the hilltop on the north end. The least cost alignment runs closest to the north end of the airport runway. The second least cost alignment is considerably further from the runway, and thus is less constraining on the airport. As stated, these options differ by less than 1%, so idealizing factors other than cost can be taken into account.

Under the assumptions of the nature of hazardous materials mentioned earlier, this route would involve some remaining risk. Most of the route would be uphill, upstream, and upwind (based on the earlier assumption of prevailing winds) of Sonora. There is therefore some continued risk due to a spill, however that risk is much less than under the current conditions.

The primary benefits of this option are realized by the portion of the alignment south of I 10. The portion traversing the quadrant from I 10 around to the northwest of the Sutton County Airport and re-joining US 277 incurs considerable cost, but does not manifest significant benefits other than to allow a high-speed interchange at the north departure point.

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Option 2- From existing US 277 south of town, east around town, rejoining US 277 north of town, crossing I 10;

Comparative cost: \$49.9M

This option is the conceptual “mirror image” of option 1 in that it departs from the existing US 277 north and south of town, but traverses around town to the east side. With respect to the Dry Devil’s River valley, the same general geometric conditions apply; at one departure point the alignment must cross the valley, while at the other it must immediately climb the hillside. However, in this case the valley is crossed south of town, and the hillside proximate to the current alignment must be climbed north of town. The proximity of the existing alignment to the hillside north of town is such that the location of the point of departure is crucial to being able to make the climb effectively. The departure point most effective in this option is similar in location to that for option 1, being only slightly further north. The visibility of Sonora from the north departure point shows the same disadvantages as for option one. However, under option 2, the town remains screened from view as the roadway climbs to the top of the hill adjacent to the existing alignment. Once atop that hill, parts of the town would become visible as the roadway descends into Lowrey Draw. The five least-cost alignments are shown in Figure 6.7.

The presence of Lowrey Draw and the hillside which constitutes its southeast valley wall are significant obstacles to this option. The roadway must ascend/cut through the hill between the existing roadway/Dry Devil’s River valley and Lowrey Draw, descend to cross Lowrey Draw, then ascend once again to cross the hill to the southeast. Upon the north flank of that hill is the I 10 alignment. Since US 277 must cross I 10 and should connect with it, the nature of that crossing is critical.

From a traffic management standpoint, it is so undesirable to sever an existing Interstate highway in order to build new grade-separation bridges on the Interstate main lanes that it might be considered infeasible. To do so is expensive, inconvenient, and presents a significant impediment to through traffic. Constructing grade separations that carry another route over the Interstate main lanes is much more tolerable. However, none of the 50 least expensive alignments for option 2 carry the US 277 route over IH-10, simply because terrain makes it cost prohibitive. All of the reasonable alignments proposed involve deep cut through the hill in question and through the IH-10 lanes, and require new bridges on IH-10. While technically possible, this scenario must be considered only marginally feasible at best. Even considering tunneling under the IH-10 alignment is feasible, although doing so increases cost by over 37%. All of this would be compounded by the need to make connections to I 10, which was not considered in detail in this option. The need for connections with I 10 is subject to some in-depth consideration; traffic coming from the north and desiring to take IH-10 could take the existing route to the current interchange without having to completely cross Sonora. Traffic from the south could be routed to the north departure point and then returned in the same way to the existing interchange.

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This option also involves the crossing of 3 smaller roadways. Each of these would require a grade separated crossing. Whether or not connections with the relief route would be provided to these roads is subject to some local influence; the general tendency to deny access would indicate no connections. However, if business access was provided along the roads in question, access might be considered advantageous to the local economy.

From I 10 south, the visibility of Sonora from the route would be quite good. From I 10 north and at I 10, visibility would be poor or non-existent. Accompanying the visibility is a potential noise factor. This route would pass in relatively close proximity to the part of town with high-value residences, and noise would be projected directly into those neighborhoods.

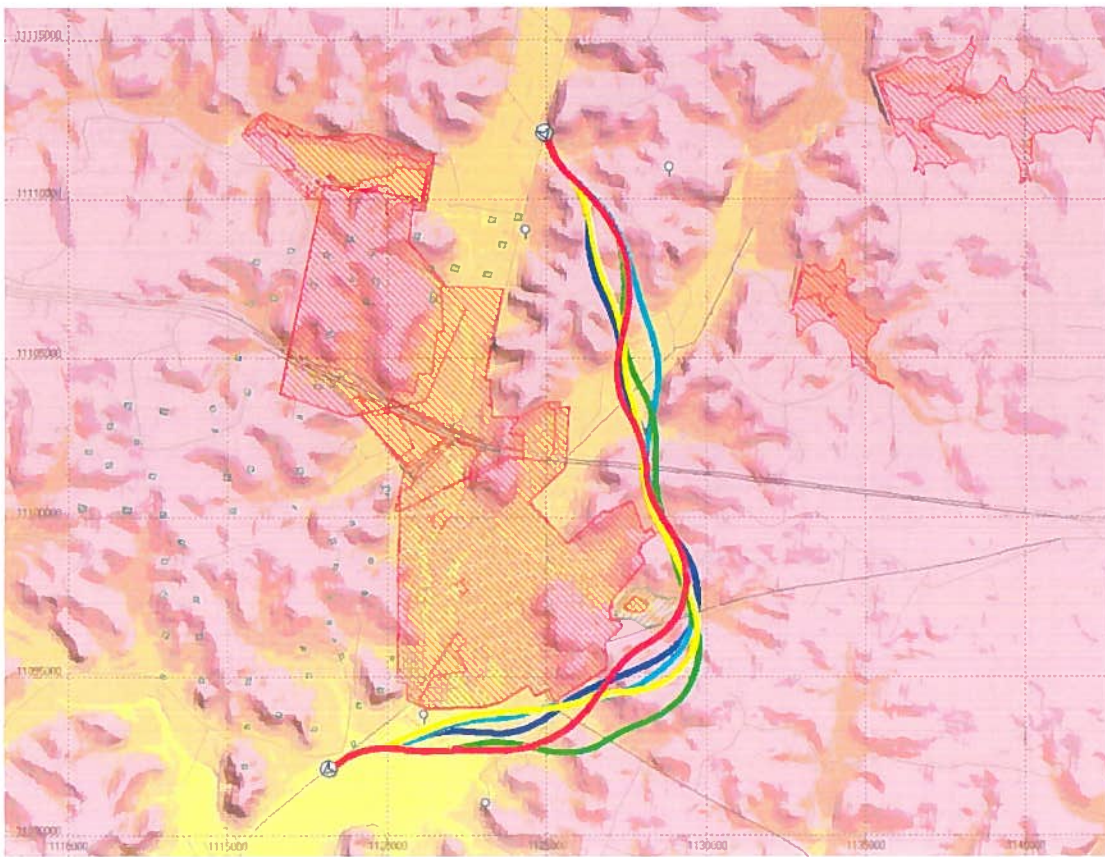


Figure 6.7; Option 2

Five least cost alignments. Order of cost- Red, yellow, green, cyan, blue. Red hatched areas are avoidance areas. When compared with Figure 6.6, an additional avoidance area had to be added to the west, between Sonora and the flood control reservoir, in order to force the Quantum program to consider alignments to the east.

Under the assumptions of prevailing wind and hazards due to material spills, this option presents a slight improvement over option 1 in that the route is downwind according to

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prevailing winds. It remains uphill and upstream, but the gradient is smaller and average distance would be slightly greater than for option 1.

All things considered, this option is easily the most expensive, being 2 ½ times more expensive than the least cost option to be presented later. It is also of doubtful feasibility because of the difficulty of crossing I 10. Overwhelmingly, the reason for the cost of this option is total length of roadway necessary. It is exacerbated by the multiple, large changes in elevation dictated by the presence of Lowrey Draw and the severity of the terrain on the north side of I 10. Multiple very deep cut and fill sections are necessary to traverse that area.

As with Option 1, the primary benefits of this option are realized by the portion of the alignment south of I 10. The portion traversing the quadrant from I 10 around to the northeast of town, crossing Lowrey Draw and the ridgeline to the west of it, and re-joining US 277 incurs considerable cost, but does not manifest significant benefits other than to allow a high-speed interchange at the north departure point.

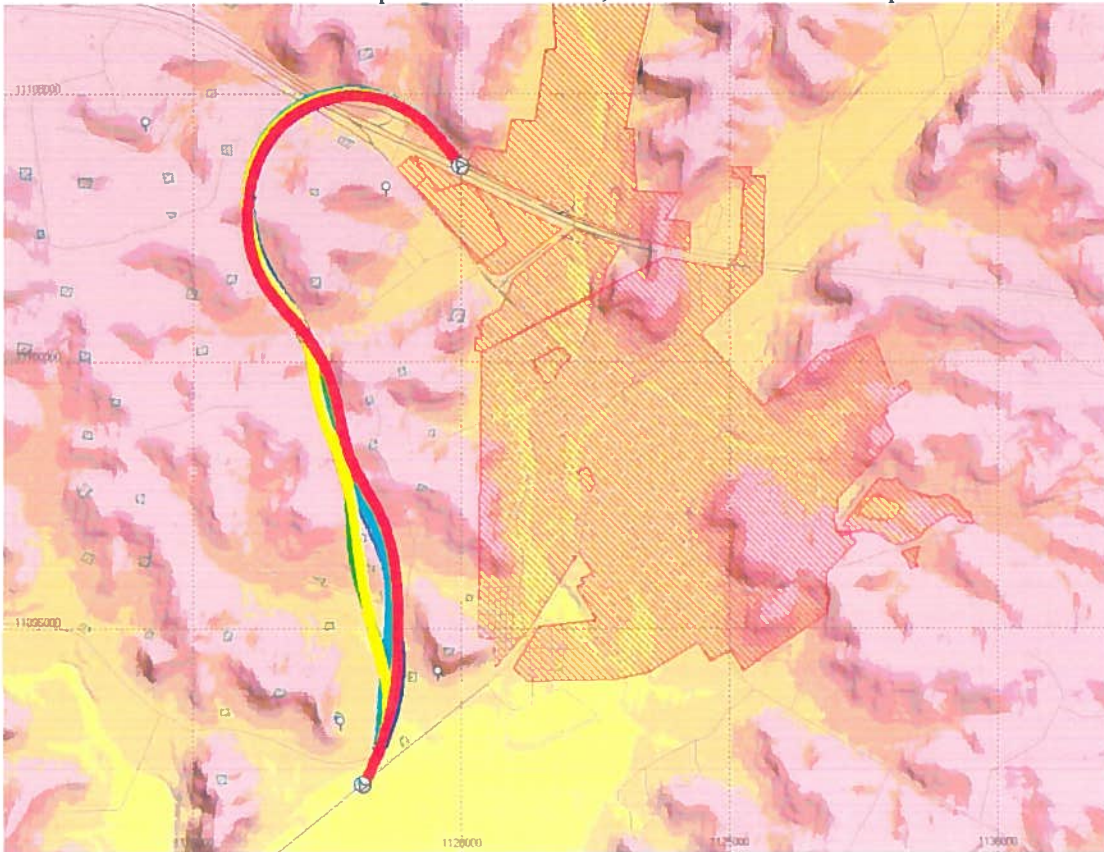
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Option 3- From existing US 277 south of town, west around town, connecting with I 10 west of town, following I 10 east until reconnecting with US 277 at the existing interchange

Comparative cost: \$26.8M

This option begins under similar assumptions as option 1; of a west route around town with very similar southern departure point conditions. However, it eliminates that part of the new alignment north of I 10. As stated earlier, it is assumed that the areas needing relief lie primarily south of I 10. Option 3 makes use of this fact, and of the existing I 10 alignment, by moving the north departure point from US 277 north of town to I 10 at the west edge of town and routing traffic along I 10 between that point and the existing intersection of US 277 and I 10.

Conditions on US 277 as it approaches from the south are the same as mentioned under Option 1, and all of the same advantages and disadvantages for the portion of this route south of I 10 are the same as option 1. However, the elimination of the portion of the



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option 1 alignment north of I 10 relieves several problem obstacles; particularly the flood control reservoir, the airport, and the golf course. It also reduces the total length of roadway necessary by a considerable margin. This results in a substantially reduced cost.

The chronic problem with visibility of Sonora from the north departure point discussed earlier is alleviated to a considerable degree in this option. Traffic approaches town from the north in the same manner that it does currently, until it reaches I 10.

Along with that advantage is an increased risk due to hazardous materials due to the proximity of approach to town. However, that risk is somewhat diluted along the I 10 alignment by the simple fact that a similar risk due to I 10 traffic already exists. When additional risk is added onto existing risk, the net increase in risk appears much different than when a similar risk is imposed where no risk has existed previously, as would be true along a new alignment. As compared to Option 1, alignments are further west when south of I 10 and are situated such that a slightly increased distance, alleviating some hazard due to flammables, and decrease in the probability of heavy TIH spills flowing into town due to gravity. The actual comparison of risks between Option 1 and Option 3 is difficult due to offsetting of one risk increase by a reduction in another. Option 1 will be considered to exhibit reduced overall proximity, but the difference is actually small.

When compared directly with the part of the option 1 alignment south of I 10, the main difference in the vicinity of I 10 is that option 3 implies high-speed connections to I 10. This necessitates “wrapping” the alignment from north-south to east-west, with the connection point near the existing west overpass. To accommodate this wraparound, the option 3 alignment projects further west than option 1 climbing the hillside south of I 10 at a point further west and along a route that is more geometrically advantageous than that for option 1.

With option 3 being located further west, the mobile home park endangered under option 1 is not endangered in this option. The option 3 alignment climbs the hillside south of I 10 on the reverse slope of the hill as seen from Sonora, giving some additional protection from noise and hazardous material as compared with option 1. There is probably some slight decrease in the visibility of town from the route in the vicinity of I 10, but that is more than offset by the increase in visibility at the north departure point. In truth, the existing US 277/I 10 intersection serves as the north departure point. The south departure point is virtually identical to that for option 1, although the alignment climbs the hillside slightly further south.

A variant of this option was considered that in essence involves the construction of the south portion of option 1, leaving the north portion for later construction. This variant has not been presented formally because it is indistinct from option 1. It possesses all of the disadvantages of the option 1 alignment south of I 10 without many of the advantages of the option 3 alignment. It involves a right-angle turn from the I 10 frontage road onto the relief route, which is disadvantageous. This configuration, if considered, should rightfully be considered as having chosen option 1 and phased the construction. If this

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was done, it is questionable whether or not the north part would ever be constructed; in which case distinct advantages exhibited by option 3 would be lost.

As can be seen in Figure 6.8, the top five alignments are all very similar in plan view. This is an indication that the geometric requirements and terrain are highly constraining, leaving little room for variation, yet that the optimum alignment is fairly well-defined optimal solution.

This option departs from the stated ideal condition of unimpeded high-speed traffic in that traffic would have to slow and make a right-angle turn at the US 277-I 10 connection. However, the severity of the constraint of that movement is much less than the constraint of existing right-angle turns in town. As an offsetting benefit in the eyes of some local business concerns, those slowing and turning activities take place within visual range of several commercial establishments.

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Option 4- From existing US 277 south of town, east around town, connecting with I 10 east of town, following I 10 west until reconnecting with US 277 at the existing interchange.

Comparative cost: \$37.8M

The difference between option 4 and option 2 is very similar to the difference between option 3 and option 1. The option 4 alignment departs the US 277 alignment at the same point on the south side of town as option 2, and is very similar as it traverses the southeast quadrant of Sonora. As with option 3, the implication of high-speed connectors forces the wraparound configuration of the connection with I 10, pushing the alignments further east. Whereas option 2 is only marginally feasible due to the difficulty of traversing I 10 and Lowrey Draw in such close proximity, the geometry of connection with I 10 is somewhat more feasible, while still expensive. In this area, the

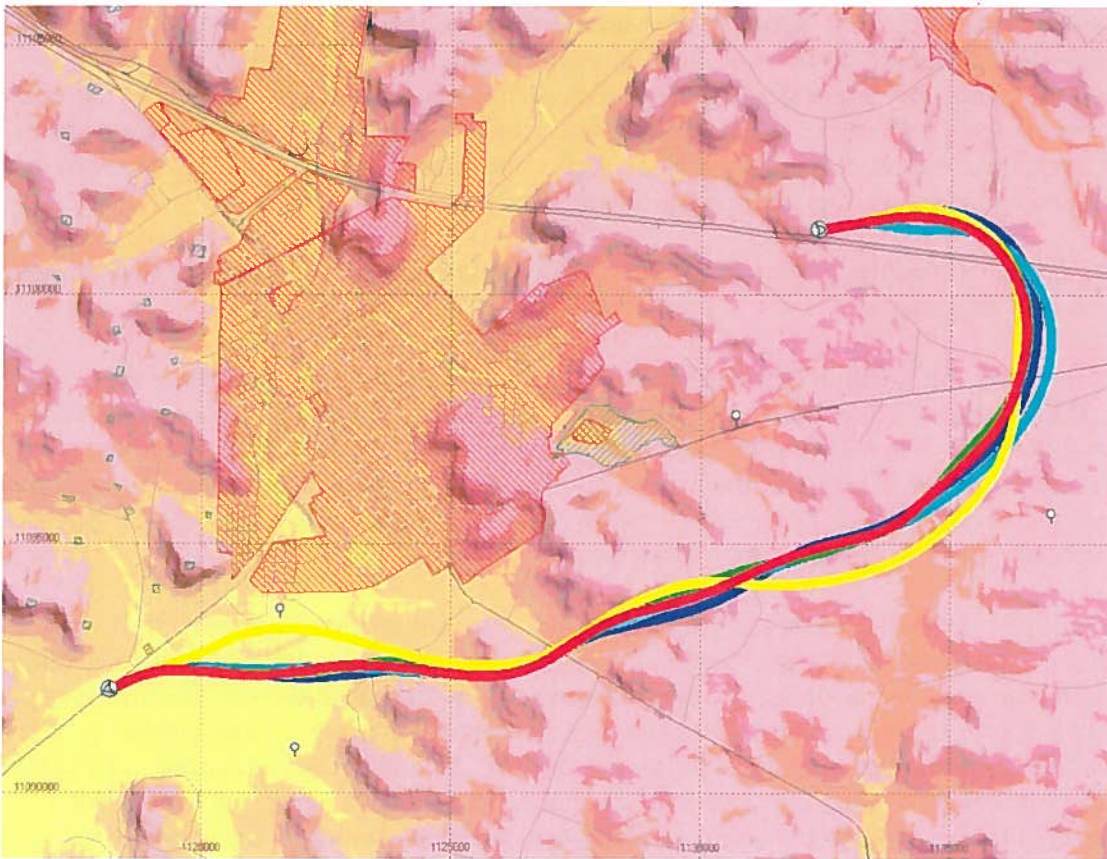


Figure 6.9; Option 4

Five least cost alignments. Order of cost- Red, yellow, green, cyan, blue. Red hatched areas are avoidance areas. When compared with Figure 6.2, the association with IH-10 occurs further east on terrain more conducive to the connection.

I 10 alignment is such that the general slope of terrain is counter to the slope needed for the roadway, forcing either bridge or very deep fill to be constructed adjacent to I 10. In

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order to minimize that effect, the north I 10 connection point for option 4 is considerably east of the crossing point of option 2, placing it near the top of the hill and on more advantageous terrain.

Option 4 involves the crossing of two of the same secondary roads as option 2, and the same decisions about access and crossing type would be involved with this option.

As with option 3, traffic arriving from the north would make the existing connection between US 277 and I 10, making that intersection the departure point from the existing US 277 alignment. It would possess the same advantages of visibility and disadvantages of noise and potential hazardous spills as for option 2. The point of interchange with I 10 would be visually screened from Sonora completely, as it would be on a hilltop to the east.

The advantages of option 4 as compared to option 2 are virtually identical to those of option 2 as compared to option 1. Prevailing winds result in reduced risk due to hazardous materials, and the forcing of the alignments further away from town make roadway geometry slightly easier to optimize. The assignment of preference to Option 2 over Option 4 with respect to hazardous material exposure mimics that of Options 1 and 3 also, with an even closer comparison. Again, the difference is small, but preference in that category goes to Option 2 on overall proximity.

Again, as with option 3, there is very little difference in either cost or in geometry among the top 5 alignments.

Contrary to the situation between options 1 and 3, in this case no investigation was conducted into the construction of a variant of option 4 that simulated the part of option 2 south of I 10. The nature of the crossing/connection with I 10 for option 2 is so indistinct that to do so would make little sense. In all likelihood, if option 2 were chosen, no direct connection with I 10 at the crossing point would be feasible; connection to IH-10 may be best handled through the existing interchange.

This option departs from the stated ideal condition of unimpeded high-speed traffic in that traffic would have to slow and make a right-angle turn at the US 277-I 10 connection in the same manner as option 3. Again, the severity of the constraint of that movement is much less than the constraint of existing right-angle turns in town. As an offsetting benefit in the eyes of some local business concerns, those slowing and turning activities take place within visual range of several commercial establishments. There does not seem to be any specific reason to favor approach and departure from that connecting intersection from or to either the east or the west.

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Option 5- From existing US 277 south of town, west around town to a point roughly in line with the projection of the existing US 277 alignment immediately south of the crossing of I 10, then descending to connect to that roadway, including a large bridge over existing Crockett Street as it intersects with existing US 277 .

Comparative cost: \$21.9M

While options 1 and 3 are closely related to each other, and options 2 and 4 are similarly related to each other, option 5 is clearly different in concept from all of those, and shares few common elements. This is the only option under evaluation that would involve significant work within the city limits of Sonora, and would certainly require the acquisition of multiple businesses and homes. It also presents the greatest engineering challenges.

As a north departure point, this option involves beginning a bridge structure on the existing US 277 alignment immediately south of the existing I 10 overpass, the bridge climbing rapidly to cross Crockett Street, connecting to the hillside now occupied by several businesses and homes, and continuing to the hilltop south of the current Crockett Street/US 277 intersection. Accommodating both the bridge mentioned, and ground-level roads for access to current businesses and the remainder of town would necessitate the acquisition of considerable right-of-way and widening of the roadway between Crockett Street and the overpass.

This option is further complicated by the fact that the I 10/US 277 overpass carries I 10 over not only US 277, but over the Dry Devil's River. There is also a bridge carrying US 277 over the river immediately north of the overpass. There are also other improved drainage features in this vicinity. However, because the north departure point of this option is south of I 10, there is neither a new connection nor a crossing of the interstate.

This option appears to present the extremes in all ways; it presents the best visibility of town and the best access to existing businesses, yet it presents the least reduction in risk from hazardous materials. It involves relatively severe grades directly in town and elevates the roadway where sound can project to almost any point, which would correlate to the most severe case of nuisance noise. It would involve the acquisition of both homes and businesses for right-of-way. Construction would be very disruptive; deep rock cuts requiring explosives would be in close proximity to homes and businesses. Yet, this is the least-cost option from a financial standpoint, and involves the most direct connection conceivable that eliminates the right-angle turns now involved without remaining in the valley and taking homes and businesses along the entire route (an option not considered viable).

The south departure point is identical in nature to that for options 1 and 3. Figure _ shows the top five alignments, which are nearly identical in plan view. This option is also very tightly constrained by geometry and terrain, there are few viable degrees of freedom, and costs are very similar.

Ch. 6- Discussion of Alternatives

If this option were chosen, environmental considerations not prevalent in the other options might exert some influence, i.e. a process known as “environmental justice” to ensure that economically and socially disadvantaged groups were not being treated unfairly. This option would place the roadway closer to the part of town that might be considered economically and socially disadvantaged.

It is logical to believe that this option would be the most divisive to the community, simply because of the extremes mentioned above. The kind of division that an option like this might bring about carries with it political ramifications and uncertainty. Local elections may result and/or legal action may occur that impair progress or result in progress accomplished being rendered futile.

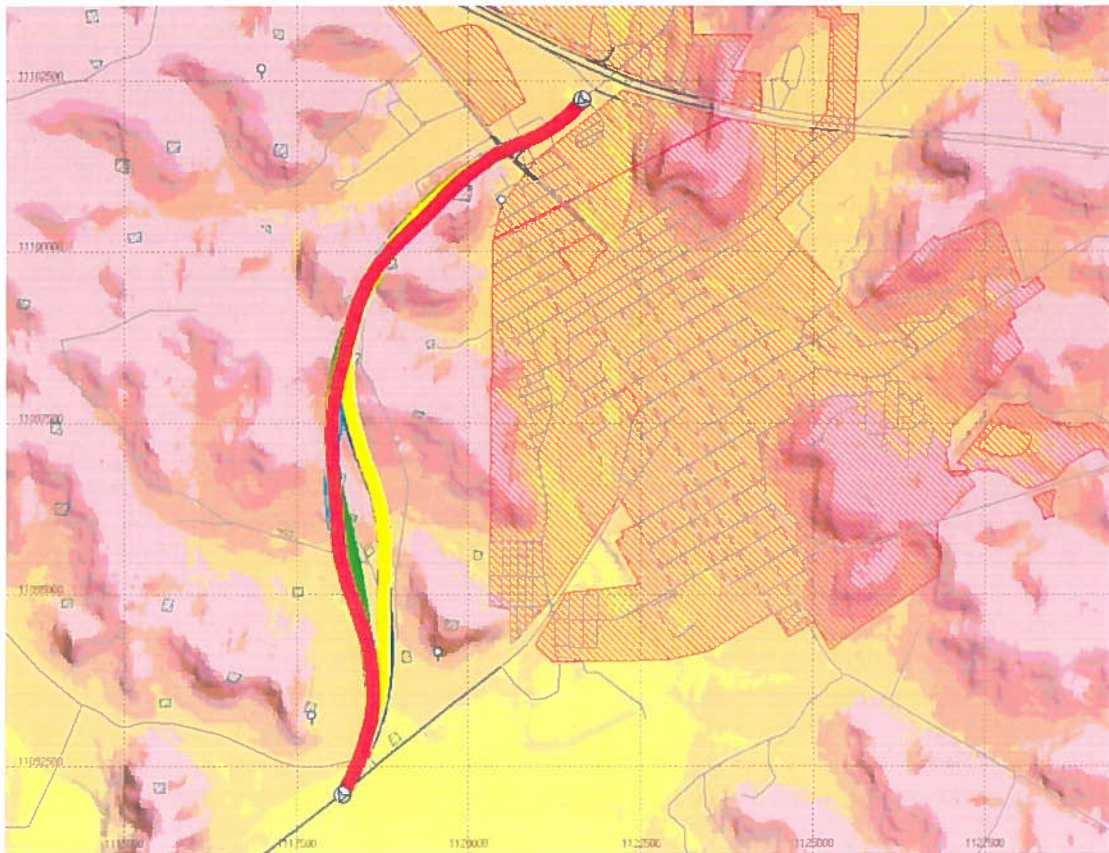


Figure 6.10; Option 5

Five least cost alignments. Order of cost- Red, yellow, green, cyan, blue.
Red hatched areas are avoidance areas.

Chapter 7- Comparison of Alternatives

Each of the options described in Chapter 6 possesses some attributes that are desirable, some that are undesirable, and some that are worthy of note and discussion without assigning them to the “desirable” or “undesirable” categories. These latter attributes may be considered desirable by some people and undesirable by others, or may be of little consequence to the overall decision-making process.

In order to avoid an overt ranking of the options, paired comparisons between all options will be made between each option and each other option. That will result in 10 paired comparisons, those being comparing 1:2, 1:3, 1:4, 1:5, followed by 2:3, 2:4, 2:5, then 3:4, 3:5, and finally 4:5. In this way, each option is directly compared to each of the others, but none of the comparisons are repeated.

The criteria used for comparison in the tables which follow, and explanations for the assignment of preferences, are explained here. It is vital to remember that these are paired comparisons; each attribute is being compared to the same attribute of one of the other options in a relative but un-quantified sense. Preference need not be due to a large difference, but it must be large enough to indicate preference as opposed to equivalence.

- **Relative cost-** this is a 1:1 comparison of the cost from one option to the other. A check mark is placed in the column of the option with the lesser of the two costs, and the relative magnitude of the greater cost (as a percentage) is placed in the column with the greater cost. For instance, of Options 1 and 2, Option 1 has the lesser cost. Option 2 costs 156% of what Option 1 costs.
- **Visibility from the north departure point-** This is considered to be where traffic departs from the current US 277 alignment on the north end. For options 3 and 4, that point is at the existing I 10/US 277 interchange.
- **Visibility from the route itself-** This is a difficult criterion to assess, and possibly subject to some disagreement. Each route may present better visibility at different points along the route. The value of visibility from the route itself is arguable; if traffic has already committed to the relief route, the enticement of visibility must be strong enough to convince passing traffic to “double back” from the point at which they re-join US 277 in order to stop, or there must exist intermediate intersections at which they can divert.
- **Access to businesses-** This criterion attempts to gauge the relative merit of options in providing easy access to existing businesses, not to possible future businesses. Access works together with visibility to allow businesses to entice potential patrons away from the traffic stream to patronize their businesses.
- **Unimpeded passage of through traffic-** An attempt to gauge the impact of features like interchanges and turning movements on overall traffic movement. Less impedance is considered more desirable. It is assumed that, at least initially,

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if traffic must enter the I 10 traffic stream, it will have to negotiate the existing I 10/US 277 intersection. This will result in some impedance of flow, but considerably less than the current situation. The ideal from the standpoint of traffic management would be high-speed directional interchanges at all connections. However, there exist in this context competing interests. Local businesses that rely on the patronage by through traffic are potentially damaged by providing unimpeded through traffic. Therefore, the interests of the population at large as idealized by minimal impedance compete and conflict with those interests that are better served by enticing traffic to patronize businesses. Preference will indicate less impedance; the position of an individual will govern that individual's opinion concerning the desirability of reduced impedance.

- **Protection from hazardous materials-** Distance, prevailing winds from the southeast to northwest part of the compass, and terrain are considered in this criterion. Preference is given to the route that exhibits the least risk of ill effects in the event of a spill along the route.
- **Impact on disadvantaged/affluent residential areas-** This pair of criteria are very similar, are equally important, and are in some ways diametrically opposed. Because of property values and assumed local political influence, adverse impacts on affluent neighborhoods are often very controversial. However, adverse impacts on disadvantaged neighborhoods often carry an even greater cost socially and in the environmental clearance process. People in disadvantaged neighborhoods are often impacted to a degree that is relatively greater than those in more affluent neighborhoods, and are less able to bear the burden of mitigating those impacts. In either case, preference in these criteria indicates less impact.
- **Impact on oil/gas wells-** As stated earlier, some routes would certainly affect wells. The overall importance of this criterion is assumed to diminish with time as the resource is depleted. It is expected to be minimal after 25 years.
- **Restricts future development-** This criterion assumes that terrain and land use would favor the expansion of development into the area in which a particular option would locate a route. Primarily, land answering that description lies to the east of town, although development to the northwest is also possible. Both the severity of terrain and the prominent presence of gas wells in the southwest quadrant make development in that area less likely in the near future.
- **Impact on businesses-** Impacts on local businesses could be either adverse impact or it could be advantageous impacts. This criterion simply makes an assessment of relative benefits. Preference indicates that overall, benefits of one are greater, or adverse impact is less, when compared to the other option of the pair being compared. Ultimately, preference may not indicate anything beneficial happening, it may simply be that fewer adverse effects occur.

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- **Requires acquisition of homes or businesses-** Preference indicates smaller need for such acquisition. As stated earlier under the assumptions section, the acquisition of homes is considered least desirable.
- **Nuisance noise potential-** a subjective assessment of the relative severity of noise effects. Distance and intervening terrain mitigate noise, steep grades imply greater engine noise and the potential for engine braking to be necessary (legal or not).
- **Steep grades/roadway geometry issues-** In addition to noise, steep grades imply speed reduction and fuel expenditure to negotiate. This reduces overall effectiveness of a route by impeding progress. Tight roadway geometry indicates higher potential for chronic high-accident locations, hazardous material spills, and other safety problems.
- **Traffic does not enter town-** This criterion would undoubtedly be considered polarizing. Some citizens would consider traffic entering town to be a good thing, others would view it as detrimental. Preference on this criterion simply indicates which option involves the least potential for traffic entering town. Interpretation of that fact as “desirable” or “undesirable” is left to each individual.
- **Requires additional interchanges-** This criterion, like the last, is subject to individual interpretation. Interchanges are expensive and require a relatively large footprint; avoiding their construction makes financial sense. However, if city planning indicates a desire to develop commercial property adjacent to a new route, opportunities are presented by interchanges. The number of new interchanges may be an indicator of potential business opportunities. Preference in this category, however, is predicated on the assumption that fewer is better simply because of cost. Preference indicates fewer.
- **Uses existing I 10 alignment-** This criterion is simply an indicator of attempted efficiency. If the I 10 alignment can be used to assist in overcoming the problem at hand, there is value added in the overall scheme of traffic management. Preference is to make the best use of existing facilities.
- **Visibility from connection/crossing with I 10-** The final criterion rates the relative strength of the visibility of Sonora from the points of intersection with I 10. Considering that the principal concern is for the conduct of US 277 north-south traffic around Sonora, it is of secondary importance that I 10 traffic that might be turning onto US 277, or that might be inclined to stop, be able to see Sonora from the connection point. All else being equal, this criterion is rather weak, but will be considered as a point of reference should the need arise. Preference will indicate the location with better visibility from the crossing/connection.

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In the tables, preference is indicated by the plus sign (+) in the column of the option preferred, and a minus sign (-) in the column of the other option. Equals signs (=) in both columns indicates that the author considered the options roughly balanced in the criterion, and that no clear preference could be found between those two options on that criterion.

These preferences should not be considered definitive; they represent the opinion of the author. Different people may assign different preferences. Ultimately, the process of negotiating to reach a consensus should begin by comparing different people's opinions on these criteria and discussing them.

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Table 7.1, Paired Comparison of Option 1 to all other options.

Criterion	Option 1	Option 2	Option 1	Option 3	Option 1	Option 4	Option 1	Option 5
Cost (Relative)	✓	156%	118%	✓	✓	119%	145%	✓
Visibility from the North Departure Point	=	=	-	+	-	+	-	+
Visibility from the route itself	=	=	=	=	-	+	-	+
Access to Businesses	+	-	-	+	+	-	-	+
Unimpeded passage of through traffic	+	-	+	-	+	-	=	=
Protection from Hazardous Materials	+	-	+	-	-	+	+	-
Impact on disadvantaged residential areas	-	+	=	=	-	+	+	-
Impact on affluent residential areas	+	-	=	=	+	-	+	-
Impact on oil/gas wells	-	+	=	=	-	+	-	+
Restricts future development	+	-	=	=	+	-	=	=
Impact on businesses	=	=	-	+	-	+	+	-
Requires acquisition of homes or businesses	-	+	-	+	-	+	+	-
Nuisance Noise Potential	+	-	-	+	+	-	+	-
Steep grades/Roadway geometry issues	+	-	=	=	=	=	+	-
Traffic does not enter town	=	=	+	-	+	-	+	-
Requires additional interchanges	+	-	-	+	-	+	-	+
Uses existing I 10 alignment	=	=	-	+	-	+	=	=
Visibility from connection/crossing with I 10	+	-	=	=	+	-	-	+

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Table 7.2, Paired Comparison of Option 2 to Options 3, 4, and 5

Criterion	Option 2	Option 3	Option 2	Option 4	Option 2	Option 5
Cost (Relative)	185%	✓	131%	✓	227%	✓
Visibility from the North Departure Point	-	+	-	+	-	+
Visibility from the route itself	+	-	-	+	-	+
Access to Businesses	-	+	=	=	-	+
Unimpeded passage of through traffic	+	-	+	-	-	+
Protection from Hazardous Materials	+	-	+	-	+	-
Impact on disadvantaged residential areas	+	-	=	=	+	-
Impact on affluent residential areas	-	+	=	=	-	+
Impact on oil/gas wells	+	-	=	=	+	-
Restricts future development	-	+	=	=	-	+
Impact on businesses	-	+	-	-	-	+
Requires acquisition of homes or businesses	=	=	=	=	+	-
Nuisance Noise Potential	-	+	=	=	+	-
Steep grades/Roadway geometry issues	-	+	-	+	=	=
Traffic does not enter town	+	-	+	-	+	-
Requires additional interchanges	-	+	-	+	-	+
Uses existing I 10 alignment	-	+	-	-	=	=
Visibility from connection/crossing with I 10	-	+	=	=	-	+

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Table 7.3, Paired Comparison of Option 3 to Options 4 and 5

Criterion	Option 3	Option 4	Option 3	Option 5
Cost (Relative)	✓	141%	123%	✓
Visibility from the North Departure Point	+	-	-	+
Visibility from the route itself	-	+	-	+
Access to Businesses	=	=	-	+
Unimpeded passage of through traffic	=	=	-	+
Protection from Hazardous Materials	+	-	+	-
Impact on disadvantaged residential areas	-	+	+	-
Impact on affluent residential areas	+	-	=	=
Impact on oil/gas wells	-	+	=	=
Restricts future development	+	-	=	=
Impact on businesses	=	=	-	+
Requires acquisition of homes or businesses	=	=	+	-
Nuisance Noise Potential	+	-	+	-
Steep grades/Roadway geometry issues	=	=	+	-
Traffic does not enter town	=	=	+	-
Requires additional interchanges	=	=	-	+
Uses existing I 10 alignment	=	=	+	-
Visibility from connection/crossing with I 10	=	=	=	=

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Table 7.4, Paired Comparison of Option 4 to Option 5

Criterion	Option 4	Option 5
Cost (Relative)	178%	<
Visibility from the North Departure Point	=	=
Visibility from the route itself	-	+
Access to Businesses	-	+
Unimpeded passage of through traffic	-	+
Protection from Hazardous Materials	+	-
Impact on disadvantaged residential areas	+	-
Impact on affluent residential areas	-	+
Impact on oil/gas wells	+	-
Restricts future development	-	+
Impact on businesses	-	+
Requires acquisition of homes or businesses	+	-
Nuisance Noise Potential	+	-
Steep grades/Roadway geometry issues	+	-
Traffic does not enter town	+	-
Requires additional interchanges	-	+
Uses existing I 10 alignment	+	-
Visibility from connection/crossing with I 10	=	=

Chapter 8- Conclusions

As stated in Chapter 2, the core activity of this study is to identify and compare alternatives for the location of a relief route. Those comparisons have been made and presented. There is a clear-cut hierarchy of relative costs, but many more criteria exist that should be considered when making such a far-reaching decision. For instance, the least-cost option also presents a solution to some of the commercial and visibility issues often cited as concerns. But that option also presents the hardest social decisions and the least protection from potential danger due to hazardous material. In general, increased cost seems to purchase greater protection from hazardous material. Along with greater protection from hazardous material comes increasing detachment from existing businesses. In general, four of the five options considered are certainly viable from an engineering standpoint, and the remaining one is arguably marginally viable (option 2) due to the constraints of geometry and constructability at the crossing of IH-10. Option 2 is also the most expensive, being well over twice the cost of the least-cost option.

The variation in cost among the other four options is to range from a 23% to a 73% increase over the least cost option; and for the five optimum particular alignments within each option to vary by not more than 2%. These four options can all be considered viable, based on current knowledge.

Over the past several decades, various opinions have been expressed regarding the desired location of a relief route around Sonora. These locations roughly correspond to those under consideration at this time and expressed in this report. In its own context, each has been deemed by proponents to be the preferred option. This study demonstrates that all of these options have some virtues and some drawbacks, and that most, if not all, of them might be considered individually preferable to the others given weight to certain interests. As some justification for the diversity of past opinions, there does not appear to be any specific issue other than cost that favors one option over the others.

The normal route selection process usually culminates in the selection of the least-cost of the options considered. The interests of the public at large are thought to be best represented by cost. However, if a particular stakeholder group holds that another option is advantageous to their interests, the normal outcome might be changed by some form of re-conditioning of the circumstances. For instance, consider that the cost of a particular option is 23% greater than the least-cost option. If, by community action, that difference in cost can be offset by ease of right-of-way acquisition, preservation of the corridor against development, or by in-kind services that add value to one option, then the cost difference issue might become insignificant. Participation in the cost does not imply that Sonora or Sutton County must bear the full brunt of costs. In general, the contribution of the difference between the least cost viable option and another, more expensive option that might be favored by the citizens and government of Sonora should bring about the consideration of relative equivalence of cost.

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In this case, the option showing the lowest monetary cost (option 5) also demonstrates the highest level of social cost and the lowest level of protection of the public. These issues are very difficult to place a “price tag” on, but are legitimate concerns that the citizens of Sonora should consider.

The option showing the highest cost (option 2) demonstrates only marginal feasibility. Objectively, option 2 can easily be eliminated from further consideration; it shows marginal geometric viability without severing IH-10 during construction, and does not possess any specific redeeming virtue to offset that issue. This leaves options 1,3, 4, and 5 as the actual options under scrutiny.

The strategy that would best serve the citizens of Sonora over the coming years would be to reach a community consensus on which option best serves the community, and then to show financial participation, cooperation, and conditions that make that option comparable in cost and effort to the least-cost option. Much can be done through the police powers of a municipality such as annexation, zoning, exertion of the rights of extraterritorial jurisdiction, and by coordinated community action. No direct action (such as right-of-way acquisition) should be undertaken without appropriate coordination with TxDOT.

If a consensus can be reached, examples of the actions and decisions that the citizens and city leaders of Sonora might undertake that could influence the ultimate placement of a relief route are whether or not connection to other roadways is desired, whether or not frontage roads and regulated access to them are desired, and actions to mitigate the impact on existing businesses of competition from new businesses if the decision to foster new businesses is taken. Public involvement to express support for the choice of a specific option should be documented according to state and federal environmental policies. Community leaders and supporters of the chosen option may solicit the cooperation and participation of affected landowners and business owners to facilitate the project development process. In consultation and cooperation with the TxDOT project development staff, environmental and topographic data collection could be undertaken to further the environmental clearance and project development processes.

Appendix A- Sample Questionnaire and Responses

QUESTIONNAIRE FOR
POTENTIAL SONORA RELIEF ROUTE

This survey is intended to gauge your concern for and familiarity with common issues that are expressed by citizens when confronted with the decision of whether increasing traffic should go through or around their town, as relates to US 277 through Sonora.

1. I think that traffic along US 277 in Sonora is:

a) Mostly local traffic.	<u>%</u> 3
b) Mostly traffic passing through.	3
c) A mix of local traffic and traffic passing through.	92
	No opinion 2

2. Is the amount of traffic along US 277 through Sonora **now** enough to cause you any problems or delays or safety concerns?

a) Yes	<u>%</u> 61
b) No	39

3. If the amount of traffic along US 277 through Sonora **doubled**, do you believe it would cause you any problems or delays or safety concerns?

a) Yes	<u>%</u> 71
b) No	16
c) I don't know (or no opinion)	13

4. Which of these ideas do you feel is more important?

a) Increased traffic through Sonora, including trucks, means an increase in commerce and an increase in prosperity to some businesses and the community. 34%

b) Increased traffic through Sonora, including trucks, means an increase in traffic accidents and an increase in inconvenience to the citizens and the community. 49%

No opinion 17%

4. Do you feel that commerce with non-local traffic along US 277 through Sonora is an important source of income for the community, local businesses, or both?

a) Community.	<u>%</u> 5
b) Local businesses.	13
c) Both.	71
d) Neither (or no opinion)	11

5. If traffic along US 277 increased substantially, would the community be better served by learning to live with it coming through town, or by building a relief route?

a) Keep it coming through town.	<u>%</u> 18
b) Build a relief route.	45
c) I don't know (or no opinion)	37

6. Do you feel that there is a real chance of danger to you or the community from trucks carrying hazardous cargo or oversized loads through town?

	<u>%</u>
a. Yes	63
b. No	16
c. I don't know (or no opinion)	21

7. Given a choice between the following two values, which is more important to you?

	<u>%</u>
a) The safety and convenience of the citizens of Sonora.	61
b) Economic prosperity for the businesses along US 277.	26
	No opinion 13

8. Who do you feel is best able to decide whether or not a US 277 relief route around Sonora is or will be needed, where it should be, and when it should be built, if ever?

	<u>%</u>
a) The citizens of Sonora.	16
b) TxDOT engineers.	8
c) The Ports to Plains coalition.	0
d) All of the above working together.	66
e) Other _____	No opinion 10

9. Considering only the overall impact to the local community, which of these types of facilities do you consider more important to preserve?

	<u>%</u>
a) People's homes	35
b) Businesses	20
c) Oil or gas wells	8
d) Cultural assets (for example historical sites or locally unique things)	25
	No opinion 12

10. If it could be demonstrated that the community would realize tangible economic benefits from having a relief route, would you be in favor of participating in the cost of the relief route with local money?

	<u>%</u>
a) Yes	42
b) No	37
	No opinion 21

11. Should there be more meetings to discuss these issues?

	<u>%</u>
a) Yes	84
b) No	3
	No opinion 13

12. The Transportation Committee of Sonora and Sutton County was formed to identify local transportation issues, gather information and encourage public involvement. Do you believe the relief route issue requires that a different stakeholder committee be formed to continue to address this issue?

	<u>%</u>
a) Yes	21
b) No	63
	No opinion 16

Comments:

What is the long term impact of the declining oilfield and can we replace this?

Safety high priority;
Stakeholders add environmental experts;
Relief Route east of town.

Consider outlying property owners whose property value depends on low economic uses such as ranching, hunting, vacant space but is important to them

I don't want someone coming in and claiming imminent domain!!:

If one is built, the cost should be born by the citizens of the state, not by the few citizens of Sonora. Who benefits the most?

I think the Reliver Route should be to the west of town but also as visible as possible from town with exit and entrance routes to the city.

It doesn't really matter what I think, TxDOT is a Monster out of control and I believe after the sunset review and the next legislature you may lose some of the monsters teeth.

Land owners should be stakeholders

It is needed and hopefully west part of town

The greatest impact, contrary to opinions of some, is not what happens to the whole, to me my life my livelihood, my way of life is in jeopardy at this point. While it has been said that all decisions will be based on what people think, the shortest distance between two points is cheapest, easiest and sadly, I am in the path of that train!

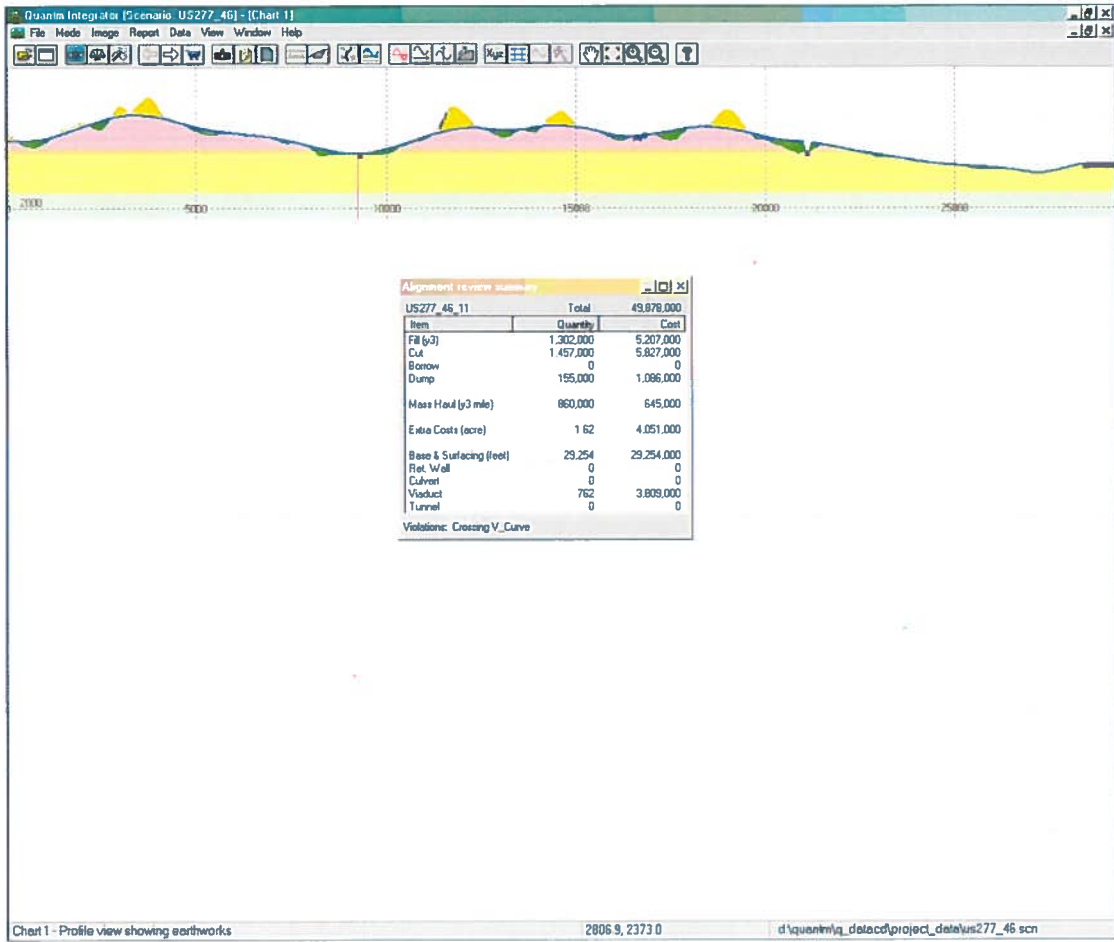
I would leave the decisions up to the people who are educated in this area. I'm sure I am no expert.

Access for landowners, businesses, etc.
Visibility of town from relief route.

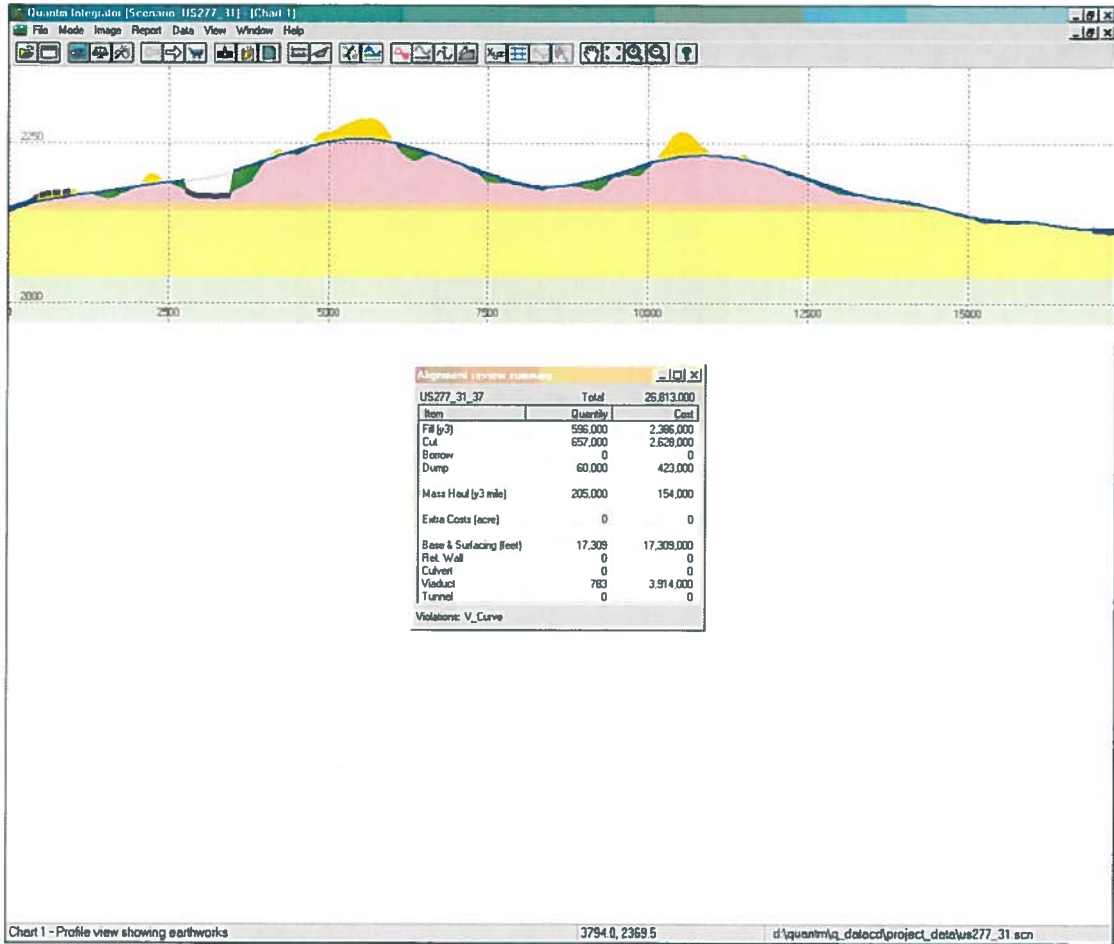
Came tonight to learn more & do not yet have a feel for the 'best possible' solution.

The 4 speakers were good!

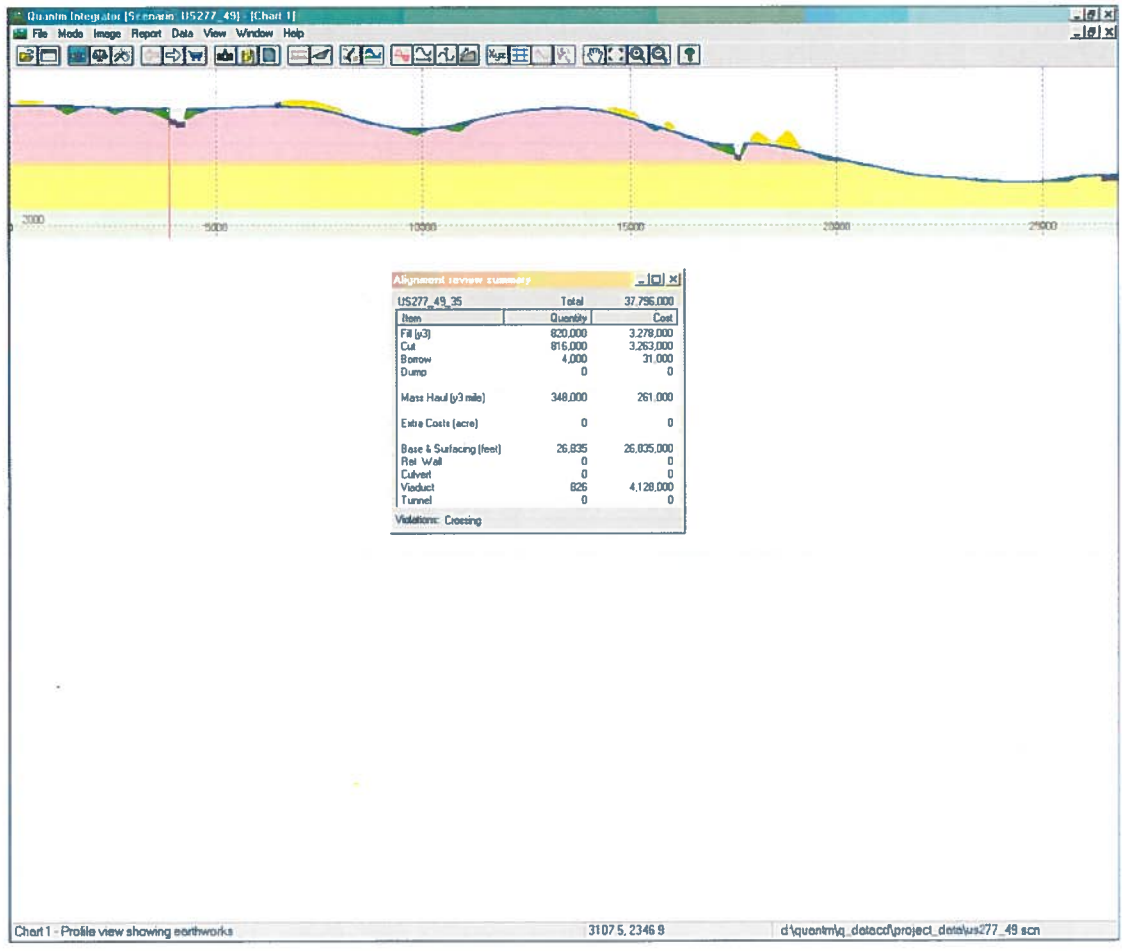
Appendix B- Sample Vertical Alignments



Option 1



Option 3



Option 4



Option 5

