PARTNERS FOR ENVIRONMENTAL PROGRESS
MARKET FEASIBILITY STUDY

REGIONAL ECONOMIC DEVELOPMENT PLAN FOR PARTICIPATING MUNICIPALITIES IN KARNES AND WILSON COUNTIES, TEXAS

FINAL REPORT

Prepared by
U.S. Army Corps of Engineers
Fort Worth District

Sponsored by
Alamo Area Council of Governments
San Antonio, Texas

SEPTEMBER 2000

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EXECUTIVE SUMMARY

The principal goal of this Partners for Environmental Progress (PEP) program is to outline a long-term economic development strategy for a two-county study area encompassing Karnes and Wilson Counties. While this study is primarily intended to develop a regional economic development paradigm based on individual and collective strengths of each participating municipality, it can serve as a prototype for economic development studies in other rural regions in Texas.

This PEP study has three components: a Geographic Information Systems (GIS) survey, and a hydrogeologic study covering Atascosa, Frio, Karnes and Wilson Counties, and an economic analysis of the two-county study area consisting of Frio and Atascosa Counties.

1. Geographic Information System (GIS) Survey

As part of the hydrologic modeling needs by Morgan Environmental Consulting Associates (MECA), AACOG collected the following data sets: geology related to aquifer formations, well locations, rainfall amounts over time, average temperatures over time, stream flow, weather station locations, and land use. In this study, the groundwater data were stored at AACOG in vector format using a program called ArcInfo.

2. Hydrogeologic Study

Surface water for the four county study area is provided by stream drainage within two large-area basins: the San Antonio Basin covering Wilson and Karnes counties and the Nueces River Basin flowing through Frio and Atascosa Counties. Stream flow data were gathered for the study area for 1990. None of these streams are impounded for water storage within the project area.
Utilizing existing reservoirs or constructing future impoundment structures can be a complex and often costly experience, especially for interbasin transfers. An alternate scenario is to use existing groundwater supplies if there is sufficient quantity.

A vast amount of water is captured underground in major and minor aquifers throughout the four counties. Using existing groundwater is much cheaper than traditional impoundment of surface streams. Significant future amounts of water could and should come from groundwater supplies. This will require "proper" management of not only the water but also of the uses of the water. In areas where groundwater supplies are threatened and surface water opportunities are nonexistent, alternate strategies for land use may help reallocate existing water for municipal uses.

Wilson & Atascosa Counties: Wilson and Atascosa Counties are blessed with the prolific Carrizo Sand. While currently overdrafted, it can probably be exploited at greater rates. Because of its tremendous size, this aquifer can likely withstand twice the pumping rates in the participating cities and experience water

level declines in the range of 40-50 feet over the next 20 years in the northern two-thirds of these two counties. Management and estimation of an acceptable rate of decline is essential. Less is known about recent water level declines for the lower third. The Queen City and Sparta Sand show potential for more development in the central and southern parts of Wilson and Atascosa.
Frio County: Frio County has experienced large declines in groundwater levels (less permeability, less recharge and not as thick, hence less storage), and future projections are even more pessimistic. Accordingly, caution should be exercised in expanding future water withdrawal. More data are needed about the other aquifers, i.e., the Queen City and the Sparta Sand, especially for the eastern half which has potential as a resource. Also, the Wilcox needs to be examined in the northern part of the county.
Karnes County: The upper one third of Karnes County can still make use of the Carrizo, but there are concerns about the temperature of the water as well as proximity to the "bad water line". Greater potential use does exist but more data are needed. For the lower two-thirds of the county, the greatest potential for groundwater development is the Catahoula Tuff and especially the Oakville Sandstone based on known thicknesses and limited data on permeability. It was difficult to access their full potential because so little data were available.

In summary, even though there continues to be data gaps necessary for a complete evaluation of the groundwater resources in the study area, it is clear from this investigation that large quantities of groundwater supplies exist. Competition for these supplies will always exist for agricultural, municipal, and industrial needs. To help secure appropriate supplies for municipal needs, there should be more coordination among the various communities. This coordination effort should, minimally, include sharing all groundwater information available for incorporation into a GIS which could be housed at AACOG for updated modeling, recording changes, and development of future scenarios. This study has begun this process, but more local participation is needed. Sharing groundwater information to understand the full potential for groundwater development in this area is critical to the future of these municipalities.

3. Economic Analysis

Three water supply and quality alternatives are analyzed herein:

1. **Thonhoff Regional Water Plan**. This alternative examines the creation of three regionalized systems within the initial four-county AACOG project area and proposes connecting infrastructure and shared water supplies.
2. **Thonhoff Autonomous Plan**. This alternative assumes each participating municipality will remain autonomous which requires upkeep of existing systems, replacement of water supply and infrastructure necessary to maintain current capacity, and construction of new supply and infrastructure to meet future demands.
3. **Aquifer Optimization Plan**. In this final alternative, recommendations for the participating municipalities in Karnes and Wilson Counties are proposed given each municipality's current and future needs and resource base.

We propose that participating municipalities within the study area remain self-reliant, that is, optimize their aquifers, in water supply/quality interests given each municipality's current and future requirements and resource base. This approach differs from the Thonhoff Autonomous Plan in that each municipality is encouraged to optimize their aquifer resources, e.g., employing one well to tap multiple aquifers concurrently. For decision makers to make an educated guess so that aquifers are optimized, the GIS/Hydrogeology portions of this study are invaluable. Thus, decision makers are provided data on aquifers beneath each municipality.

The immediate benefit to provincial control of water supply is self-reliance. To be sure, independence is ideal but it is clear that while some municipalities will benefit from a sovereign approach, others will gain from a regional arrangement. Irrespective of choices made by decision makers, each municipality is free to choose according to their needs. The function of the Corps of Engineers is not to presume to tell municipalities what is best for them. Rather, it is illuminate the choices available to each.

The main difficulty with a sovereign approach, however, is the existing groundwater law in Texas. Groundwater, like oil, is treated with the English Rule, or Rule of Capture principle, giving land owners the "property rights" to all water extracted from under the owner's land. Since groundwater does not recognize property lines, one can foresee the potential of one land owner encroaching the "property rights" of another. Tietenberg refers to this type of resource as a common property resource. Common property resources are those that can be exploited on a "use it or lose it" basis. Texas groundwater law virtually insures that dramatic "drawdown" events can and will result from overpumping. When this occurs, surrounding wells may go dry which potentially induces disputes, legal action, and expensive resolutions.

To optimize aquifer usage for each municipality we recommend the development of a Municipal Groundwater Co-operation (see Section 6.1). In this co-operation all municipalities will have equal representation thereby maximizing both individual (municipal) and collective (county) benefits. This group will not have a regulatory mission, but will function as a groundwater data collection and record maintenance co-operation. Each municipality in the group could contribute annual dues so that a full-time group coordinator can collect, synthesize, and maintain essential data, e.g., location and number of wells, and pumping rates. Benefits of the co-operation include accessible and credible data on each aquifer. During the course of this study, for example, several data gaps impeded the forward progress of the GIS/Hydrogeologic portions of this report. The institution of a Municipal Groundwater Co-operation would expedite any future groundwater studies by readily furnishing reliable data.

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1.0 INTRODUCTION

1.1 Objective and Scope

The primary objective of the Partners for Environmental Progress (PEP) program is to encourage greater private sector investment in water dependent environmental infrastructure which has typically been publicly financed. These infrastructure investments include water supply and quality, treatment and distribution, and other critical water dependent infrastructure support facilities. Market Feasibility Studies (MFS) provide Corps of Engineers expertise and services to small and/or disadvantaged communities that do not have the capabilities or resources to fully evaluate whether privatization of a particular environmental infrastructure is desirable and/or feasible. MFS are also intended to encourage the involvement of the private sector in the planning, design, financing, construction, operation, and maintenance of non-Federal water dependent environmental infrastructure.

In July 1994 a report was issued from a study co-sponsored by the Alamo Area Council of Governments (AACOG) and the Texas Water Development Board (TWDB), and conducted by Thonhoff Consulting Engineers (TCE), Inc. This report, hereafter referred to as the Thonhoff Report, recommended a plan to establish three Regional Water Systems to develop a water source of better quality and more dependable yield. The Thonhoff Report identified and evaluated the current and future needs and supply sources for seven participating municipalities in Atascosa, Frio, Karnes, and Wilson Counties. These municipalities included Falls City, Floresville, Karnes City, Kenedy, Pearsall, Pleasanton, and Runge.

The present PEP, the subject of this report, is actually two studies conducted concurrently: one covers Frio and Atascosa Counties, and the other Karnes and Wilson Counties. Several sections in this report are identical to the Thonhoff Report because of overlapping data. Both studies build upon the work performed by TCE, Inc. with the intent to carry that analysis forward to an implementable project plan. To that end, this study is distinguished from the prior effort in three general areas:

(1) The geographic focus includes a two-county study area: Karnes and Wilson Counties.
(2) A framework is developed to identify and compare advantages and disadvantages of alternatives to each specific participating municipality.
(3) An implementation plan is developed which includes financial and institutional considerations for public and private sector participants.

The MFS performs four major tasks:

(1) Develop information to a comparable level of detail for those municipalities in the two-county study area that did not participate in the Thonhoff study.
(2) Evaluate cost and water quality advantages/disadvantages for each participating entity with respect

to their decision whether to regionalize.

(3) Explore opportunities for private sector participation and economic development incentives in solving the region's water supply problems.

(4) Perform detailed financial and institutional analysis in support of developing a specific implementation plan.

1.2 Authority

The authority for conducting this Fiscal Year 1994 "Market Feasibility Study" with AACOG on behalf of Frio and Atascosa Counties, Texas is drawn from the Energy and Water Development Appropriations Act for Fiscal Year 1991 (Public Law No. 101-514). This legislation contains the Congressional intent for the Corps of Engineers to conduct jointly financed studies in partnership with State and local governments. As abstracted from the House Report accompanying the Fiscal Year 1991 Energy and Water Development Appropriations Act, the general objective remains as stated:

> "...The Committee intends the Department of the Army to work with the Environmental Protection Agency, the Department of Energy and other Federal agencies in a partnership with State and local governments to encourage the involvement of the private sector in the planning, design, financing, construction, operation and maintenance of the local service-related infrastructure. Funds would be used to initiate Corps of Engineers managed, jointly financed, market feasibility studies to identify opportunities; to analyze public/private financing capabilities; and to develop model contract agreements for use in this effort."

1.3 Problem Identification

Presently, all water supply in Atascosa, Frio, Karnes, and Wilson Counties is derived from the Live Oak, Carrizo-Wilcox, Queens City-Mt. Selma formations, and other minor aquifers. Groundwater is distributed by a mixture of public and private water supply companies and individual wells. Since 1956, overpumping has significantly lowered water levels (up to 200 feet in some portions of the groundwater service area). A lack of dependable water quality is severely curtailing economic growth from other sectors of the economy, e.g., a migrating "bad water" line in the Carrizo Aquifer. Also, pumping costs are impacting the region's agricultural future where high quantities of silica causes pumping problems. Additionally, problems are created by the overlap and competition between public and private water companies.

1.4 Acknowledgments

Preparation of this report was a joint effort between the Army Corps of Engineers Fort Worth District, and AACOG. Morgan Environmental Consulting Associates (MECA) functioned as a consultant to the Corps of Engineers preparing major sections of this report concerning groundwater resources.

TCE, Inc. performed as the engineering consultant to the Fort Worth District gathering data on municipalities not included in the Thonhoff Report. In addition, the participating municipalities provided local data, and resources to support the development of this project.

2.0 GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

2.1 General

While the scope of work for this PEP did not require a GIS/Hydrogeology model, these models have proven to be an integral component of resource management alternatives. Planning agencies today often need to organize and analyze large volumes of spatial data for area wide resource investigations. These data include maps, imagery, tables, and statistical information.

In recent years, there has been a dramatic growth in the interest and use of computer-based *Geographical Information Systems (GIS)* that allow users to store, process, and display spatial and tabular data used to make maps. These systems are emerging as a major data handling technology for solving complex resource management problems such as those related to groundwater monitoring and modeling.

Utilizing desktop computers and GIS software, investigators are able to process and display many layers of information simultaneously for interpretation. At a GIS computer workstation, planners are able to correlate land use, geology, aquifer characteristics and recharge data into an integrated system that can be combined and cross-referenced for composite analysis and management. With a properly constructed GIS, the user is able to input, rectify, merge and display multiple data sets at various scales for interpretation. Using the GIS, managers can query the shared database to find "best" locations for drilling new water wells. GIS technology is providing more information with greater accuracy and at a lower cost than previously thought possible.

2.2 GIS Characteristics

Throughout the literature most agree that a geographic information system should have the following four functions: Data Input, Storage (retrieval), Analysis (manipulation), and Display (maps). Data input is usually accomplished using computer tapes, digitizers, scanners or manual encoding of geographically registered grid cells, points, lines, polygons or tables. This information is stored in X and Y position coordinates along with associated attributes representing specific parameter values e.g., the concentration of nutrients at a particular location along a stream. Grid cell encoding is referred to as raster data, while points, lines, and polygons are called vector data. In this study, the groundwater data were stored at AACOG in vector format using a program called ArcInfo. This is one of the most popular software packages used today and runs on Sun and PC workstations.

Data are stored in a hierarchical format as theme directories and files so that the user can easily organize the information. Typical directories might include: land cover, geology, topography, depth to groundwater, and pumpage volumes, etc.

Analysis is accomplished from menus within the GIS software to produce new data files or maps. These menus are often set up to be user friendly (especially desktop versions) for easy data manipulation. Most popular interactive menus include general functions such as: display, overlay, combine, mask, classify, statistics, zoom, rectify, map and label. It is not uncommon for a GIS such as ArcInfo to contain more than 200 interactive programs within its menu. Maps to be displayed are called up from stored files or interactively generated for visual interpretation and evaluation. Display devices normally associated with a GIS workstation are: printers, plotters, and color monitors (CRTs).

2.3 Use of the GIS

If properly constructed, a GIS can be utilized on virtually any scale limited in general, by the resolution of the information base, quality of the data, and computer capabilities (i.e., hardware and supporting software). Resource planning and management agencies are sometimes required to integrate as many as 20 or 30 different themes (data layers) on large-scale projects. A properly configured GIS can be used to integrate and display the data base for area wide monitoring, derivative mapping and environmental management.

As mentioned earlier, for this study the GIS database was set-up by AACOG using existing reports, maps, tables and satellite imagery. Collected information relating to groundwater assessment was stored by AACOG using ArcInfo as vector data (points, lines, and polygon layers) to produce maps indicative of the resources in the four counties. The data layers included such maps as geology, land cover, city locations, precipitation, recharge zones, depth to water, aquifer thickness, porosity, permeability, well locations, yield and pumpage characteristics. All of this and more is now housed at AACOG for retrieval, map production, downloading, modeling, future scenario development and updating.

Once the GIS was built, it used the data for virtually all of the maps produced in this report as well as for the aquifer modeling. Participating municipalities can also utilize this rather large database by coordinating with AACOG for downloading to software like PC ArcInfo which runs on Pentiums and 486's. Local areas now have a centralized database for archiving and retrieval. While the database is not entirely complete at this time (i.e., some well data are still missing) , updating will be easy as more information is collected.

2.4 Data Used in the Study

As part of the hydrologic modeling needs of MECA, AACOG staff assembled several sets of information through the use of AACOG's GIS and general computer resources (such as programming) in the Regional Data Center. AACOG staff collected the following data sets: geology related to aquifer formations, well locations, rainfall amounts over time, average temperatures over time, stream flow, weather station locations, and land use.

Geologic formation outlines were digitized from various TWDB reports which covered the area and were supplied by MECA. These reports, which were also the main source of other hydrogeological information, were produced for Wilson County (in 1957, Bulletin 5710), Karnes County (1960, Bulletin 6007) Atascosa and Frio counties (1966, Report 32), and the following neighboring counties: Bexar (1959, Bulletin 5911), Live Oak (1961, Bulletin 6105), Bee (1966, Bulletin 17), DeWitt (1965, Bulletin 6518), Goliad (1957, Bulletin 5711), Guadalupe (1966, Report 19), Medina (1956, Bulletin 5601), Gonzales (1965, Report 4), and La Salle and McMullen counties (1965, Bulletin 6520).

Weather station locations with the associated rainfall were received from the State Climatologist's office at Texas A&M University and processed at AACOG. MECA used the data to produce a map of the average annual precipitation in the study area for the 1983-94 period. This map, together with the air temperature data, was then used to estimate the potential evapotranspiration and, consequently, recharge to the area aquifers.

The State Climatologist's office at Texas A&M also provided to AACOG the data on air temperature data for each of the stations in the area for further processing.

As part of the project, Landsat satellite imagery was used to delineate land cover. Two categories of land use were identified per 2x2 mile modeling grid cell based on the predominant(>50%) coverage; forested land or agricultural soil were the categories. They were then used to estimate the relative recharge distribution.

Surface stream flow rates were provided by MECA from USGS data for the area.

Roadway mapping was done using the Census Bureau's TIGER street file. This file also supplied the city boundary outlines used in locating wells within cities in the study area.

The principal non-GIS data collected in the study was related to wells. The TWDB supplied available data for wells in the region. While well locations were largely taken from TWDB data, a significant amount of the data needed for sample wells was contributed by the Evergreen Underground Water Conservation District. The district provided water level measurements and well schedules for use in the study. In addition, well data was provided by a number of cities and water suppliers in the project area. From these sources, water pumpage rates, altitudes of the area aquifers' tops and bottoms, aquifer thicknesses, were collected.

Finally, As a minor part of the study, AACOG constructed a grid which served as the modeling grid for MODFLOW. This two mile by two mile grid covered an extensive area and is illustrated in Figure 1 in Appendix A.

3.0 HYDROGEOLOGIC STUDY

3.1 Surface Water

3.1.1 Streams in the Four County Area

Historically, people have tried to solve water shortages by diverting from surplus areas to nearby basins with deficits. This practice is referred to as *interbasin transfers or water importation.* Experience has shown that interbasin transfer leads to a multitude of economic, social and political problems. A more appropriate and less complex alternative is usually to stay within a basin for water use in lieu of importation. Many think the same principle applies to groundwater use.

Surface water for the study area is provided by stream drainage within two large-area basins: the San Antonio Basin covering Wilson and Karnes counties and the Nueces River Basin flowing through Frio and Atascosa counties. Stream drainage for both basins is northwest to southeast (see Figure 3-1). None of these streams are impounded for water storage within the project area.

Stream flow data were gathered for the study area for 1990 and are given in Table 3-1. This table gives the station ID, area, Jan-Dec average flow (cfs), annual flow average (cfs) and XY state plane coordinates. A few streams (e.g., San Antonio and Atascosa Rivers) may have some future development possibilities, but any serious considerations would require more data collection about stream flow, topography and land values and would ultimately require *sizable financial resources* to be able to construct impoundment facilities. If any future impoundment plans are developed, water appropriation should probably be limited to same-basin use rather than interbasin transfers.

3.1.2 Near-by Reservoirs

As Figure 3-1 shows, three reservoirs are proposed by 2040 (Thonhoff Report, 1994) just outside of Karnes and Wilson counties. If constructed, Cuero, Lindenau and Goliad are proposed as a source of water for San Antonio. There is still a question whether these new reservoirs could or would provide water for the eastern part of the study area via a purchase arrangement. If construction of these reservoirs is successful, then the potential exists for employing these surface water supplies.

As noted earlier, water from the proposed Lindenau and Cuero reservoirs would be an interbasin transfer if used by any of the four counties in this study and poses potential concerns. However, Lake Goliad would be constructed within the San Antonio River Basin and would be less of a problem for water management in the area. This reservoir might be of particular value to Karnes County by supporting the municipal needs of that county since the area lies outside of the Carrizo-Wilcox system of "good" water. Economic and political arrangements may be difficult but should be explored over the next few years. The greatest potential for reliable water for Karnes County is dependent upon the development of the minor groundwater aquifers that exist in the area (to be discussed later).

The nearest existing large reservoir is Choke Canyon Lake located within the Nueces River Basin in the western part of the study. No surface water rights have been obtained for the four county area (Thonhoff Report, 1994). Choke Canyon Reservoir and the Frio River currently serves the City of Corpus Christi. Additional water treatment facilities associated with Choke Canyon Reservoir might provide an opportunity for water use by the four county area. As stated by the Thonhoff Report (1994), any construction for surface water supplies in or near the project area will be "dependent upon financing from a large municipality such as San Antonio or Corpus Christi". Buying water from one of these cities appears to be slight but nevertheless a future possibility. Another possibility is financing impoundment procured through a state agency.

An option not discussed by the Thonhoff Report (1994) is the use of water from Medina Lake in Medina County. Constructed in 1912, Medina Lake holds approximately 254,000 acre-feet of water and has been a traditional source of water for farming in the area. Lake Medina is owned by the Bexar-Medina-Atascosa Counties Water Control & Improvement District (BMA). Any future water appropriation agreements will have to be coordinated through the BMA.

Over the last few years, agricultural demand has declined making the reservoir a potential source for municipal uses (BMA, 1995). In 1991, BMA entered into an agreement to provide water to BexarMet for primarily municipal water use north of the four county area studied in this report. BMA continues to work, plan and develop additional water to sell. Although Lake Medina is outside the project area, it could and should be studied for its potential to provide water. Distance of water transfer is a potential problem. The biggest problem would be the affordability of any proposed project that would bring the water from Lake Medina to the project area for municipal use.

Utilizing existing reservoirs or constructing future impoundment structures as discussed above is a complex and often costly experience. Surface impoundment is implemented to help regulate surface water flow. An alternate scenario is to use existing groundwater supplies if there is sufficient quantity.

3.2 Groundwater Resources

A vast amount of water is captured underground in major and minor aquifers throughout the four counties. Using existing groundwater is much cheaper than traditional impoundment of surface streams. A more detailed examination of groundwater supplies is in Appendix A.

Significant future amounts of water could and should come from groundwater supplies. This will require "proper" management of not only the water but also of the *uses* of the water. In areas where groundwater supplies are threatened and surface water opportunities are nonexistent, alternate strategies for land use may help reallocate existing water for municipal uses.

A study was performed on the Wilcox, Carrizo, Queen City Sand, Sparta Sand, Catahoula Tuff, and Oakville Sandstone aquifers in the four county area. Information was collected on: recharge rates, water levels (1970 & 1990) Hydrogeologic parameters (permeability, storage, porosity, and thickness), and pumping rates. Serious data gaps exist for all aquifers except the Carrizo. A modified version of MODFLOW (a computer program that models the movement or flow of water in an aquifer) was used to simulate natural groundwater flow in the Carrizo Sand aquifer and the Queen City Sand aquifer. Other aquifers could not be modeled extensively because of the lack of available data.

3.2.1 Wilson and Atascosa Counties

Wilson and Atascosa Counties are blessed with the prolific Carrizo Sand. While currently overdrafted, it can probably be exploited at greater rates. Because of its tremendous size, this aquifer can likely withstand twice the pumping rates in the participating cities and experience water level declines in the range of 40-50 feet over the next 20 years in the northern two-thirds of these two counties. Management and estimation of an acceptable rate of decline is essential. Less is known about recent water level declines for the lower third. The Queen City and Sparta Sand show potential for more development in the central and southern parts of Wilson and Atascosa.

3.2.2 Frio County

Frio County has experienced large declines in groundwater levels (less permeability, less recharge and not as thick, hence less storage), and future projections are even more pessimistic. Accordingly, caution should be exercised in expanding future water withdrawal. More data are needed about the other aquifers, i.e., the Queen City and the Sparta Sand, especially for the eastern half which has potential as a resource. Also, the Wilcox needs to be examined in the northern part of the county.

Figure 3-1: RIVER BASINS IN THE STUDY AREA

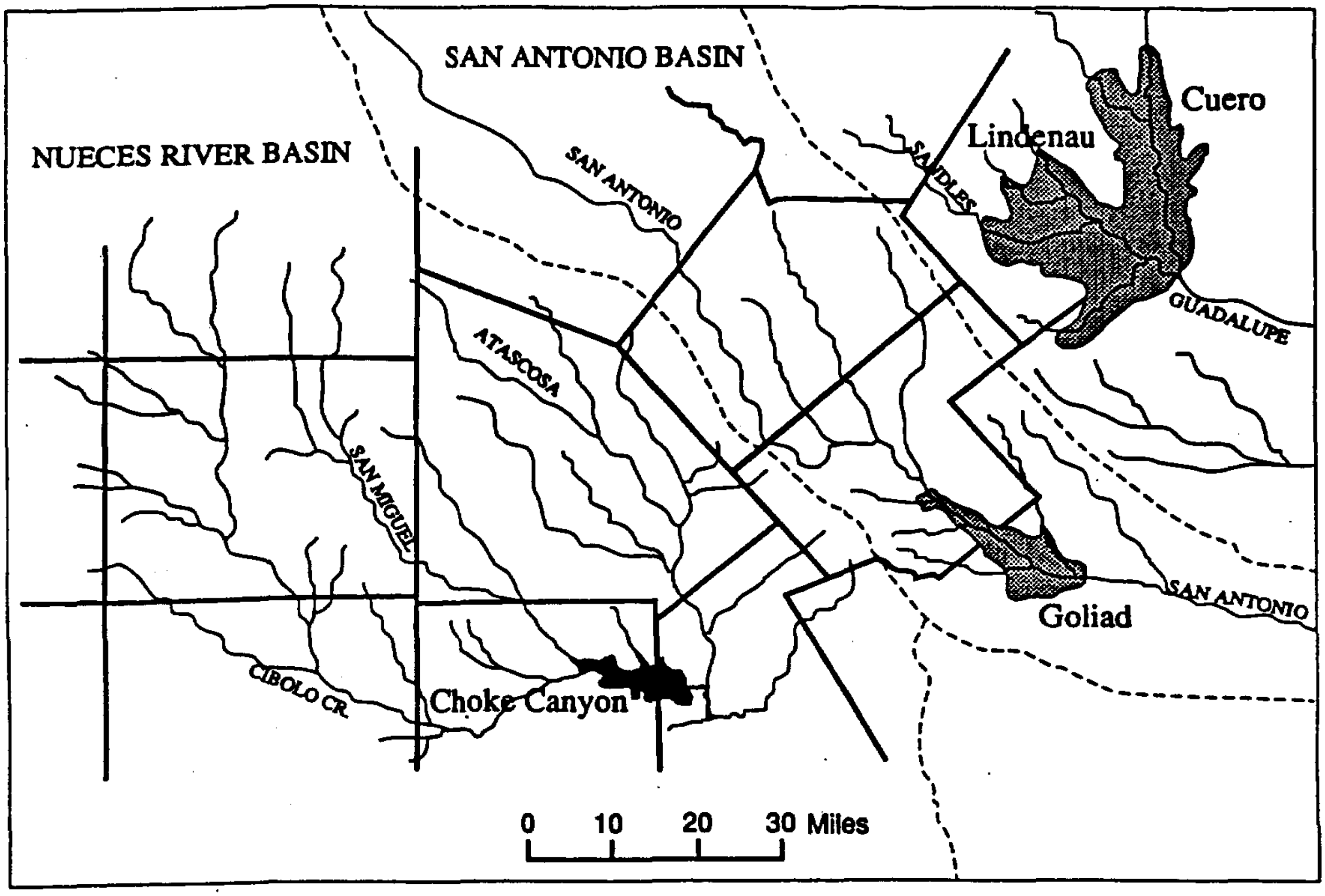


Table 3-1: STREAMFLOW DATA IN THE STUDY AREA

D	Area	Jan ave	Feb ave	March ave	Apr ave	May ave	June ave	July ave	Aug ave	Sept ave	Oct ave	Nov ave	Dec ave	Ann ave	X-coord(SP)	Y-coord(SP)
8166500	239.00	25.55	25.71	13.55	45.56	61.36	74.44	5.11	32.74	83.48	25.46	23.59	16.43	36.20	2392826	397166
8166500	239.00	#####	######	#######	######	######	######	######	1.28	1.69	######	######	######	1.49	2392826	397166
8165500	665.00	17.42	16.38	51.60	413.20	73.49	66.60	15.66	12.92	12.78	23.30	27.72	17.62	61.72	2301879.25	527214.625
8186000	827.00	13.19	15.90	19.77	22.78	26.39	28.90	29.29	29.51	26.85	22.84	18.63	13.67	22.84	2341972.75	430844.156
8186000	827.00	10.94	13.30	16.91	20.12	23.80	26.14	26.59	26.61	24.20	20.50	16.45	11.62	19.99	2341972.75	430844.156
8186000	827.00	12.07	14.42	18.28	21.32	24.97	27.40	27.84	27.97	25.46	21.96	17.07	12.62	20.99	2341972.75	430844.156
8186000	827.00	16.20	18.59	21.48	22.88	24.13	27.14	28.27	28.73	28.11	26.43	21.50	18.19	23.77	2341972.75	430844.156
8186000	827.00	90.08	92.22	34.45	163.75	225.78	206.04	100.54	55.37	167.18	106.47	85.94	71.02	118.02	2341972.75	430844.156
8186000	827.00	#####	######	#######	######	######	######	######	######	2.60	######	######	######	2.88	2341972.75	430844.156
8186000	827.00	#####	######	1285.60	######	######	1111.82	1251.23	######	######	######	1160.75	######	1230.98	2341972.75	430844.156
8186000	827.00	#####	######	1224.22	######	######	1012.46	1192.45	######	######	######	1076.02	######	1181.46	2341972.75	430844.156
8186000	827.00	#####	######	1243.88	######	######	1079.08	1208.17	######	######	######	1118.13	######	1190.20	2341972.75	430844.156
8186000	827.00	#####	######	1280.33	######	964.46	1120.61	1209.28	######	######	######	1125.47	######	1144.14	2341972.75	430844.156
8180800	967.00	159.95	190.73	156.93	164.31	267.97	634.72	312.11	196.18	154.79	225.57	175.83	143.19	231.91	2133271	520049.469
8180800	967.00	#####	######	#######	######	######	######	######	######	5.58	######	######	######	6.88	2133271	520049.469
8180800	967.00	8.68	8.78	7.60	8.69	8.93	7.78	6.28	5.56	6.02	8.28	9.64	9.07	7.96	2133271	520049.469
8181500	1317.00	16.27	17.75	20.08	22.73	26.08	28.11	28.50	28.95	27.02	23.86	20.55	17.16	23.39	2168357	516918.844
8181500	1317.00	14.51	16.12	18.52	21.20	24.66	26.58	27.13	27.65	25.79	22.22	18.81	15.20	21.76	2168357	516918.844
8181500	1317.00	15.31	16.86	19.24	21.83	25.31	27.30	27.80	28.29	26.38	22.98	19.70	16.15	22.47	2168357	516918.844
8181500	1317.00	153.28	177.07	130.66	161.86	225.45	366.15	196.50	140.01	136.73	201.59	150.47	132.63	188.30	2168357	516918.844
8181500	1317.00	#####	######	#######	######	######	######	######	######	4.28	######	######	######	4.29	2168357	516918.844
8181500	1317.00	879.41	915.21	923.81	934.85	900.86	841.25	799.92	939.88	911.13	859.27	960.77	968.12	907.43	2168357	516918.844
8181500	1317.00	824.97	853.27	871.27	873.70	832.97	779.51	743.46	892.74	852.19	882.60	897.26	930.00	848.81	2168357	516918.844
8181500	1317.00	865.47	887.85	896.04	893.37	861.92	809.93	773.93	915.85	882.90	922.89	931.89	951.04	896.14	2168357	516918.844
8181500	1317.00	8.79	8.73	8.39	7.86	7.39	7.25	7.17	6.82	6.88	8.87	7.35	8.79	7.76	2168357	516918.844
8181500	1317.00	8.76	7.98	7.57	7.35	6.88	6.60	6.72	6.37	6.37	6.15	6.83	7.94	7.19	2168357	516918.844
8181500	1317.00	9.20	8.33	7.93	7.37	7.15	6.94	6.92	6.58	6.60	6.38	7.07	8.27	7.41	2168357	516918.844
8181500	1317.00	8.03	7.97	8.02	7.93	8.03	8.12	8.07	8.07	8.07	7.98	8.10	8.15	8.06	2168357	516918.844
8181500	1317.00	7.86	7.81	7.87	7.80	7.86	7.98	7.94	7.94	7.94	7.84	8.05	8.00	7.91	2168357	516918.844
8181500	1317.00	7.98	7.80	7.94	7.87	7.96	8.06	8.02	8.01	8.01	7.91	8.12	8.08	7.98	2168357	516918.844
8207700	32.80	0.06	0.07	0.04	0.05	0.13	0.09	0.04	0.08	0.16	0.08	0.06	0.03	8.07	2190100.5	430537.344
8182400	7.01	0.05	0.08	0.03	0.07	0.11	0.07	0.04	0.07	0.10	0.10	0.07	0.04	8.87	2225135.25	563031.25
8182500	77.20	14.64	13.04	3.26	10.23	19.98	7.44	1.65	2.40	15.22	9.30	8.01	4.35	9.08	2225417	519765.25
8183000	1786.00	319.83	268.51	293.63	336.02	377.35	289.18	192.98	131.46	787.38	688.18	346.89	299.73	356.19	2235724.5	503104
8183500	2113.00	15.12	16.71	18.51	22.62	26.14	28.66	29.65	30.14	27.74	23.82	20.30	15.09	23.08	2299329.75	407572.25
8183500	2113.00	14.19	15.67	18.45	21.52	25.17	27.33	28.41	29.01	26.57	22.48	19.21	14.06	21.98	2299329.75	407572.25
8183500	2113.00	14.66	16.18	18.00	22.05	25.85	27.94	28.97	29.57	27.13	23.05	19.77	14.57	22.44	2299329.75	407572.25
8183500	2113.00	382.45	394.76	331.89	430.34	557.49	696.31	405.38	286.23	484.57	428.05	364.09	330.89	424.22	2299329.75	407572.25
8183500	2113.00	#####	######	#######	######	######	######	######	######	1.86	######	######	######	1.88	2299329.75	407572.25
8183500	2113.00	911.51	922.92	936.66	916.54	947.80	953.71	933.42	######	941.91	977.61	936.67	990.89	946.27	2299329.75	407572.25
8183500	2113.00	837.01	842.04	862.76	844.51	821.03	882.08	795.92	916.91	832.86	896.48	858.85	922.53	868.01	2299329.75	407572.25
8183500	2113.00	878.57	882.07	890.21	866.13	912.02	918.81	886.44	985.88	890.87	938.19	894.75	960.69	909.61	2299329.75	407572.25
8183500	2113.00	8.98	7.75	7.11	6.05	5.93	7.04	6.58	5.84	6.31	7.62	7.98	8.86	7.08	2299329.75	407572.25
8183500	2113.00	7.87	6.64	6.12	5.22	5.22	5.85	5.08	4.67	5.20	6.29	6.58	7.42	5.98	2299329.75	407572.25
8183500	2113.00	8.27	7.21	6.64	5.57	5.52	6.23	5.73	5.12	5.67	6.80	7.08	7.99	6.48	2299329.75	407572.25
8183500	2113.00	8.02	7.87	7.81	7.88	8.02	8.16	7.93	7.80	7.81	7.90	7.81	7.87	7.92	2299329.75	407572.25
8183500	2113.00	7.77	7.65	7.63	7.70	7.80	7.92	7.66	7.53	7.65	7.64	7.55	7.75	7.68	2299329.75	407572.25
8183500	2113.00	7.91	7.76	7.71	7.80	7.82	8.05	7.79	7.67	7.78	7.77	7.70	7.88	7.89	2299329.75	407572.25
8199700	1460.00	0.00	0.00	0.00	385.66	19.31	8.75	66.59	0.00	0.00	9.54	0.00	0.00	39.10	1869693.5	455684.813
8181800	1743.00	17.03	18.70	21.18	24.14	27.17	28.83	30.02	30.65	28.69	25.30	22.35	18.92	24.84	2201860.5	511268.281
8181800	1743.00	15.32	17.05	19.38	22.15	25.13	26.83	28.03	28.65	26.97	23.54	20.68	17.10	22.89	2201860.5	511268.281
8181800	1743.00	15.96	17.70	20.31	23.05	26.08	27.76	28.97	29.62	27.81	24.41	21.42	17.58	23.29	2201860.5	511268.281
8181800	1743.00	15.32	16.36	19.43	21.96	24.16	26.89	27.97	27.90	26.55	23.03	19.35	16.78	22.19	2201860.5	511268.281
8181800	1743.00	481.63	486.04	417.96	489.79	682.91	957.96	521.28	420.10	502.98	514.81	455.94	411.22	528.14	2201860.5	511268.281
8181800	1743.00	#####	######	#######	######	######	######	######	5.51	6.72	######	######	######	6.44	2201860.5	511268.281
8181800	1743.00	858.26	886.07	899.55	892.58	882.51	833.91	854.93	924.44	887.31	860.37	895.65	919.13	882.47	2201860.5	511268.281
8181800	1743.00	795.79	799.17	822.92	805.07	793.41	748.76	776.06	897.12	799.84	790.09	818.64	863.81	804.84	2201860.5	511268.281
8181800	1743.00	837.54	863.30	863.41	882.88	838.87	803.08	838.49	896.72	827.78	832.07	852.08	885.07	860.08	2201860.5	511268.281
8181800	1743.00	820.89	836.60	848.55	810.52	748.38	792.86	800.14	788.23	747.75	780.94	794.63	833.23	800.88	2201860.5	511268.281
8181800	1743.00	821.38	834.80	832.08	869.22	732.37	886.14	753.56	796.66	784.59	755.71	787.52	820.89	787.68	2201860.5	511268.281
8181800	1743.00	7.51	7.12	6.84	5.78	6.63	6.57	6.52	5.96	5.96	6.66	7.12	7.97	6.60	2201860.5	511268.281
8181800	1743.00	6.86	6.40	6.00	5.00	5.66	5.42	5.10	4.71	4.97	5.90	6.53	7.24	5.79	2201860.5	511268.281
8181800	1743.00	7.21	6.79	6.42	5.30	6.08	5.97	5.69	5.23	5.42	6.28	6.81	7.60	6.21	2201860.5	511268.281
8181800	1743.00	7.83	7.79	7.78	7.86	7.94	7.82	7.86	7.87	7.88	8.05	7.73	7.68	7.84	2201860.5	511268.281
8181800	1743.00	7.54	7.64	7.63	7.71	7.78	7.66	7.76	7.75	7.70	7.60	7.61	7.80	7.67	2201860.5	511268.281
8181800	1743.00	7.68	7.72	7.71	7.79	7.86	7.75	7.82	7.81	7.79	7.84	7.68	7.65	7.76	2201860.5	511268.281

3.2.3 Karnes County

The upper one third of Karnes County can still make use of the Carrizo, but there are concerns about the temperature of the water as well as proximity to the "bad water line". Greater potential use does exist but more data are needed. For the lower two-thirds of the county, the greatest potential for groundwater development is the Catahoula Tuff and especially the Oakville Sandstone based on known thicknesses and limited data on permeability. It was difficult to access their full potential because so little data were available.

3.2.4 Summary

Even though there continues to be data gaps necessary for a complete evaluation of the groundwater resources in the study area, it is clear from this investigation that large quantities of groundwater supplies exist. Competition for these supplies will always exist for agricultural, municipal, and industrial needs. To help secure appropriate supplies for municipal needs, there should be more coordination among the various communities. This coordination effort should, minimally, include sharing all groundwater information available for incorporation into a GIS for updated modeling, recording changes, and development of future scenarios. This study has begun this process, but more local participation is needed. Sharing groundwater information to understand the full potential for groundwater development in this area is critical to the future of these municipalities.

3.3 Iron and Manganese Removal

High levels of soluble iron (Fe) and Manganese (Mn) in municipal water supplies cause numerous problems including "black water." The Fe and Mn is soluble because of reducing (or anoxic - without oxygen) conditions often found in the groundwater.

Because these elements are much more soluble (dissolved in the water) in the reduced chemical state than the oxidized chemical state, the most common method for their removal is oxidation into a much-less soluble oxidized state. This is normally accomplished by aeration which oxidizes the soluble Mn^{2+} to insoluble MnO_2 and Fe^{2+} to Fe_2O_3 and other insoluble iron oxides and carbonates. The rate of this oxidation (from soluble to insoluble) is pH dependent and is favored by a high pH; in fact, if there is a high level of $FeCO_3$ and $MnCO_3$ (carbonates - CO_3^{2-}) in the water, lime (calcium carbonate) or sodium carbonate can be added to the water to effect the precipitation and removal of the iron and manganese. However, this approach is less popular than oxidation.

All of the conventional treatment processes fall into one of seven main categories. They are :

1. Aeration followed by sand filtration (or dual-media filtration). This method is often complemented by a contact tank, settling, or flotation (O'Conner, 1971; Degrémont, 1991; Barnhoorn and Tye, 1984).

2. Chemical oxidation (without pre-aeration) followed by filtration. Common oxidants include chlorine dioxide (ClO_2) and potassium permanganate ($KMnO_4$).

3. Filtration with a special medium that acts as an ion or electron exchanger, for example, manganese greensands, zeolites, or sand that is naturally coated with manganese dioxide to simulate a 'natural greensand effect' (Aiello, *et al.*, 1978; Knock, *et al.*, 1991a; Knock, *et al.*, 1988; Qureshi and Barnes, 1994).

4. Magnesium oxide and diatomite. This method is analogous to using magnesium hydroxide to remove manganese (Coogan, 1962; Thompson, *et al.*, 1972).

5. Using normal water treatment procedures combined with lime softening (Degrémont, 1991).

6. Using sodium silicate, phosphates, or polyphosphates as sequestering agents (Dalga, 1975).

7. *In situ* (or in place) treatments in which oxygenated water is introduced into the aquifer by means of feed wells, thus creating a treatment area around the main well (Hallberg, Martinell, and Vyredox, 1976; Seyfried and Olthoff, 1985). This method is based on the combined effect of simultaneously occurring physical, chemical and biological phenomena (Rott, 1985).

3.3.1 Potential Problems with Conventional Methods

Municipalities using one of these conventional methods may not meet current standards for iron and manganese. The methods normally work, but consistent and satisfactory results are obtained when the following potential problems are eliminated:

- Too low oxidation pH
- Change in raw water quality
- Oxidation time too short
- Improper dosage locations and amount
- Filter sand particles too large
- Interference by the nitrification process
- Iron interference due to complexation (most common problem)

One of the most common problems, iron complexation, can be eliminated by using chemical oxidation, coagulation-flocculation, or both as complementary treatment steps. Reagent dosing location is also quite important.

3.3.2 Biological Removal

Iron was one of the first elements for which biological removal techniques have been employed. The use of iron bacteria, especially *Gallionella ferruginea* (stalked) and *Leptothrix ochracea,* (filamentous or sheathed) to remove iron has been quite effective. These bacteria have the unique property of causing oxidation and precipitation of dissolved iron under pH and redox potential (Eh or oxygen level) conditions that are intermediate between those of natural groundwater and those required for conventional (physical-chemical) iron removal. In nature, iron bacteria are quite widespread and are prevalent in groundwater. Biological iron removal is ideal for water with a slightly acid to neutral pH (5.5-7.0), high iron and silica contents, and devoid of toxic substances such as hydrogen sulfide (rotten egg smell); although the hydrogen sulfide is frequently removed by aeration and does not present a problem.

3.3.3 Summary

Conventional methods for iron and manganese removal have historically employed aeration plus filtration; and when necessary, injection of a strong oxidant, flocculent, or hydroxide. These types of techniques can present problems especially if there is a high concentration of silica or humic acids. Biological processes may offer a better alternative and are now starting to be seriously considered (Bouwer and Crowe, 1988) in the United States.

4.0 STUDY AREA DEMOGRAPHICS

The study area includes all participating municipalities in both Frio and Atascosa Counties, and Wilson and Karnes Counties. It is essential in a study such as this to analyze the characteristics of these counties independently to determine their individual strengths and weaknesses, and collectively to establish the synergistic effects of their combined resources in contrast to their individual limitations. It is equally vital to analyze the socio-economic characteristics that are common to rural areas throughout South Texas vis-à-vis their impact on economic development.

4.1 General

According to the Crossmatch/Tri-County Rural Economic Development Demonstration Project, the 1990 average unemployment rate for the study area was 7.9% compared to a state average of around 7.1%. Coincidentally, approximately 4.0% of the school aged population is not currently enrolled in school. If this enrollment figure is indicative of the high school dropout rate, it suggests that most unemployed individuals lack a high school education. Furthermore, one-third of the total population is currently under the age of eighteen, and the current population growth is 14%. If a high school education is any determinant of employability, there seems to be a fairly high likelihood that an increasing proportion of the population will be unemployed or unemployable. The alternative, of course, is to provide school aged children with essential skills for employment, either through the public school system or some alternative means. The level of education for the region is displayed in Table 4-1 and Figure 4-1.

Median per capita income as well as median household and family income has decreased between 1980 and 1990 for the four county area. Persons below the poverty level over the decade has increased approximately 41 percent across the study area. In 1990, 31% of total wages earned in all four counties was earned through employment in either federal, state, or local government. Another 12% was earned in the service sector. The remaining 57% was divided among agriculture, construction, finance, insurance and real estate (FIRE), manufacturing, mining, transportation, and retail and wholesale trade. This distribution of the local wage base is precariously imbalanced. In order to achieve a greater dispersion of the wage base, so that government and services at least equal all other sectors combined, it is essential to either increase the volume of existing businesses or establish some new enterprise based upon the aforementioned considerations. Civilian labor force characteristics are exhibited in Tables 4-2a and 4-2b, and Figures 4-2a and 4-2b.

All four counties are "rural". The economic base of each county lies in agriculture. Total production of agricultural and related goods for the region in 1992 was nearly $1 billion, which was evenly distributed over the four counties. However, total wages earned in the agribusiness industry is one-tenth of the total wages earned in local government ($3 million vs. $30 million), and is low in comparison to most other industries throughout the region. This is due, in part, to the high number of capital intensive privately owned and operated farms and ranches. More importantly, however, it is due to the relative lack of local processing of agricultural goods produced in the region. For an array of aggregated county business patterns refer to Figures 4-3a, 4-3b, and 4-3c.

TABLE 4-1: FOUR-COUNTY LEVEL OF EDUCATION										
	Atascosa County		Frio County		Karnes County		Wilson County		Texas	
	value	pct.	value	pct.	value	pct.	value	pct	value	pct.
Total Persons Age 25+	17,648	100	7,425	100	7,671	100	13,743	100	10,310,605	100
•less than 9th grade	4,365	24.7	2,458	33.1	2,568	33.5	3,138	22.8	1,387,528	13.5
•9th to 12th grade, no diploma	2,907	16.5	1,244	16.8	1,168	15.2	2,201	16.0	1,485,031	14.4
•high school graduates or equivalent	5,553	31.5	2,141	28.8	1,952	25.4	4,482	32.6	2,640,162	25.6
•some college, no degree	2,640	15.0	798	10.7	1,015	13.2	2,254	16.4	2,171,439	21.1
•associate/bachelor's degree	1,717	9.7	591	8.0	817	10.7	1,324	9.6	1,959,571	19.0
•graduate/ professional de	466	2.6	193	2.6	151	2.0	344	2.5	666,874	6.5

Note: Numbers may not sum to total due to rounding.
Source: 1980 and 1990 summary tape files 3, U.S. Bureau of the Census.

Figure 4-1: FOUR-COUNTY LEVEL OF EDUCATION

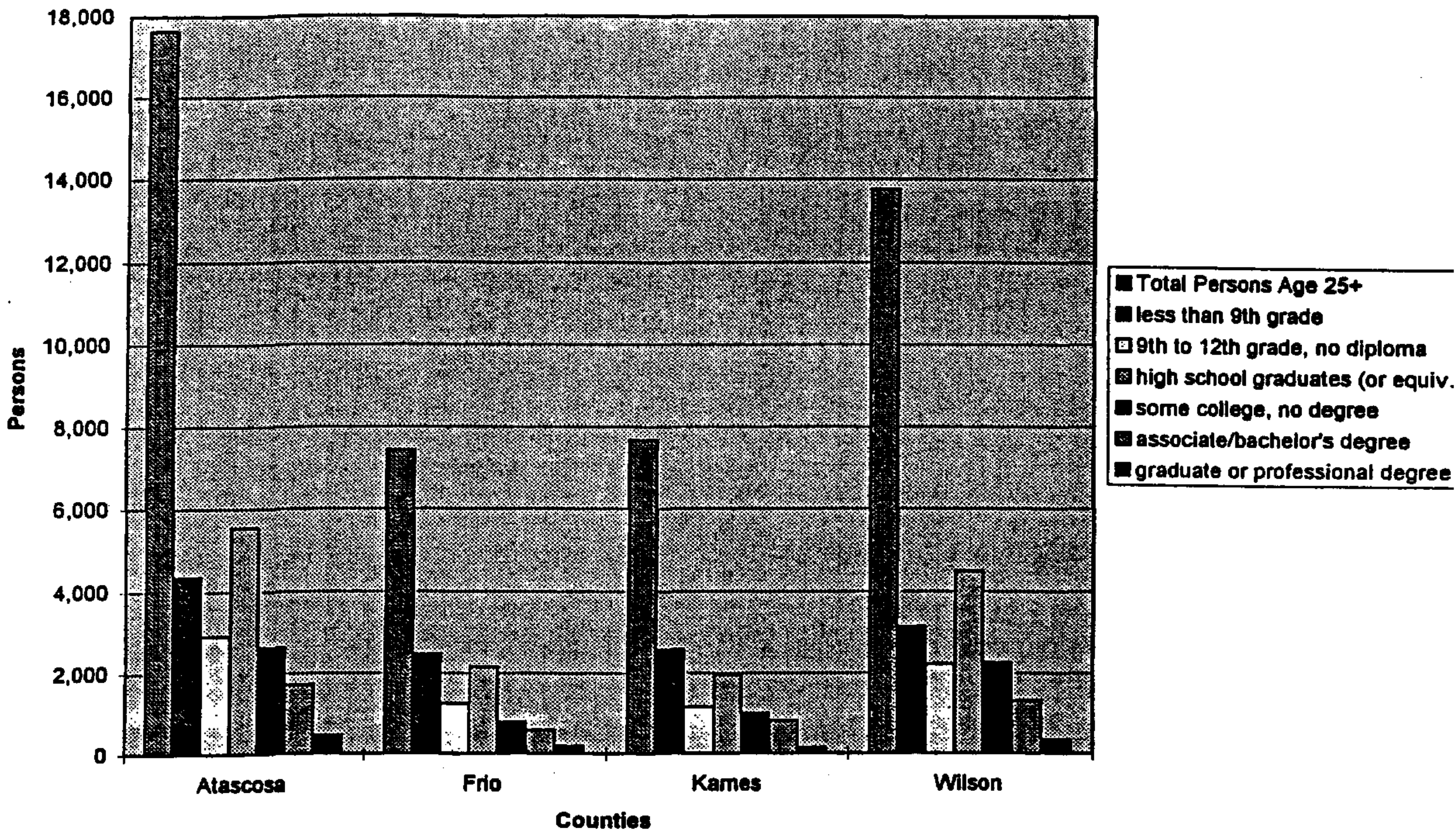


Table 4-2a: FOUR-COUNTY CIVILIAN LABOR FORCE CHARACTERISTICS, BY SELECTED INDUSTRY (1990)					
	Atascosa County	Frio County	Karnes County	Wilson County	Texas
Total Civilian Labor Force	12,357	5,394	4,948	10,055	8,219,028
▪female participation rate*	45.0	44.5	44.6	50.0	56.3
Total Employed	11,306	4,955	4,508	9,447	7,634,279
▪agriculture, forestry, and fisheries	9.1	16.6	10.2	8.1	2.8
▪manufacturing	5.0	4.2	10.4	9.8	14.4
▪wholesale and retail trade	20.5	18.2	20.3	20.6	22.4
▪finance, insurance, and real estate	4.2	3.6	4.5	5.3	6.8
▪health services	6.7	5.7	7.0	7.6	7.3
▪public administration	5.2	5.8	3.7	5.5	4.5

* Female civilian labor force as a percent of civilian females 16 years and older.
Note: Numbers may not sum to total due to rounding.
Source: U.S. Bureau of the Census. *County and City Data Book*: 1994. Washington, D.C.: U.S. Government Printing Office, 1994.

Table 4-2b: FOUR-COUNTY CIVILIAN LABOR FORCE CHARACTERISTICS (1990)					
	Atascosa County	Frio County	Karnes County	Wilson County	Texas
Total Employed Persons Age 16+	11,306	4,955	4,508	9,447	7,634,279
▪manager and professional specialty	15.7	14.3	17.6	17.2	26.1
▪technical, sales, and administrative support	27.4	20.3	24.3	28.0	32.6
▪service occupations	14.2	17.4	17.9	12.6	13.5
▪farm, forestry, and fishing	8.2	15.6	9.8	7.5	2.6
▪all others	34.5	32.3	30.4	34.7	25.3

Note: Numbers may not sum to total due to rounding. Source: 1980 and 1990 summary tape files 3, U.S. Bureau of the Census.

Figure 4-2a: FOUR-COUNTY CIVILIAN LABOR FORCE CHARACTERISTICS, BY SELECTED INDUSTRY (1990)

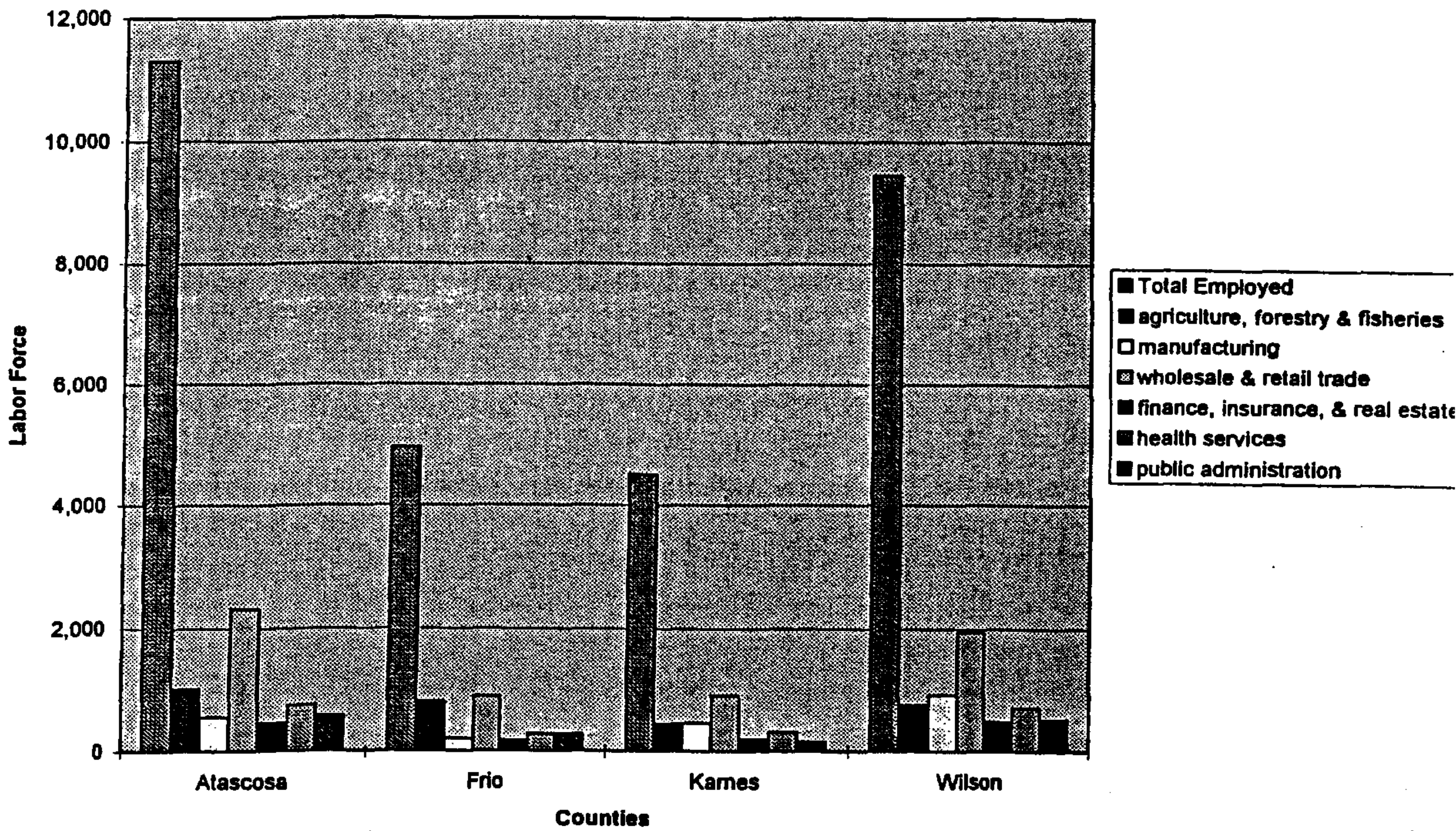


Figure 4-2b: FOUR-COUNTY CIVILIAN LABOR FORCE CHARACTERISTICS (1990)

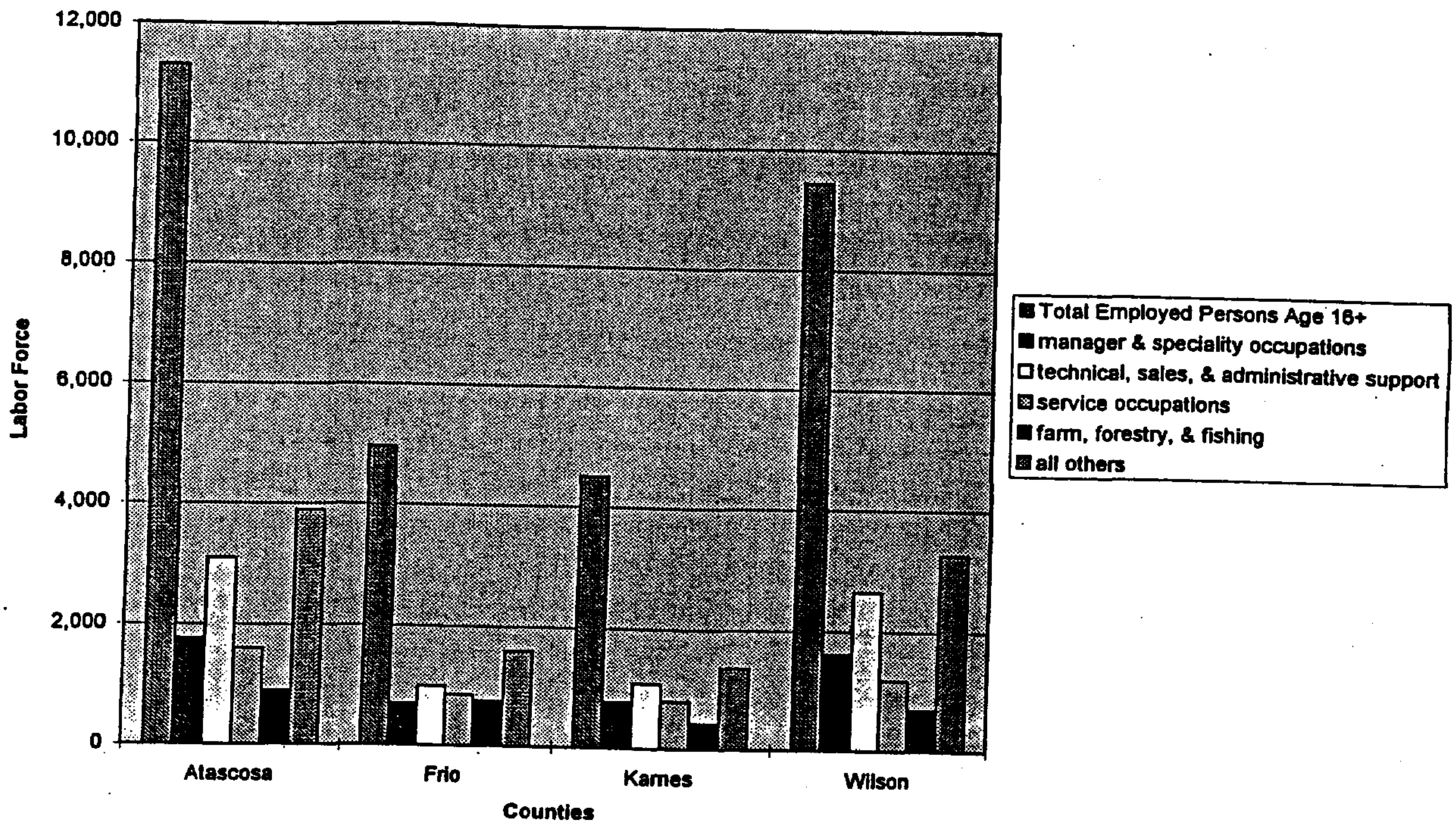


Figure 4-3a: AGGREGATED BUSINESS PATTERNS, EMPLOYMENT

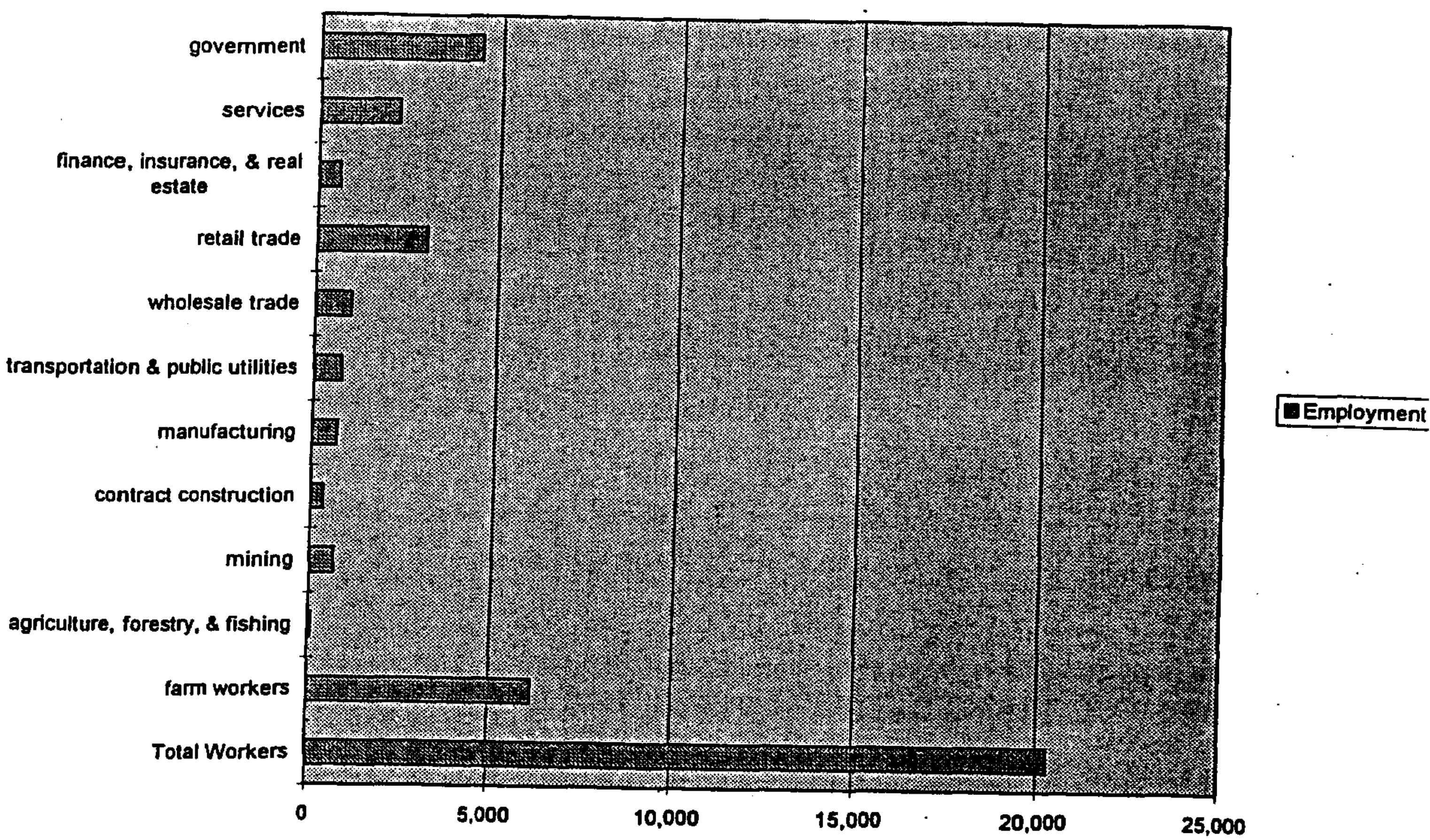


Figure 4-3b: AGGREGATED BUSINESS PATTERNS, INCOME

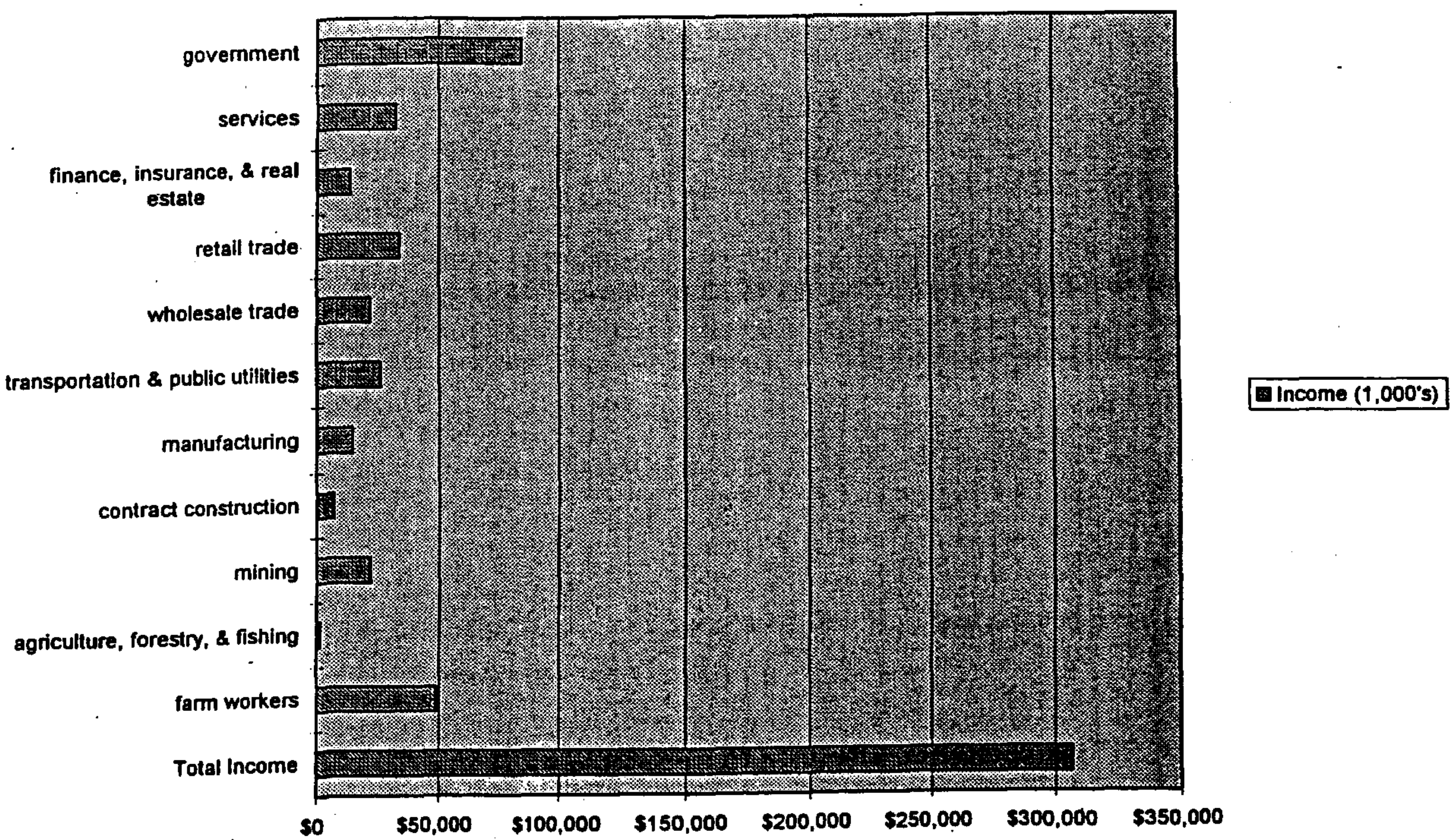
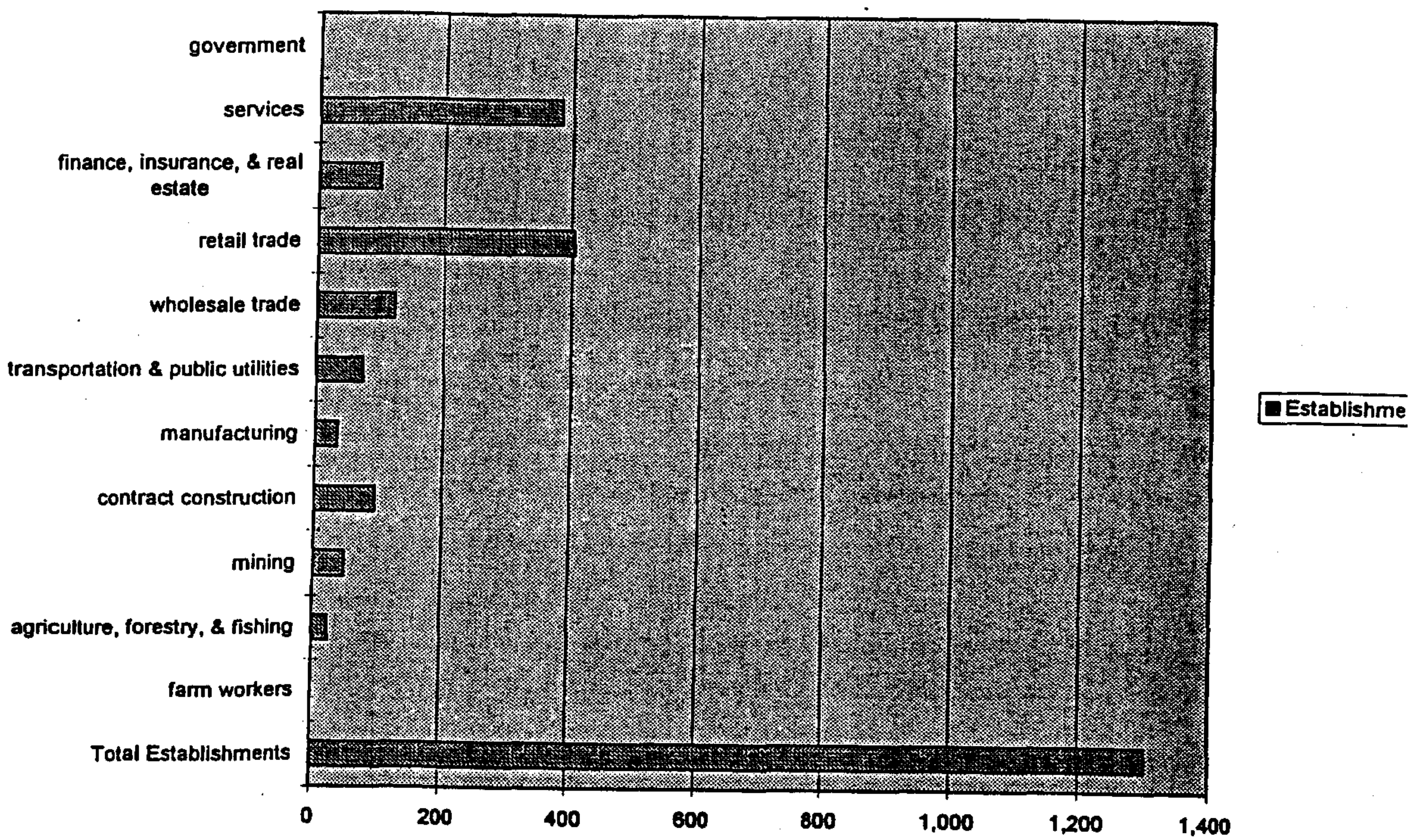


Figure 4-3c: AGGREGATED BUSINESS PATTERNS, ESTABLISHMENTS



4.2 Karnes and Wilson Counties

4.2.1 Karnes County

Karnes County encompasses an area of 753.5 square miles. The 1994 population in Karnes County was 12,945, with a 1990 median household income of $16,155, and 1990 per capita income of $8,229 which is 64% of the statewide per capita income. The physical features of Karnes County includes sandy loam, dark clay, and alluvial soils in rolling terrain with mesquite and oak trees. The county is traversed by the San Antonio River. Businesses include agribusiness, mineral production, varied manufacturing, and tourism. Karnes City is the county seat with a 1994 population of 2,964. The median household income in 1990 was $14,629, and per capita income was $6,965. Businesses in Karnes City include farm trade, a processing center, oil-field servicing, and varied manufacturing. Other municipalities include Falls City, Kenedy, and Runge. Falls City has a 1994 population of 493, and has provincial uranium processing. Kenedy has a 1994 population of 3,777, a 1990 median household income of $13,834, and per capita income of $5,965. Runge has a 1994 population of 1,168.

The population of Karnes County is largely rural, with low educational attainment and low income. Approximately 49% of the adults over 25 have not graduated from high school. The 1990 unemployment rate was 8.9 percent compared to 7.1 percent statewide, and 6.3 percent nationally. The unemployment rate in Karnes grew from 1980 to 1990 by 163 percent. The corresponding percentage change in unemployment for the decade in Texas and the nation was 122 and 14 percent, respectively.

4.2.2 Wilson County

Wilson County encompasses an area of 808.5 square miles. The 1994 population in Wilson County was 23,539, with a 1990 median household income of $23,184, and 1990 per capita income of $9,728 which is 75% of the statewide per capita income. The physical features of Wilson County include rolling plains, sandy soils, the San Antonio River, and Cibolo Creek. Business is chiefly agribusiness. Many residents commute to their places of employment in San Antonio. Floresville is the county seat with a 1994 population of 5,349. The median household income in 1990 was $19,199, and per capita income was $8,218. Businesses in Floresville include a hospital and a nursing home, agribusiness center, and a shopping mall. Other municipalities include Poth and Stockdale. Poth has a 1994 population of 1,725. Stockdale, with a 1994 population of 1,195, has businesses involved in food processing, health care, and recreation.

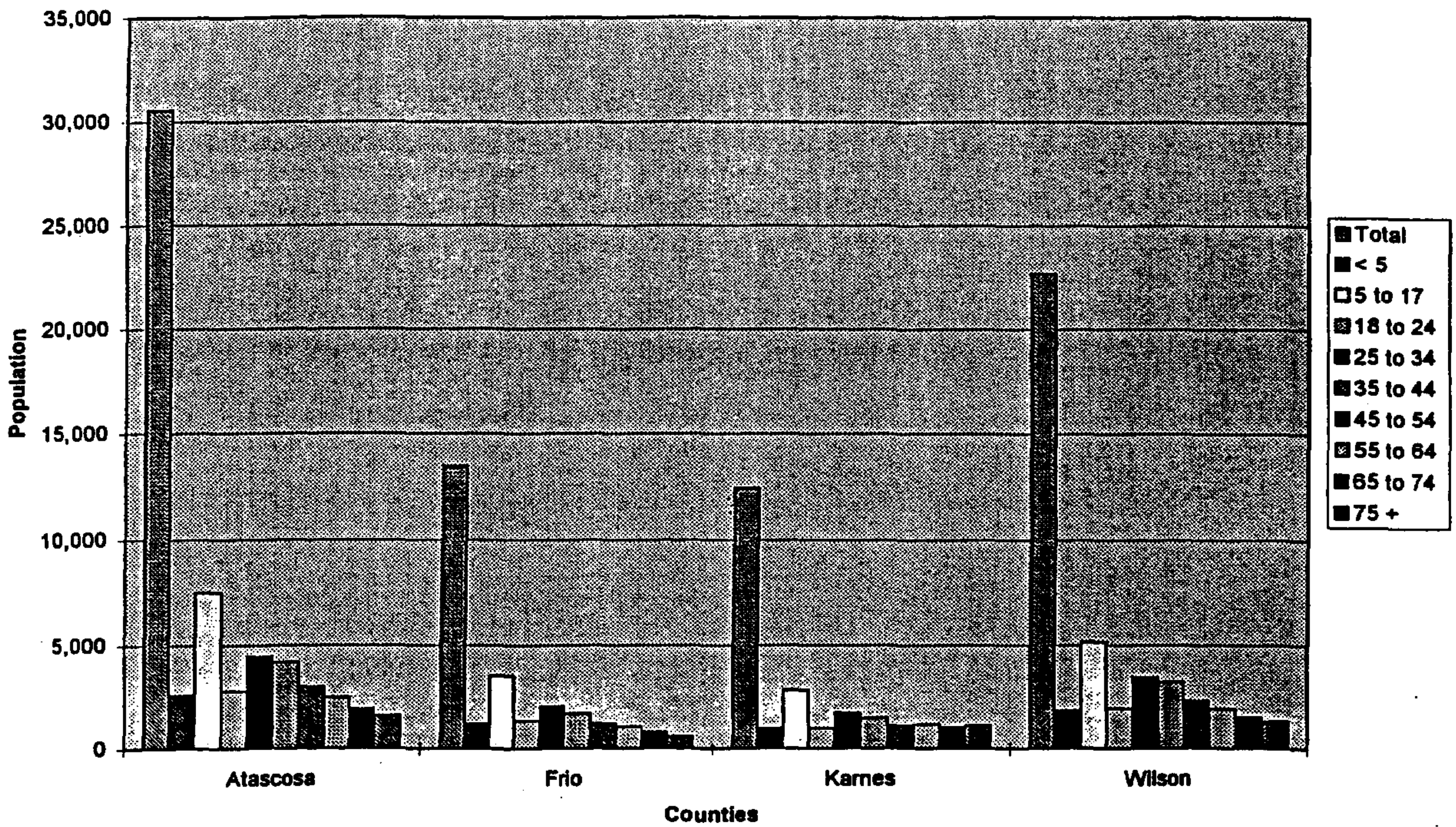
Wilson County has recently been designated as a component of the San Antonio Metropolitan Area, and of the four counties, it has experienced the most dramatic population growth over the past ten years (35%), more than double the growth of the region (14%). Population characteristics by age group for the region are presented in Table 3 and Figure 4. Approximately 39% of the adults over 25 have not graduated from high school in Wilson. The 1990 unemployment rate in Wilson was 6.1 percent compared to 7.1 percent statewide, and 6.3 percent nationally. The unemployment rate for Wilson County increased from 1980 to 1990 levels by 144 percent. The corresponding percentage change in unemployment for the decade in Texas and the nation was 122 and 14 percent, respectively.

TABLE 4-3: FOUR-COUNTY POPULATION CHARACTERISTICS, BY AGE GROUP (1990)

	Atascosa County	Frio County	Karnes County	Wilson County	Texas
Total Persons	30,533	13,472	12,455	22,650	16,986,496
▪under 5 years	8.5	8.9	7.9	8.1	8.1
▪5 to 17 years	24.6	26.1	22.5	22.7	20.4
▪18 to 24 years	9.1	9.9	7.9	8.5	10.8
▪25 to 34 years	14.7	15.2	13.9	15.3	18.4
▪35 to 44 years	13.7	12.6	11.9	14.2	15.0
▪45 to 54 years	9.8	9.0	8.9	10.2	9.7
▪55 to 64 years	8.1	7.7	9.3	8.4	7.6
▪65 to 74 years	6.3	6.1	8.5	6.7	5.9
▪75 years and over	5.2	4.5	9.0	5.8	4.2
▪males per 100 females	98.0	98.1	91.4	99.1	97.0

Note: Numbers may not sum to total due to rounding.
Source: 1980 and 1990 summary tape files 3, U.S. Bureau of the Census.

Figure 4-4: FOUR-COUNTY POPULATION CHARACTERISTICS, BY AGE GROUP (1990)



5.0 ALTERNATIVES

5.1 General

Economic analysis is a systematic method for studying problems of choice. Alternative ways to satisfy a goal are studied by evaluating the quantifiable costs and benefits of each alternative. Theses costs are measured objectively using economic and statistical techniques so that alternatives can be compared through a numerical ranking. The principle of life-cycle costing is used in economic analysis. Economic analysis is a common sense approach for optimizing the use of scarce resources.

According to the Thonhoff Report, evaluation of the alternatives recommended for further study considered location, water use, water quality, proposed facilities, and cost. The water supply source and supply facilities were sized and evaluated on the basis of average daily demand. Water supply sources are generally lakes or aquifers with large storage capacity that are able to equalize peak demands. Water treatment and high service pumping, however, were sized and evaluated on the basis of peak day demand. Use of peak day demand sizing of water system infrastructure lends confidence to the design adequacy for all supply needs.

TCE, Inc. evaluated water quality by comparing drinking water quality records of each participating municipality to published Drinking Water Standards of the Texas Natural Resource Conservation Commission (TNRCC) and the Environmental Protection Agency (EPA). The primary concern of drinking water quality in the AACOG project area has been with Total Dissolved Solids (TDS) concentration and other TDS contributing elements such as chloride and sodium. Currently, State and Federal drinking water standards allow TDS of a maximum 1000 ppm. Secondary TDS standards are proposed of a maximum 500 ppm. High Total Dissolved Solids concentrations have shown to be detrimental to poultry production and may increase risk to human health.

5.2 The Decision Objective

The objective of this analysis is to determine which of the proposed alternative methods of providing sources for improved water supply, treatment, and distribution will prove to be the most cost effective alternative. The software used in this analysis is ECONPACK 4.0, a comprehensive program incorporating economic analysis calculations, documentation, and reporting capabilities.

5.3 Alternative Courses of Action

Three water supply and quality alternatives are analyzed herein:

1. **Thonhoff Regional Water Plan**. This alternative examines the creation of three regionalized systems within the initial four-county AACOG project area and proposes connecting

infrastructure and shared water supplies.

2. **Thonhoff Autonomous Plan**. This alternative assumes each participating municipality will remain autonomous which requires upkeep of existing systems, replacement of water supply and infrastructure necessary to maintain current capacity, and construction of new supply and infrastructure to meet future demands.

3. **Aquifer Optimization Plan**. In this final alternative, recommendations for the participating municipalities in Karnes and Wilson Counties are proposed given each municipality's current and future needs and resource base.

5.4 Assumptions and Methodology

1. The current Federal discount rate of 7_ percent was applied (per Economic Guidance Memorandum Number 96-1: "Fiscal Year 1996 Interest Rates") to convert capital costs to average annual equivalent values.

2. Discount calculations for expense elements were performed using an end-of-year convention.

3. All costs are estimated in current 1995 dollars, hence price level changes due to inflation are included in this analysis.

4. To remain consistent with the Thonhoff Report, the length of the analysis period is 26 years (1996 through 2021).

5. Cost components for the No Action and the Resource Optimization plans include construction (capital), planning and design, and local operations and maintenance costs. The Thonhoff Regional Water plan includes these costs plus regional operation and maintenance costs.

6. The estimated period of construction for the Thonhoff Autonomous and Aquifer Optimization Plans is 1 year. Construction for the Thonhoff Regional Plan is assumed to be 3 years.

7. A straightline method of depreciation is calculated.

5.5 Economic Analysis Results

Results of the economic analysis by municipality are shown below in Tables 5-1a and 5-1b. Table 5-1a displays the estimated cost of alternative water works systems, and Table 5-1b exhibits the estimated cost of alternatives per million gallons. A more detailed treatment of these analyses including estimated costs gathered by TEC, Inc and output produced by ECONPACK is in Appendix B.

The conceptual basis for evaluating the benefits of improved water quality is society's willingness to pay for improved water supply, treatment, and distribution. ER 1105-2-100, p. 6-5 paragraph 6-7, provides the following guidance: Where the price of water reflects its marginal cost, use that price to calculate willingness to pay for the bolstered water quality. In the absence of such direct measures of marginal willingness to pay, the benefits from an improved water quality plan are measured instead by the resource cost of the alternative most likely to be implemented in the absence of the plan. The objective, then, is to choose the least costly alternative which provides those water quality/quantity improvements desired by each municipality. In so doing, decision makers are empowered to make their judgement based solely upon the needs of their community.

5.5.1 Net Present Value (NPV)

NPV is calculated for each alternative. The alternative with the lowest NPV is the preferred option. The NPV is calculated for an alternative discounting the value of the costs for each year and summing over the years for a total or net value. NPV analysis shows that all life-cycle costs need to be considered, i.e., initial outlays alone do not provide enough information to support a decision.

5.5.2 Equivalent Uniform Annual Cost (EUAC)

The NPV method assumes that all alternatives have equal lives or lives greater than the period of analysis. It is not unusual, however, for the lives of alternatives to differ. When this occurs, all of the alternatives must be compared on a common basis of time to make valid comparisons. The EUAC method allows us to make such comparisons.

The EUAC is an approach for evaluating alternatives with unequal economic lives that are less than the minimum requirement time period. It converts each option into an equivalent alternative having uniform recurring costs. The conversion is such that the total NPV costs of the actual alternative and its equivalent are the same. The alternatives can then be compared. The best alternative corresponds to the best actual alternative, which is the best economic choice for the project. Assuming that the alternatives are equally effective over their lives, the one with the lowest EUAC is the most economical choice.

5.6 Evaluation of Alternatives

5.6.1 Thonhoff Regional Plan

As discussed in the Thonhoff Report, a regional water system would interconnect water supplies from adjacent water purveying entities. Advantages would include:

- Greater component reliability
- Immediate increase in water supply
- Allow postponement of procuring independent water supplies
- Show shared expenses in processing new "best quality" water supplies
- Provide revenue for individual entities that sell water to regional system

The AACOG project area lends itself to division into three (3) regional systems. Region A would incorporate entities in Wilson and Karnes County. Region B would incorporate entities in Atascosa County, and Region C would incorporate entities in Frio and possibly Medina County. These areas, as displayed in the Thonhoff Report, are illustrated in Appendix B, Figures B-2 through B-5. Proposed infrastructure is also shown in these figures. Estimated life-cycle costs are itemized in Appendix B (Figure B-1) for each region and are summarized as follows:

	NPV	EUAC
Region A	$12,836,800	$1,135,400
Region B	$10,204,000	$902,500
Region C	$13,059,600	$1,155,100

These life-cycle cost estimates are aggregate values for each region. Estimates by municipality are displayed above in Tables 5-1a and 5-1b. The method of disaggregation in Table 5-1a is based upon the assumption that municipalities with larger populations will bear a greater financial responsibility. Therefore, the estimated cost of the Thonhoff Regional Plan by municipality is based on high population projections (Table 2.3-2) from the Thonhoff report. Cost data for the Thonhoff Regional Water Supply Plan were taken from the Thonhoff Report (Appendices C-3 through C-5).

Factored into total costs for the Thonhoff regional plan is the assumption that all municipalities will continue to utilize, repair, replace, and expand their existing water systems until the regional system is in place. Consequently, a portion of total costs for the regional water system include the current autonomous system.

TABLE 5-3a ESTIMATED COST OF ALTERNATIVE SYSTEMS (IN THOUSANDS)								
	Thonhoff Plan Region A		Thonhoff Autonomous Plan		Aquifer Optimization Plan			
	NPV	EUAC	NPV	EUAC	NPV (10")	EUAC (10")	NPV (14")	EUAC (14")
KARNES								
Falls City	$823.2	$72.8	$999.9	$88.4	$1,099.6	$97.3	$1,118.2	$98.9
Karnes City	$2,870.9	$253.9	$2,425.5	$214.5	$2,875.6	$254.3	$2,929.2	$259.1
Kenedy	$4,952.6	$438.0	$7,016.5	$620.6	$8,331.8	$736.9	$8,421.2	$744.8
Runge	$1,325.1	$117.2	$1,584.5	$140.1				
WILSON								
Floresville	$7,144.1	$631.9	$7,100.9	$628.0	$8,662.5	$766.2	$8,683.8	$768.1
Poth	$2,888.0	$255.4	$4,614.1	$408.1	$5,581.6	$493.7	$5,624.8	$497.5
Stockdale	$1,964.6	$173.8	$3,274.7	$289.6				

TABLE 5-2b ESTIMATED COST OF ALTERNATIVES PER MILLION GALLONS	Thonhoff Plan Region A	Thonhoff Autonomous Plan	Aquifer Optimization Plan (10")	Aquifer Optimization Plan (14")
KARNES				
Falls City	$1,790	$2,180	$2,390	$2,430
Karnes City	$1,590	$1,340	$1,590	$1,620
Kenedy	$1,600	$2,270	$2,690	$2,720
Runge	$1,770	$2,110		
WILSON				
Floresville	$1,080	$1,080	$1,310	$1,320
Poth	$1,400	$2,230	$2,700	$2,720
Stockdale	$1,310	$2,190		

Cost data for the Thonhoff Regional Water Supply Plan and the No Action Plan were taken from the Thonhoff Report (Appenciecs C-3 through C-5, and Appendicies C-1 and C-2). For municipalities that did not participate in the Thonhoff study, TEC, Inc. gathered the cost data for this study. Cost estimates for the Resource Optimization Plan are based on well drilling costs approximated by the Corps of Engineers. The components of the well drilling costs include well diameter, cost of drilling per foot, cost of gravel/concrete, well capacity (GPM), and the cost of a pump. The estimated cost of alternatives per million gallons is based on high water use projections in MGD (Table 2.3-2) from the Thonhoff report.

5.6.2 Thonhoff Autonomous Plan

Currently, all participating municipalities are autonomous in their water supply, treatment and distribution systems. It is possible that all participating municipalities remain autonomous in their water systems through the planning period. Previous sections have noted that groundwater is available in adequate supply for all cities in the planning area.

The cost of remaining autonomous is based upon maintenance of the existing system, replacement of water supply and infrastructure as required to sustain current capacity, and construction of new supply and infrastructure to meet future demands. In the Thonhoff Autonomous Plan, we make the *a priori* assumption that cities will remain in their current aquifer.

Cost data for the Thonhoff Autonomous Plan were taken from the Thonhoff Report (Appendices C-1 and C-2). For municipalities that did not participate in the Thonhoff study, TEC, Inc. gathered the cost data for this study.

5.6.3 Aquifer Optimization Plan

Table 5-2 below displays the depths of each aquifer from which municipalities can choose, i.e., optimize their aquifer resources. Cost estimates are based on well drilling costs approximated by the Corps of Engineers. The components of the well drilling costs include well diameter, cost of drilling per foot, cost of gravel/concrete, well capacity (GPM), and the cost of a pump.

Similar to the Thonhoff Autonomous Plan, the cost of the Aquifer Optimization Plan is based upon maintenance of the existing system, replacement of water supply and infrastructure as required to sustain current capacity, and construction of new supply and infrastructure to meet future demands. However, this plan differs from the Thonhoff Autonomous Plan in that each municipality knows what aquifer systems lie beneath them. Armed with this knowledge, each municipality can make an informed decision about what aquifers are accessible and which one/s to tap.

In making a *rational*[1] choice, decision makers strive to maximize net benefits such that costs are minimized and benefits are maximized. The cost data contained in this document allows decision makers to choose among alternatives based on estimated costs of each. The benefits of each alternative, on the other hand, are more subjective in nature. That is, benefits are a function of the needs of individual municipalities. For example, even though a 14" diameter well in a more shallow

[1]Rational behavior describes choices that are made "...among the available alternatives in such a manner that the satisfaction derived from consuming commodities (in the broadest sense) is as large as possible. This implies that [the consumer] is aware of the alternatives...and is capable of evaluating them" (Henderson and Quant, 1980).

aquifer may increase yield, the cost of treating that yield increases dramatically. This trade-off may be one that Community A is willing and able to accept, but one that Community B would not consider.

5.6.4 Conclusion

Given the preponderance of evidence presented, we propose that participating municipalities within the study area remain self-reliant in their water supply/quality interests given each municipality's current and future requirements and resource base. This approach differs from the Thonhoff Autonomous Plan in that each municipality is encouraged to optimize their aquifer resources, e.g., employing one well to tap multiple aquifers concurrently. For decision makers to make an educated guess so that aquifers are optimized, the GIS/Hydrogeology portions of this study are invaluable. Thus, decision makers are provided data on aquifers beneath each municipality. Additional information is archived at AACOG.

The immediate benefit to provincial control of water supply is self-reliance. To be sure, independence is ideal but it is clear from the above analysis that while some municipalities will benefit from a sovereign approach, others will gain from a regional arrangement. Irrespective of choices made by decision makers, each municipality is free to choose according to their needs. The function of the Corps of Engineers is not to presume to tell municipalities what is best for them. Rather, it is illuminate the choices available to each.

The main difficulty with a sovereign approach, however, is the existing groundwater law in Texas. Groundwater, like oil, is treated with the English Rule, or Rule of Capture principle, giving land owners the "property rights" to all water extracted from under the owner's land. Since groundwater does not recognize property lines, one can foresee the potential of one land owner encroaching the "property rights" of another. Tietenberg refers to this type of resource as a common property resource. Common property resources are those that can be exploited on a "use it or lose it" basis. Texas groundwater law virtually insures that dramatic "drawdown" events can and will result from overpumping. When this occurs, surrounding wells may go dry which potentially induces disputes, legal action, and expensive resolutions.

To optimize groundwater usage for each municipality we recommend the development of a Municipal Groundwater Co-operation (see Section 6.1). In this co-operation all municipalities will have equal representation thereby maximizing both individual (municipal) and collective (county) benefits. This group will not have a regulatory mission, but will function as a groundwater data collection and record maintenance co-operation. Each municipality in the group could contribute annual dues so that a full-time group coordinator can collect, synthesize, and maintain essential data, e.g., location and number of wells, and pumping rates. Benefits of the co-operation include accessible and credible data on each aquifer. During the course of this study, for example, several data gaps impeded the forward progress of the GIS/Hydrogeologic portions of this report. The institution of a Municipal Groundwater Co-operation would expedite any future groundwater studies by readily furnishing reliable data.

TABLE 5-2: AQUIFER DEPTHS FOR EACH MUNICIPALITY (IN FEET)							
AQUIFER	KARNES				WILSON		
	Falls City	Karnes City	Kenedy	Runge	Floresville	Stockdale	Poth
Oakville		300	300	200 *			
Catahuala	320	900 *	600 *	900			
Sparta Sand	1,000	ID	ID	ID			410
Queen City	BW	BW	BW	BW	400		1,000
Carrizo	3,600*	BW	BW	BW	1,200 *	450 *	1,500 *
Wilcox	BW/ID	BW/ID	BW/ID	BW/ID	1,600	1,400	2,100

Source: TWDB, Thonhoff Report (Table 4.1-1), AACOG, MECA
ID = insufficient data
WD = bad water
* = principal aquifer

6.0 REGIONAL ECONOMIC DEVELOPMENT ALTERNATIVES

6.1 General

Generally, rural economic development poses a number of very special problems. Isolation, small population, low population densities, absence of critical services, limited tax base, lack of diversity and limited institutional capacity all tend to mitigate against long term economic development in rural areas. In many instances, these conditions are exacerbated by poverty and a dearth of employment opportunities.

To meet the needs of rural areas and small communities, a broad strategy for economic growth and development is imperative. At a minimum, this strategy should include the following:

1. Greater emphasis must be placed on diversifying the economic base of rural areas. This can be done by encouraging small business development, enhancing the area's infrastructure, bringing in new industry, expanding existing industry, exploiting new technologies and markets, and developing an economic development strategy that focuses on the long term.

2. Additional emphasis must be placed on multi-jurisdictional cooperation in rural areas. Local

communities and jurisdictions often tend to compete against one another in order to gain a small advantage in the "game" of economic development. This kind of competitiveness is no longer advantageous for rural areas. Instead, communities and counties must work in concert to develop their economic base.

3. New partnerships are needed. Collaboration between public and private sectors encouraging economic development is imperative. This private/public partnership can take on many forms. The key to its successful realization, however, is based on the concept of mutual benefit and the sharing of scarce resources.

4. A strategic approach is necessary. To enhance economic development and growth in rural areas, emphasis must be placed on long-term strategies that encompass many dimensions, e.g., industrial, educational, environmental, public policy and leadership development.

6.2 South Texas Economic Region Growth Potential

According to the 1994-95 Texas Almanac, the South Texas Economic Region, which includes the study area, is geographically the largest of the economic regions in Texas. The region's future growth, resulting from increases in the manufacturing, services, transportation, and trade sectors, is forecast to match Texas' rate of growth. Growing trade with Mexico will increase employment in the services, transportation, and trade sectors. In retail trade, tourists have had a major effect on the economy. Tourism in San Antonio and along the Texas-Mexico boarder boosts the export potential of the region's trade and service sectors, bringing dollars from outside the region, state, and country. Government and manufacturing are also important sectors in the region. There are several industries within the manufacturing sector that are important contributors to the South Texas economy. Among them is apparel manufacturing primarily because the industry is labor intensive and the wage rates in the region are below state and national averages.

6.3 Regional Pork Processing Plant

The Crossmatch/Tri-County Rural Economic Development Demonstration Project, hereafter referred to as the Crossmatch study, asserts that Texas produced 950,000 Market hogs in 1990 which was a slight decrease from 1989 when 985,000 market hogs were produced in the state. In 1987 and 1988 Texas market hog production increased each year from a level of approximately 850,000 produced in 1986. Since January 1990, Texas has produced approximately 2,600 to 3,000 hogs per day for slaughtering. Currently all hogs are shipped out of state to be butchered/processed, then shipped back retail for consumer consumption.

Hog production in Texas is spread throughout the state, with both small and large farms. Most of the large (500 plus sows) farms are located west of Interstate Highway 35, with several in northwest

Texas and the panhandle region. However, a large percentage of the total production is located in the central and south central regions of the state.

There is interest for building new production in Texas for large scale operations and small, low cost farms. It is a goal of the Texas Pork Producers Association for the state to be producing 1,750,000 market hogs annually by the year 1997. This level of production should insure any size of packing plant with a sufficient supply of hogs for processing.

6.3.1 Wilson County and Region

According to the Crossmatch study, Wilson County is an ideal location for a pork processing plant. Approximately 75 producers are located in Wilson County, in which 55,000 hogs in "finished" weighing of 220-250 pounds annually. The six contiguous counties of Atascosa, Bexar, Gonzales, Guadalupe, Karnes and Wilson Counties produce over 120,000 swine each year. Wilson County alone produces almost half of that output.

Wilson County is in the heartland of the major pork producing area of Texas. Approximately 60% of 570,000 head of the total market hog production is located within a 200 mile radius of Floresville, Texas, the county seat of Wilson County. The size of farms within this area range from 1 to 1,500 sows and feedlots producing from 50 to 25,000 market hogs per year. Most farms tend to be less than 100 sows and less than 1,000 feeder pigs in feedlots.

Within 30 miles of San Antonio, the 9th largest city in the U.S., Wilson County has an excellent road system (Highways U.S. 87 and 181 and State Highway 97) connecting with Interstates 35, 37, and 10 in adjacent counties. Additionally, rail service is available.

6.3.2 Facility Benefits and Advantages

The proposed plant should be located near the metropolitan areas of San Antonio, Houston, Corpus Christi or Austin. The close proximity to these areas allows delivery of fresh pork within two to three days after processing. Local pork producers will benefit by increasing revenues two to four cents above prices they currently earn. These additional revenues are freight charges saved by local pork producers currently shipping live hogs out of state.

The labor force necessary to operate the processing plant is available and comparatively advantaged towards agriculture or agri-business economic development. Because the cost-of-living is relatively low in the study region, employees can be hired at low to medium rates.

Because pork processing is a water intense operation, additional investigations should be undertaken to determine groundwater requirements in addition to resource sustainability. Opportunities could exist for a co-operative arrangement between the pork processing investors and local municipalities to address mutual water needs.

6.3.3 Local Commitments

Marketing study information compiled by the Texas Department of Agriculture can be made available concerning type and quality of pork purchased, prices, supply markets and overall needs.

Special assistance can be provided on:

A. Site locating layouts with maps, property inventories, utility services, permit needs and construction development.

B. Financing programs from the State of Texas Small Business Administration and interested local banks.

C. Coordinate processing of job applications, job training assessments OJT contracts and qualified workforce.

D. Special entity Tax incentives or abatement agreements as necessary.

6.4 Tourism

Tourism is forecast to become the world's leading industry in the 21st century. Within the San Antonio area, service industries related to tourism are the number two employer, following only jobs related to the military and government employment. According to the 1994-95 Texas Almanac, tourism has already become a major economic factor in hundreds of Texas communities. The estimated impact of visitors on local economies reached more than $17.7 billion in 1991. The following table shows the economic impact of tourism on the four-county study area.

As stated in the Crossmatch study, AACOG's tourism initiative began in late 1988 during a period of drought and lagging oil production. Agricultural production was profoundly affected as was the morale of many rural communities. Out-migration in some areas served as a grim indicator of the degree of economic distress. Despite an economic downturn in the region, the tourism industry in San Antonio continued to experience growth. San Antonio ranked as the State's premiere tourist destination city among short-term, long-term and international tourists. The counties and communities surrounding San Antonio are rich in history, cultural diversity, beautiful by-ways, ranches, farmlands, brush country and tree-studded limestone hills. In short, these surrounding communities possess all those attributes that make-up the internationally perceived "Texas mystique".

While tourism is forecast to become a leading industry in the area, it is pro-cyclical and is consequently subject to trough periods in addition to the peak periods.

County	Expenditures	Payroll	Employment	State Taxes	Local Taxes	Total
Atascosa	$8,080,000	$1,400,000	120	$280,000	$180,000	Injections: $9,940,000 Jobs: 120
Frio	10,840,000	2,040,000	180	470,000	250,000	Injections: $13,600,000 Jobs: 180
Karnes	5,900,000	980,000	80	220,000	190,000	Injections: $7,290,000 Jobs: 80
Wilson	5,880,000	750,000	60	220,000	140,000	Injections: $6,990,000 Jobs: 60
Total	$30,700,000	$5,170,000	440	$1,190,000	$760,000	Injections: $37,820,000 Jobs: 440

Source: The Dallas Morning News. *1994-95 Texas Almanac*, 1993.

6.5 Economic Development Coordinator

Recall, the principal goal of this PEP program is to outline a long-term economic development strategy for the two-county study area. Also, while this study is intended to develop a regional economic development model based on individual and collective strengths of each participating municipality, it can serve as a prototype for economic development studies in other rural regions in Texas. The most feasible alternatives might be beyond the fiscal capability of individual municipalities in the study area, and may require private sector participation and the pooling of public resources across municipal, county, and conceivably river basin boundaries. For these reasons, and for reasons listed in Section 6.1, future economic development efforts would be more effectively promoted if each county were to establish a full-time Economic Development Coordinator.

Each Economic Development Coordinator should be a member of an Economic Development Committee to be facilitated by AACOG. This committee would make economic development recommendations for the study area. It is once again vital to stress the necessity of a collective effort by each member of this committee. While each member is encouraged to function independently, i.e., act in the best interest of their respective county, they too must act in concert thus optimizing each economic development effort for the entire region.

The Economic Development Coordinator would be responsible for developing, administering, and coordinating a comprehensive economic development program for the employing county. The incumbent would assist business and industry with expansions and relocations, create economic opportunities for each municipality within the county, promote international trade, provide technical assistance in financing, direct the preparation of economic development strategies, and other relevant economic development activities. The Economic Development Coordinator would serve as liaison to the local business community and business executives, public entities, and work directly with county municipalities. Work would involve coordination with state and federal legislators and other organizations in developing and recommending legislation enhancing economic development and would require extensive coordination with other municipal entities, state and federal economic development agencies, the private sector, and the State Legislature. The incumbent would receive general direction from county and municipal officials, AACOG, and the Economic Development Committee, in developing programs, policies, and legislation.

Atascosa County currently has an Economic Development Corporation which is financed through several means including tax dollars, county, participating municipality, and chambers of commerce contributions, and grants. Currently, the Executive Director along with AACOG representivities are working with Wilson County officials to establish an economic development program in that county. The mission statement, duties and responsibilities of the Executive Director, and composition of the Board of Directors for the Economic Development Corporation in Atascosa County can be found in Appendix C.

6.6 NAFTA Superhighway Designation

6.6.1 Introduction

Since the North American Free Trade Agreement (NAFTA) went into effect on January 1, 1994, the importance of Interstate Highway 35 (IH-35) and the demands placed on it are expected to increase dramatically. The Texas portion of IH-35, which bisects Frio County, will serve as the major north-south artery bearing the heavy commerce traffic into and out of the U.S. and Mexico directly connecting the major population and commercial centers of Laredo, San Antonio, Austin, Dallas/Ft. Worth, Oklahoma City, Wichita, Kansas City, Des Moines, Minneapolis, Duluth, and Central Canada. Texas highways carry approximately 75 percent of combined cross-boarder trade valued at $55 million, the majority of which is transported on IH-35. Estimates are that between 35,000 and 38,000 18-wheel trucks cross into and out of Mexico at Laredo every month, the majority of which travel on IH-35. U.S. trade related to NAFTA is projected by Federal and Texas officials to double by the year 2000 and double again by 2010.

Not only are there local and regional rents[2] to capture via IH-35, but also consider that IH-35 provides access to all major interstate routes running east to west across the U.S. To be sure, the effects of NAFTA will quickly assimilate to the rest of the nation creating the potential for rents to be captured nationally.

It is not enough to weigh the costs and benefits of alternative means (or the expansion of preexisting means) for moving goods and people. The possibilities of trade-off between transport investment and other capital investments also must be deliberated. Moreover, since transport resources are often critical as inputs in other economic projects, what may initially appear to be an efficient allocation of transport investment, when viewed in isolation, may be inefficient when viewed in terms of the opportunity cost of that allocation in the broader context of national planning. It is, therefore, requisite upon the economic analysts and decision makers to incorporate in their analysis the benefit and cost functions of the nation.

It is essential, then, to apply a method by which the benefits of a transport project of this magnitude are real and quantifiable. Because the benefits of an IH-35 expansion project are not limited to local and regional levels, a national development policy also must evolve which too can be measured in quantifiable, real terms. Benefit-cost analysis (BCA) is the primary tool of public sector investment project evaluation:

> When interpreted in strict economic terms, [BCA] is a pragmatic realization of the theory of welfare economics, providing a specific organizing framework and a set of procedures to summarize information and display the tradeoffs associated with these actions - generally in monetary terms (Smith, 1986).

6.6.2 Methodology

In general, to analyze the economic feasibility of any undertaking is to ask the question, Will the benefits from the project be greater than the costs and therefore justify diverting financial and economic capital to that project? More specific to the issue of an IH-35 expansion project, for example, several questions can be posed:

(1) What will be the marginal impact of expanding IH-35 by one lane?

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[2]*Economic Rent* is the excess return to an input (resource), i.e., the difference between the payment for use of the resource (hire price) and the lowest payment the owner of the resource would have been willing to accept.

(2) With an increase in economic growth, what is the value of one lane?
(3) What will be the impact on the economy of increased traffic flow?
(4) Because of NAFTA, what predictions can be made of how traffic density will increase?
(5) What are the short-term and long-term expected benefits and expected costs?
(6) By what amount will an additional lane decrease travel time?[3]

Benefit-cost analysis maintains that consumers' values should be the basis for measures of the benefits of an action. In defining these benefits, economic analysts typically use an individual's willingness to pay for the good or service provided by the proposed action. Decision makers commission benefits assessments to help them make decisions, i.e., to help them choose among alternative courses of action (including inaction). To make these difficult choices the decision makers must do the following:

(1) identify the policy alternatives that could be adopted
(2) circumscribe the set of policy-relevant consequences that these alternatives could create
(3) estimate the magnitude of each alternative's consequences were it adopted
(4) evaluate the benefits and costs that affected individuals would derive from these consequences
(5) aggregate benefits across individuals

(Fischhoff et al., 1986)

It should be noted that the above framework is suitable when the set of policy alternatives is small, and is thus applicable in IH-35 expansion analysis.

Ideally, costs are to be measured by the opportunity costs of the resources used in the allocation decision. When the action involves expanding IH-35, or building a bridge, for example, engineering estimates of the costs of the project are constructed as part of its design. While there may be technical issues associated with the treatment of capital and operating costs, these tasks are more direct than many benefit estimation problems. Smith (1986) lists two methods for cost estimation: econometric cost models and engineering estimates. He claims that most studies have relied on the latter method:

> As a rule, the cost estimates needed are either too specific or detailed to be consistent with the more general ones which could be developed from econometric models, largely because of the

[3]Intuitively, this question is particularly important because it addresses an optimization problem: by decreasing (minimizing) travel time, we are able to increase (maximize) the efficiency of transporting goods, such that the value of the goods being transported is equivalent to the time value.

state of the art of neoclassical modeling and data limitations (Smith, 1986).

Benefit-cost analysis is not the only tool available to the economist for public policy evaluation. Economic impact analysis[4] also can be employed. This analysis has at its disposal many methods for evaluating actions providing the basis for estimating what groups will gain and lose from (specifically) IH-35 expansion. For example, models can be constructed estimating travel demand from which we can extrapolate an estimated impact on travel demand given IH-35 expansion. Additionally, models can be structured to estimate the elasticity of individual responsiveness to congestion from which the following question can be entertained: How much will expansion diminish congestion?

In terms of the national effects of NAFTA and an IH-35 expansion, historical expansion projects can be studied with the intent of valuing the interstate system. For example, perhaps studies assessing the economic value of IH-635 in North Texas, or IH-495 encircling the Washington, D.C. area, controlling for unrelated factors, e.g., area growth, could be extrapolated to IH-35 and the major interstate routes running east to west across the U.S. that are accessed from IH-35. Unquestionably, the IH-35 corridor coalition must secure an International NAFTA Superhighway designation for this country to realize the full potential of free trade with bordering countries.

6.6.3 Conclusion

Frio County is in the unique position to participate in the development of this country's capacity to trade freely and efficiently with Mexico (and Canada). The challenge is in developing the techniques that will be socially and politically amenable to quantify the growth potential. Careful selection of available quantitative methods (e.g., benefit-cost analysis) is paramount to the success of this national agenda. Therefore, future market feasibility studies should investigate dovetailing economic development of this region and NAFTA development along the IH-35 corridor.

[4]Evaluation of the effects on an action on prices, output, employment, and other economic features of industries, regions, and governmental units (Smith, 1986).

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APPENDIX A - Review of Groundwater Resources

1.0 INTRODUCTION

This study was initiated as a review of the Thonhoff/AACOG Report (September, 1994) titled "Regional Water Plan for Participating Municipalities in Atascosa, Frio, Karnes, and Wilson Counties" prepared by the Alamo Area Council of Governments and Thonhoff Consulting Engineers, Inc. During the initial readings of the report and discussions regarding the proposed plan, several additional tasks emerged:

- Evaluation of groundwater resources in the study area based on the collection of all available data and integration into a GIS database.
- Building of preliminary, regional groundwater models for identified aquifers.

Figure 1 shows the location of the study area which includes Atascosa, Frio, Karnes and Wilson counties, as well as parts of some of the surrounding counties.

The main reason for expanding the Thonhoff/AACOG Report with this study was that it focused on seven participating municipalities, out of forty six identified water purveying entities, and did not study in detail all present aquifers and groundwater pumpage data. This new study examines the four county aquifer potential in more detail and assists the AACOG in developing a groundwater-related geographic information system. AACOG is ultimately responsible for the GIS design and data collection. This study was prepared by Neven Kresic, Professional Hydrogeologist, IAH #988.

2.0 THONHOFF/AACOG REPORT: PRESENT AND FUTURE GROUNDWATER USE

According to the Thonhoff Report "The vast majority of groundwater is produced for irrigation purposes in the area, and groundwater provides essentially all of the public supply water to cities in the area" (Section 3.1). This report did not provide data on the actual total present groundwater withdrawal in the AACOG Project Area. However, water usage projections for the area are given for years 1990, 2000, 2010, 2020, 2030, and 2040 based on the following:

1) a survey of seven participating municipalities (Falls City, Floresville, Karnes City, Kenedy, Pearsall, Pleasanton, and Runge);
2) a preliminary search of records from the Texas Natural Resource Conservation Commission for other water purveying entities in the area.
3) TWDB Water Demand projections and population figures for Atascosa, Frio, Karnes, and Wilson counties.

Estimated groundwater withdrawal in 1990 is given for twenty-six water purveying entities out of forty-three identified (Table 5.1-1, Section 5.1 "Water Supply"). Projections for the year 2000 and later are given for fourteen entities. The Thonhoff Report did not specifically address groundwater withdrawal for irrigation or industrial purposes and the total projected water use for the four counties does not include these figures (Table in the Executive Summary; Table 2.4-1 in the Section 2.4 "General Water Use Projections for Four County Area"). Section 3.1.2 "Carrizo Sand" gives the irrigation pumpage from the Carrizo of 228 MGD in 1969. In the same year, public supply pumpage accounted for about 8 MGD, or 3 percent of the total pumpage. Corresponding data are not available for the present or projected water use for the individual aquifers.

Projected water use in the year 2000 for the fourteen purveying entities is 9.77 million gallons per day (MGD) calculated from the data in Table 5.1-1. Compared to the estimated total water use of 16.20 MGD (or 17.11 MGD in the case of high estimate) this number seems questionable. In other words, all twenty-nine remaining water purveying entities account for only 6.43 MGD (or 7.34 MGD in the case of high estimate). Only 1990 data were submitted by several entities and therefore not included in the 2000 year estimate. However, significant water use is apparent (all figures in MGD): City of Lytle - 0.493, McCoy WSC - 0.326, El Oso WSC - 0.998, SS WSC - 0.606, Sunko WSC - 0.340. This, together with the fact that there are no data available for as much as seventeen entities, indicates that the public water use projections for the four-county area may be underestimated.

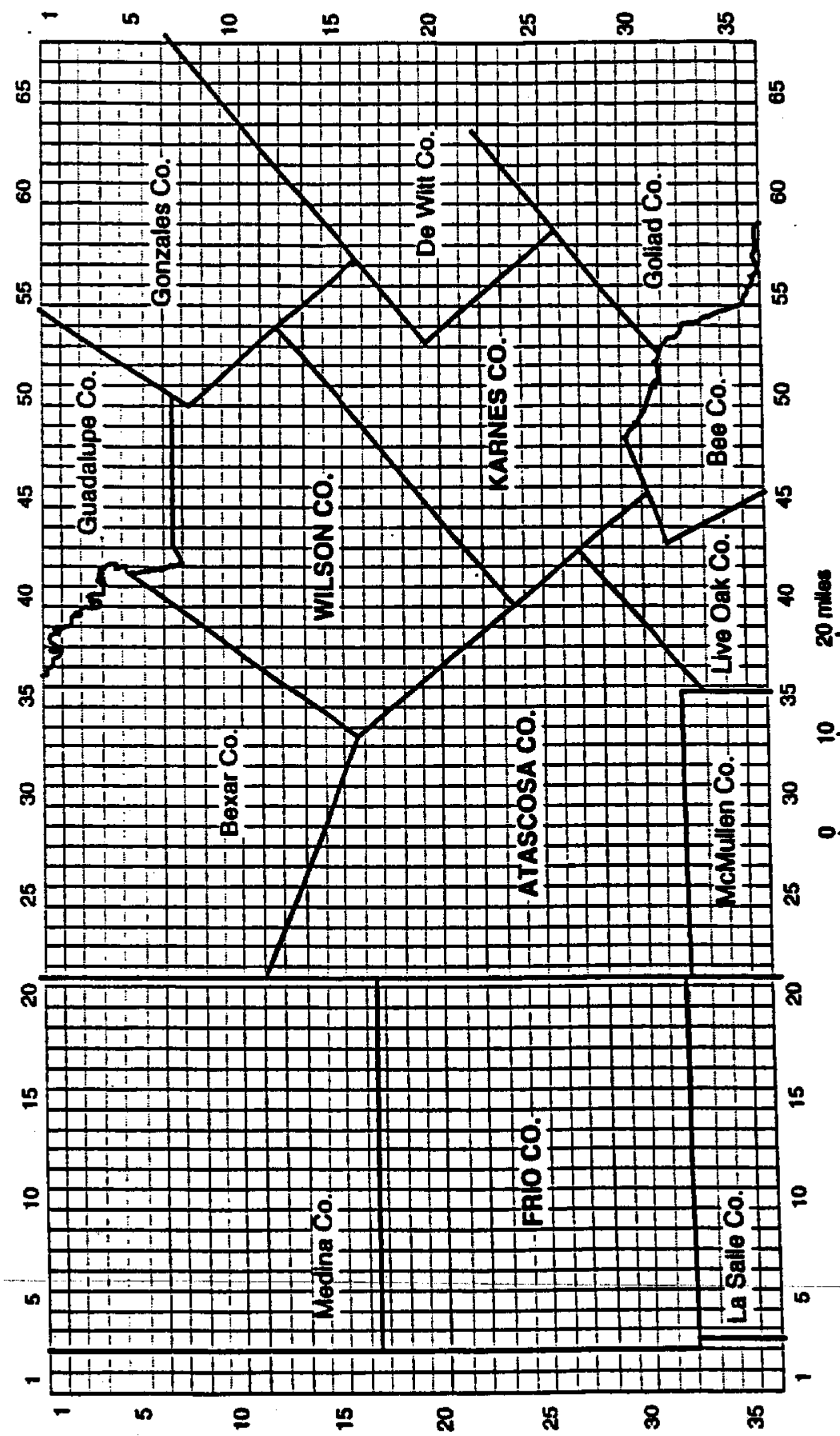
3.0 AQUIFER INFORMATION IN THE THONHOFF/AACOG REPORT

The Thonhoff/AACOG Report identified three "major" aquifers in the Project Area: Wilcox, Carrizo and Queen City. Although shown on Geohydrologic Cross-Sections, Figures 3.1-1 and 3.1-2, the Sparta-Laredo aquifer is not described in the report. Based on its thickness and description in Table 3.1 ("medium to fine sand, some interbedded clay") it appears that the Sparta-Laredo aquifer may be a potentially important source of groundwater in the area. Two "secondary" aquifers that outcrop only in Karnes County were also identified: the Catahoula and Oakville.

Approximate range of aquifer thickness is given only for Carrizo (150 to 1,200 feet), Queen City (500 to 1,400 feet), Catahoula (maximum thickness of 1,700 feet), and Oakville (950 feet maximum thickness). However, these data are not consistent with TWDB reports data. It is also not clear if the given values are actual thicknesses in the four-study area. Particularly problematic are values given for the Catahoula and Oakville aquifers. With the thickness of 1,700 feet, Catahoula would be the thickest aquifer in the Project Area, even though it is not shown on the maps and cross-sections, or identified as a major aquifer. It is more likely that this value is a geologic estimate of the original deposition thickness and not the actual present thickness. Also, thicknesses obtained from the deep well logs are only up to 1,500 feet in Karnes County.

The Thonhoff/AACOG Report did not provide data on aerial distribution of hydrogeologic

Figure 1: STUDY AREA WITH THE SUPERIMPOSED GROUNDWATER MODELING GRID



parameters for the identified aquifers but listed ranges of transmissivities for the aquifers. Also omitted was information on groundwater levels and maps of the potentiometric surfaces (water levels registered in wells) for the aquifers. This new report will furnish some of this information and provide a more accurate profile of the potential for groundwater use in the four county area.

4.0 DATA USED IN THE PRESENT STUDY

To provide a more accurate assessment of the potential for further groundwater development in the area, the following data bases/GIS layers were developed and later used for groundwater assessment and preliminary regional modeling:

1. *Geologic map* showing outcrops of major and secondary aquifers, as well as aquitards. The map was compiled from geologic maps published in "ground-water reports" by Texas Water Development Board (previously "Texas Board of Water Engineers") and Texas Water Commission , and then digitized at AACOG. These reports, also the main source of other hydrogeological information, were produced for Wilson County (in 1957, Bulletin 5710), Karnes County (1960, Bulletin 6007) Atascosa and Frio Counties (1966, Report 32), and the following neighboring counties: Bexar (1959, Bulletin 5911), Live Oak (1961, Bulletin 6105), Bee (1966, Report 17) De Witt (1965, Bulletin 6518), Goliad (1957, Bulletin 5711), Guadalupe (1966, Report 19), Medina (1956, Bulletin 5601), Gonzales (1965, Report 4), La Salle and McMullen counties (1965, Bulletin 6520). TWDB Report 210 titled "Ground-Water Resources of The Carrizo Aquifer in The Winter Garden Area of Texas" and published in 1976, was also used as a source of important hydrogeological information in this study.

2. *Precipitation* data for area gauging stations was provided by AACOG. These data were used to produce a map of the average annual precipitation in the study area for the 1983-1994 period. This map, together with the air temperature data, was then used to estimate the "potential evapotranspiration" and, consequently, "aquifer recharge".

3. *Air temperature* data for the area gauging stations was provided by AACOG.

4. Data on *land cover* was derived from a processed Landsat TM satellite image. Two categories of land use were identified per 2x2 mile groundwater model cells based on the predominant (>50%) coverage: forested land or agricultural soil. These categories were then used to estimate the relative recharge distribution assuming less infiltration over forested areas.

5. Data on altitudes of the area *aquifers' tops and bottoms*. These data base were developed and provided by AACOG from the TWDB ground-water reports/geologic cross-sections showing locations and well logs of deep (oil ?) wells. Altogether, data from 96 wells scattered throughout the study area are included in the database which was used to determine aquifer thicknesses and produce contour maps of their top and bottom elevations. At this time, data were sufficient to most accurately map the Wilcox, Carrizo and Queen City aquifers (see next sections). Other related figures in TWDB reports, were also used to produce maps for the study area. In addition, data for the Wilcox and Queen City aquifers had to be adjusted/changed during the map development to maintain consistency with TWDB maps.

6. Data on *well pumpage* provided by AACOG and organized in two data layers: one containing individual well data and one containing data of the well pumpage per 2x2 mile cells. The individual well database includes the following information: well ID number, longitude/latitude, year of completion, well depth, aquifer pumped, pumping rate in gallons per minute, and well usage (irrigation, municipal, industrial, other). The well pumpage database has the following information: number of the 2x2 mile cell within the grid developed for groundwater modeling, state coordinates of the cell centroid, aquifer pumped, and total pumping rate in gallons per minute for all wells within that cell. The data were used to estimate groundwater withdrawal in the study area, and for calibration of the preliminary, regional groundwater models.

7. Data on *groundwater levels* measured in individual water wells were provided by AACOG. The related data base includes the following information: well ID, state coordinates, year of measurement, surface elevation, depth to water level, water level altitude, and aquifer measured. The available data were sufficient to produce a contour map of groundwater altitudes for the Carrizo Sand aquifer. The most recent year with a considerable amount of data available for the map is 1990. The 1990 map and a map of groundwater altitudes in the Carrizo Aquifer in 1970 based on TWDB Report 210 are presented.

5.0 DESCRIPTION OF AREA AQUIFERS

5.1 Wilcox Group

The Wilcox Group outcrops in a NE-SW belt from 3 to 10 miles wide along southern Medina County, and northern parts of Frio and Atascosa Counties (see Figure 2). The Wilcox is composed mostly of clay, shale, lenticular beds of sand, and discontinuous beds of lignite. The shale and clay generally contain gypsum (calcium sulfate).

Relative thickness of the Wilcox Group, as measured along vertical (well axes, see Figure 3), varies from 300 feet in outcrop areas to over 2,200 feet in southern Atascosa county. Figures 3 through 5 show locations of deep wells used to determine the top and bottom of the Wilcox Group, and altitude in feet of the aquifer top and bottom. Gradient (slope) of the aquifer top is about 140 feet per mile, and the aquifer bottom surface slopes about 150 feet per mile, i.e. its average dip is 1.5° toward the southeast.

Figure 6 shows groundwater levels registered in water wells in 1990 (most recent year with the largest amount of data available as provided by AACOG). Practically all of the 11 measured wells are in the aquifer's recharge area (outcrop). Virtually no information was collected down dip of the outcrop area (i.e., the southern parts) severely limiting the ability to fully assess the potential of the Wilcox. If more well data are collected in a future study the Wilcox could be more accurately evaluated.

According to TWDB reports, this aquifer yields small to moderate quantities of fresh water to a few wells in the northern part of the study area. The electric logs indicate that the water in the Wilcox is fresh in areas within a few miles of the outcrop and slightly saline in most of the remainder of the study area. In Karnes County, Wilcox water is very saline and it is usable for water supply or irrigation. Yields of wells taping the Wilcox Aquifer range mainly from 100 to 350 gallons per minute.

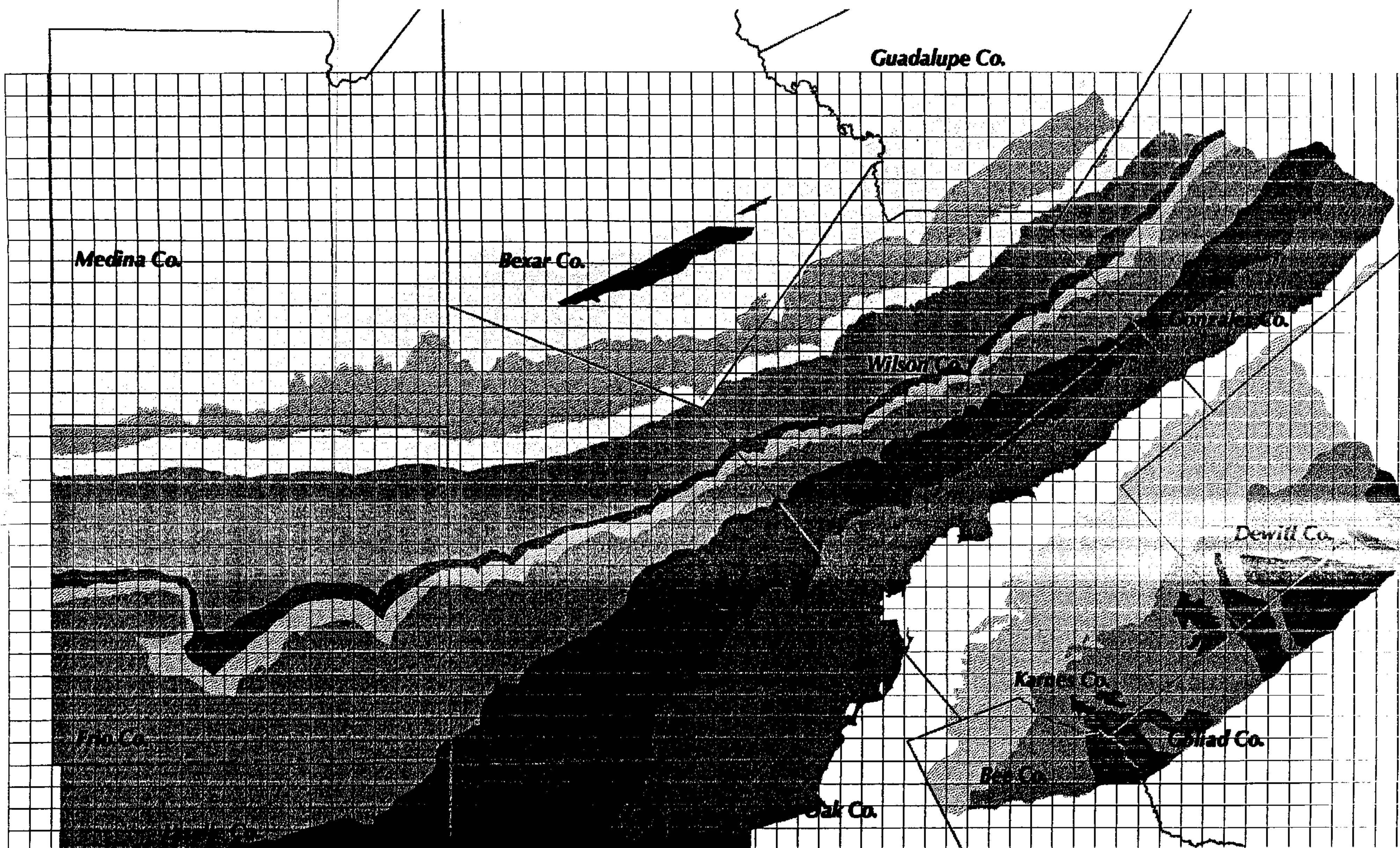
No actual data in TWDB reports were available on the distributions of aquifer transmissivity, hydraulic conductivity or storage. In its Report 210, TWDB gives an estimate of the aquifers transmissivity of 44,000 gpd per foot. The artesian storage coefficient is estimated to be 0.0005 while there are no data on the storage for unconfined (water table) conditions. Clearly, more hydrologic assessment of the Wilcox is needed.

5.2 Carrizo Sand

The Carrizo Sand Aquifer is the most important source of water supply and irrigation in the study area. It is also the aquifer with the most data available, including an extensive study on its ground-water resources (TWDB Report 210).

The Carrizo Sand overlies the older Wilcox Group and is exposed at the surface in a belt from 3 to 7 miles wide in southern Medina County, the northernmost parts of Frio and Atascosa Counties, and southern parts of Bexar and Guadalupe Counties. The Carrizo consists almost entirely of sand and contains minor amounts of shale or clay and lignite. However, in southeastern Frio County and southern Atascosa County, the electrical logs show impermeable shale lenses sometimes more than 50 feet thick.

The relative thickness of the Carrizo ranges from about 300 feet near the outcrop to about 1,000-1,100 feet in southern Atascosa County. Locations of deep wells containing information on the aquifer's top and bottom altitudes (which is part of the AACOG data base) are shown in Figure 7. Contour maps of the Carrizo Sand aquifer top and bottom are shown in Figures 8 and 9. As mentioned earlier, these maps are derived from maps included in the TWDB Report 210. Figures 8 and 9 also show the position of the "bad water line" in Karnes County, (i.e. approximate downdip limit of fresh to slightly saline water (less than 3,000 miligrams per liter dissolved solids) in the Carrizo aquifer.



Tc - Carrizo Sand
Reklaw Formation
Tcm - Cook Mountain Formation
Tct - Catahoula Tuff
Tg - Goliad Sand
Tj - Jackson Group
Tl - Lagarto Clay
To - Oakville Sandstone
Tqc - Queen City Sand
Ts - Sparta Sand
Tw - Weches Greensand
Twp - Wills Point Formation
Twu - Wilcox Group undifferentiated
Ty - Yegua Formation

Figure 2
Geologic Map of The Study Area

Source : TWDB Reports

Scale : 1 inch = 16 miles

ALAMO AREA COUNCIL OF GOVERNMENTS

Figure 3: WELLS USED FOR DEFINING THE TOP AND BOTTOM OF THE WILCOX AQUIFER

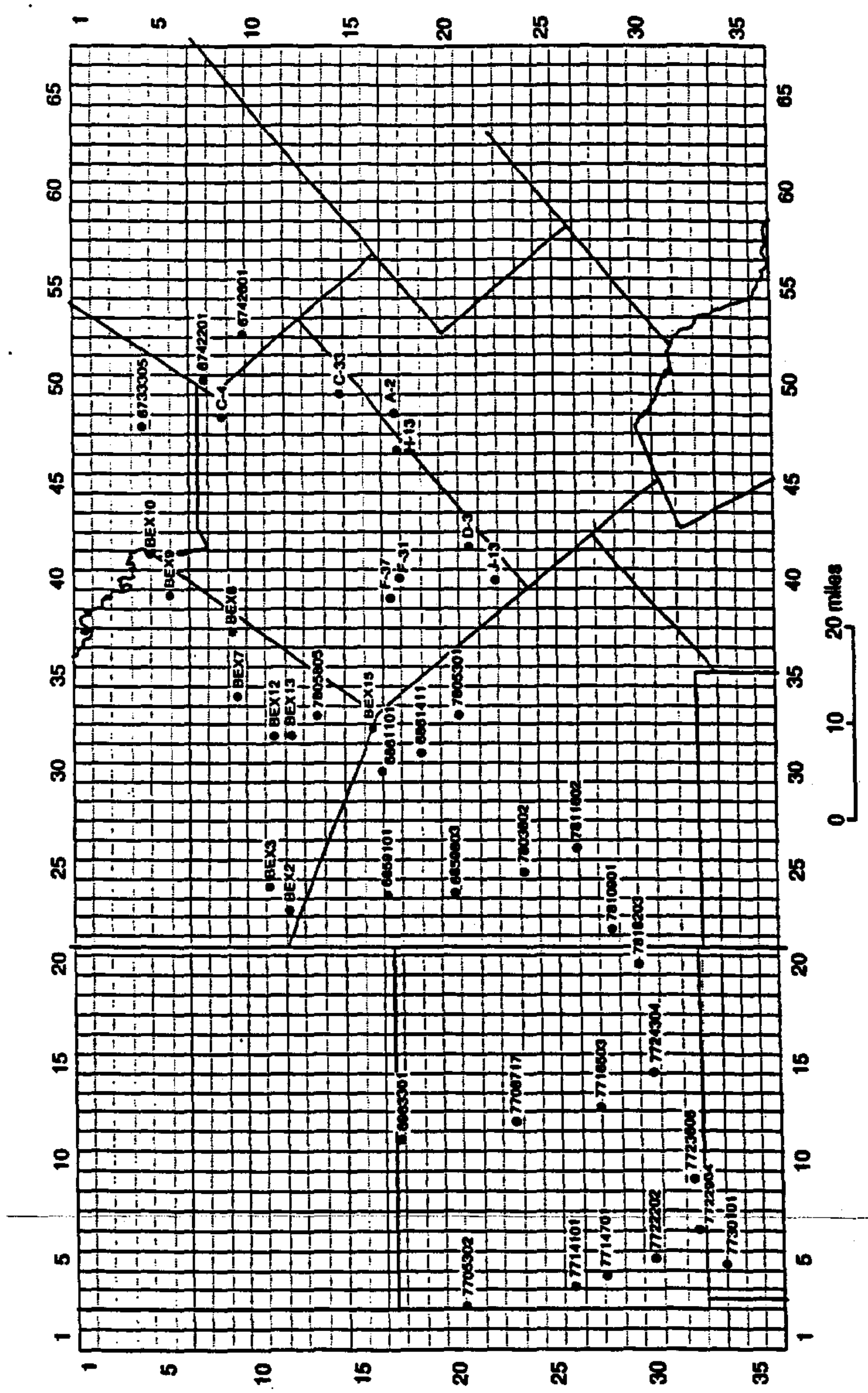


Figure 4: ALTITUDE IN FEET OF THE TOP OF THE WILCOX AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS

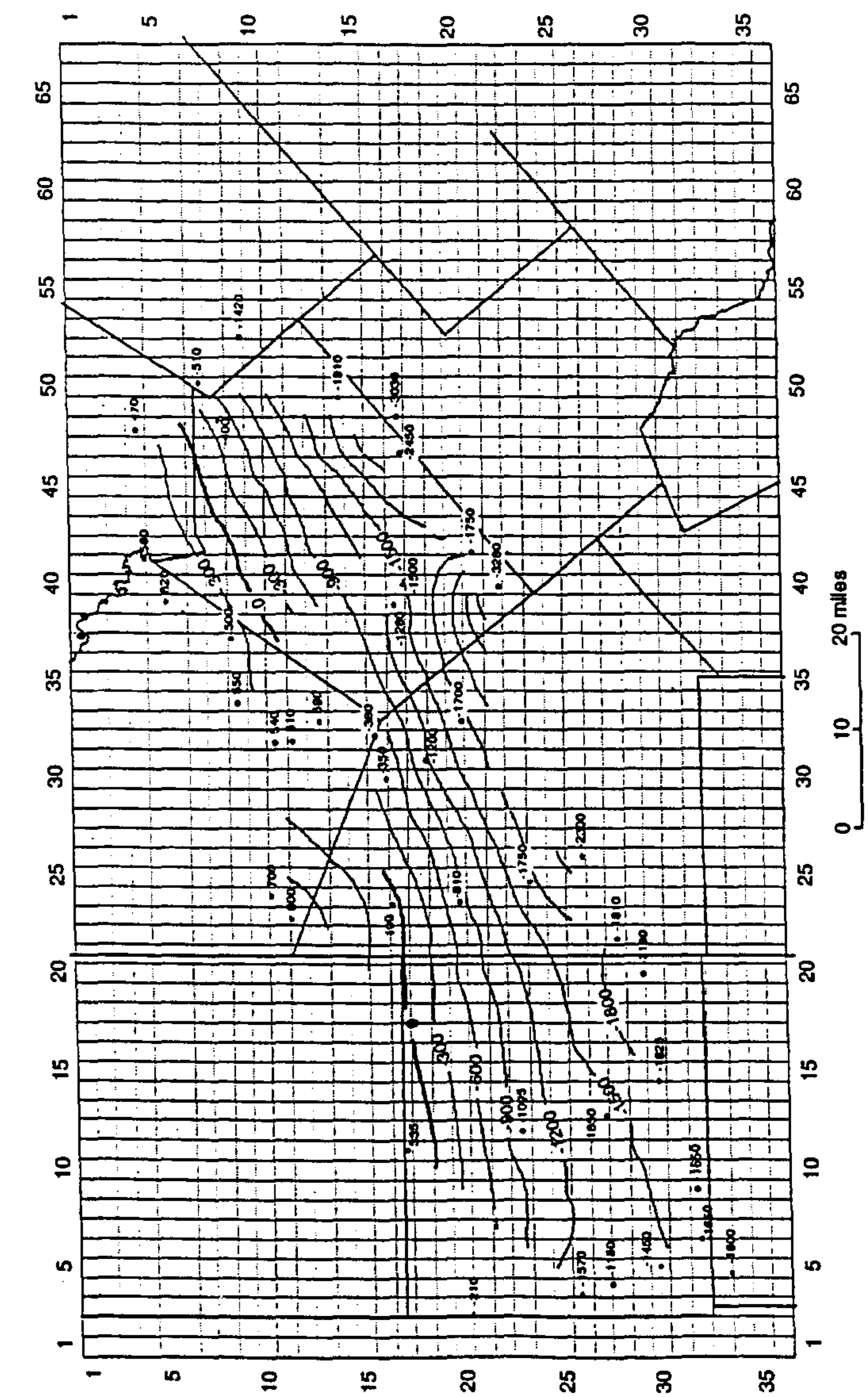
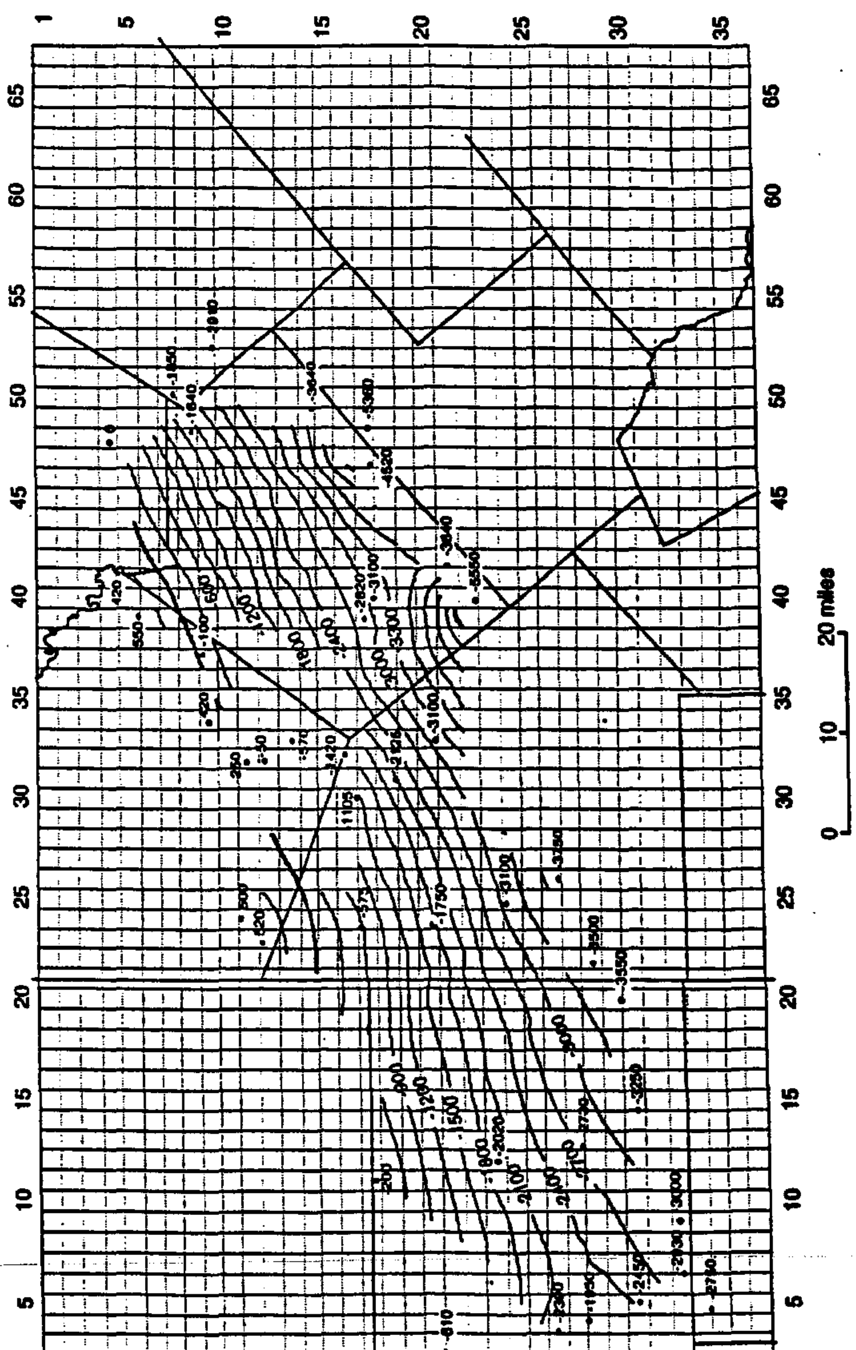


Figure 5: ALTITUDE IN FEET OF THE BOTTOM OF THE WILCOX AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS



In Atascosa County, the dip of the Carrizo is southeasterly at about 100 to 130 feet per mile. In Frio County, the dip is more southerly at about 100 feet per mile in the northern part of the county, and southeasterly at about 50 feet per mile in the southern part of the county. The Carrizo aquifer dip is deepest in southern Wilson County and north/northwestern part of the Karnes county at about 200-250 feet per mile.

Figures 10 and 11 show the altitude of water levels in the Carrizo Sand aquifer in 1970 and 1990 respectively. The maps show a general decline of 80 to 100 feet in the central parts of Frio and Atascosa counties. This decline is smaller in the northern parts of these counties and is about 40 to 60 feet. The difference may be explained by the fact that more water is pumped out of the aquifer in the northern parts of the two counties which decreases the amount available for withdrawal in the central and southern parts. The most obvious effect is around Campbellton in southeastern Atascosa County where the decline is 120 feet. This area has the lowest registered groundwater levels in both 1970 and 1990 indicating very heavy pumping. However, pumpage data in the area provided by AACOG, coupled with other information on this part of the Carrizo (thickness, hydraulic conductivity), when simulated with the preliminary, regional groundwater model do not produce the observed drawdown. Part of the explanation, in addition to the indicated low hydraulic conductivity (see Figure 12), may be a low efficiency of the water well(s).

The decline in groundwater level seems much better in Wilson County compared to Frio and Atascosa Counties. Although data available are not sufficient for a more exact evaluation (nearly the entire southern and eastern parts of Wilson County are without data on groundwater levels in 1990), it seems that the decline is about 20 feet. Assessment on groundwater levels and its possible decline could not be made for Karnes county since only one measurement was available.

A "Digital Computer Mathematical Model" developed by the TWDB (Report 210) predicted a maximum decline of water levels in the Carrizo aquifer of only 20 to 40 feet throughout the study area in the 1970-1990 period. Part of the explanation may be inaccurately estimated groundwater withdrawal from the aquifer used in the model. Another possible reason for largely underestimating water levels declines by the model during the period 1970-1990 is an overestimated leakage to the aquifer from other aquifers.

Figure 12 shows the distribution of hydraulic conductivity (permeability) in the Carrizo sand aquifer based on the map covering the Winter Garden Area and is included in the TWDB Report 210. This aquifer parameter is, together with the aquifer thickness and storage, essential for determining groundwater flow rates and available reserves. Hydraulic conductivity of the Carrizo is generally highest in the outcrop zone (about 50 to 60 feet/day on average) and decreases toward the south and southeast. It is lowest in the area closest to the "bad water line" which is an approximate downdip limit of fresh to slightly saline water (less than 3,000 miligrams per liter dissolved solids) in the Carrizo aquifer. This line extends from northeast toward southwest through central parts of Karnes

Figure 6: ALTITUDE OF WATER LEVELS IN THE WILCOX AQUIFER, 1990 (WELL ID/WATER LEVEL ALTITUDE)

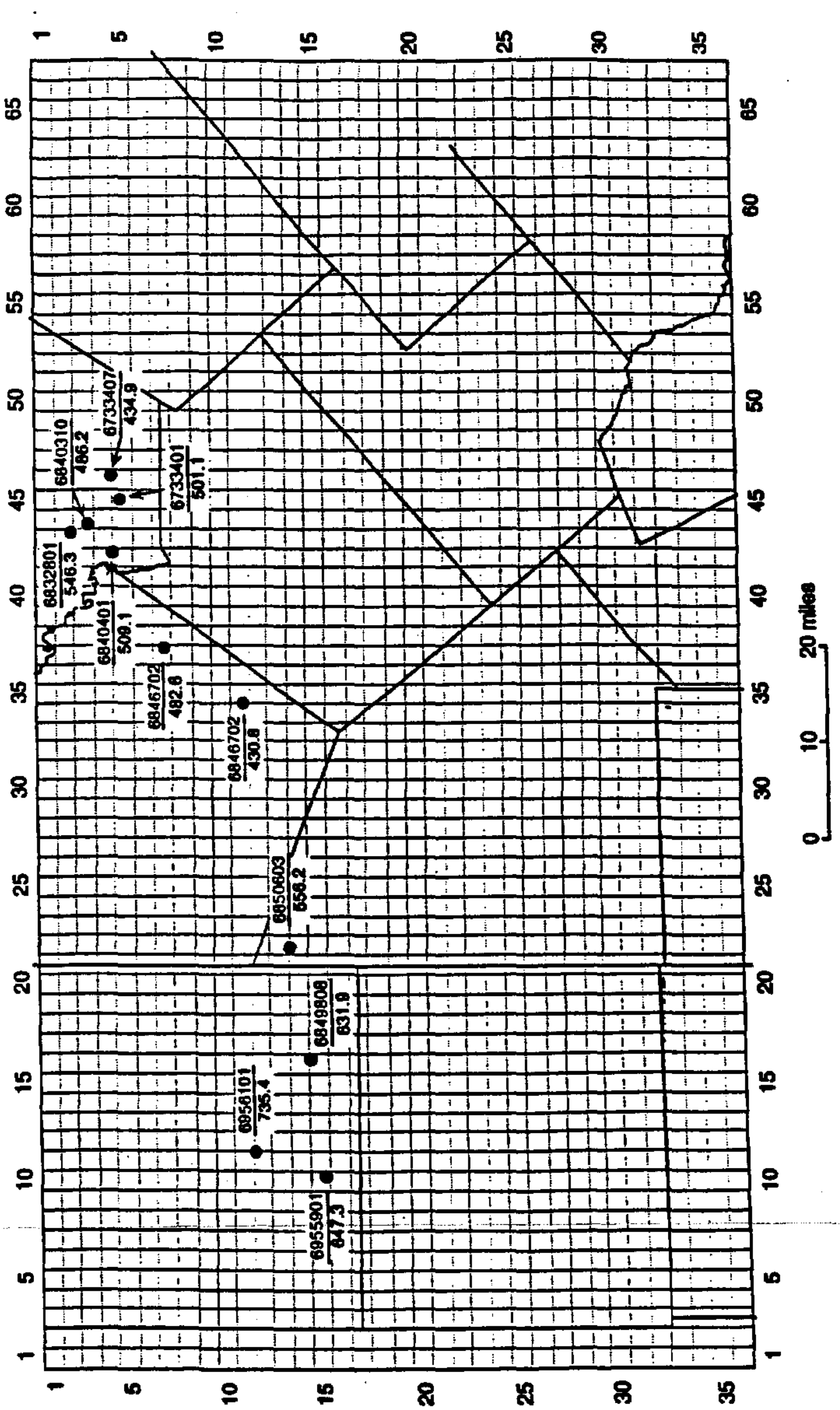
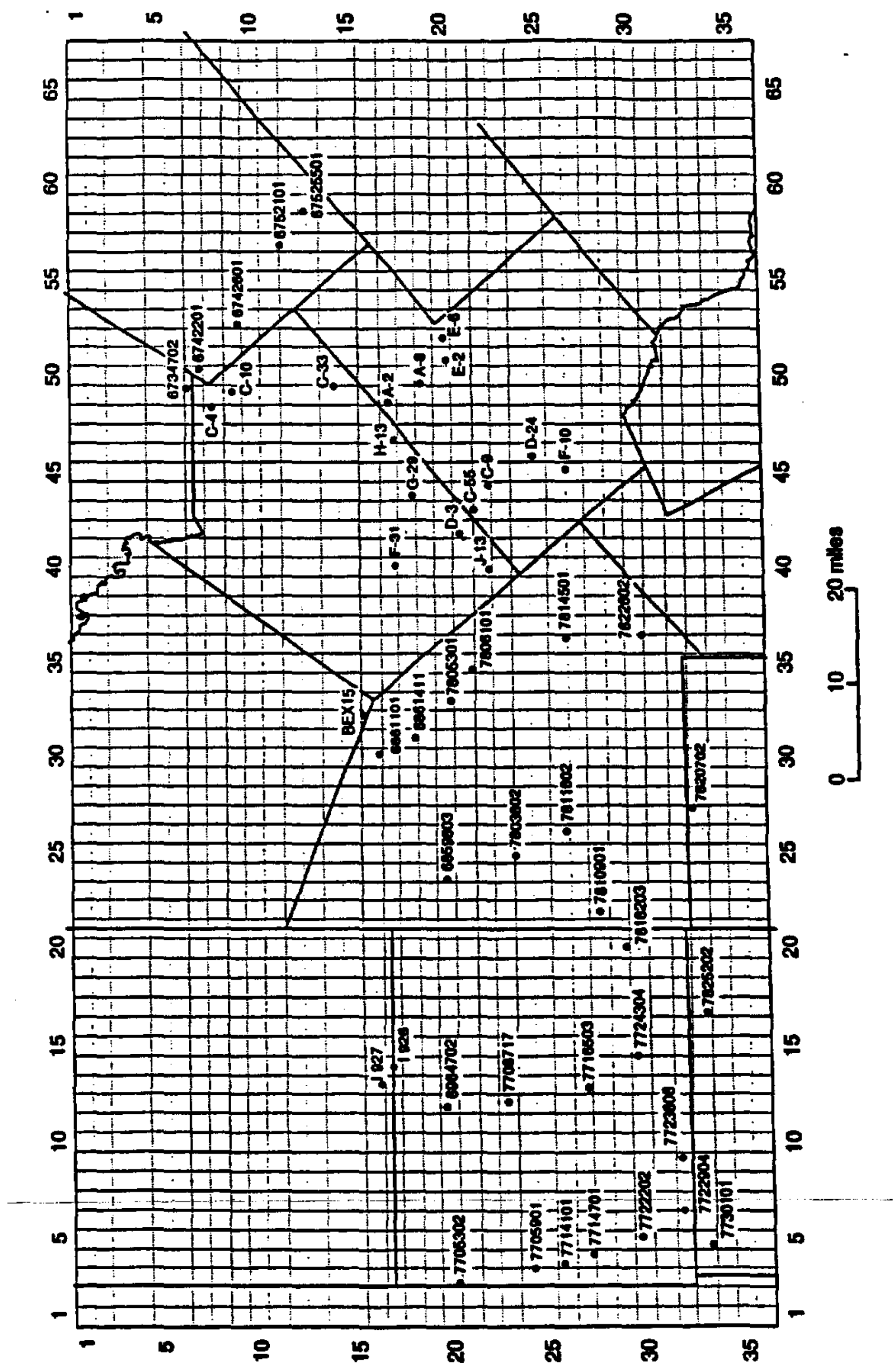


FIGURE 7: DEEP WELLS WITH ELECTRIC LOGS AND THE INFORMATION ON THE TOP AND THE BOTTOM OF THE CARRIZO SAND



county.

The average coefficients of transmissivity determined from tests of 12 wells tapping the Carrizo in Frio and Atascosa Counties ranged from 36,000 gallons per day per foot at Dilley to 150,000 gpd per foot near Poteet and Pleasanton (Report 32 and Bulletin 5710). A pumping test at Floresville, Wilson County, showed the transmissivity of 29,000 gpd per foot and the coefficient of storage of 0.00014. Report 210 gives the following largest transmissivities found in Atascosa, Frio and Wilson Counties: 317,000 gpd/ft, 230,000 gpd/ft and 301,000 gpd/ft respectively. The average coefficient of storage in the outcrop, under water table conditions, is estimated to be 0.25. Downdip, where the aquifer is confined, the average coefficient of storage is approximately 0.0005 (Report 210). There were no aquifer tests reported for Karnes County.

The Carrizo Sand yields large quantities of fresh water to over 1,300 registered (until 1988) wells in the study area. Its heavy pumpage continues to cause large-scale declines of water levels throughout the study area as explained earlier and shown in Figures 10 and 11. That portion of the Carrizo that lies beneath the southern half of Karnes County is not heavily pumped because of high total dissolved solids (TDS) in the groundwater. The aquifer's "bad water line" bisects the county (an approximate downdip limit of fresh to slightly saline water with less than 3,000 milligrams per liter TDS, is shown in Figures 8 through 12).

5.3 Queen City Sand

The Queen City Sand aquifer conformably overlies the Reklaw Formation which separates it from the Carrizo Sand aquifer. It crops out in a belt from 6 to 12 miles wide south or southeast of the Reklaw outcrop (see Figure 2). The Queen City is composed of beds of medium to fine sand, sandy clay, silty clay, and shale. The thickness of the Queen City Sand in the study area ranges from about 600 feet in the outcrop area to over 1,200 feet in southeastern Atascosa County. Figures 13 and 14 show altitudes of the aquifer's top and bottom as determined from the deep-well logs data base provided by AACOG.

Average transmissivity of the Queen City aquifer determined by several pumping tests at Pleasanton is 12,000 gpd per foot which, when divided by the aquifer thickness, yields the value of hydraulic conductivity of 60 gpd per square foot. Storage coefficients of the aquifer are about 0.0001. TWDB estimates an average transmissivity of the Queen City Sand aquifer to be 14,000 gpd per foot in the Winter Garden Area (Report 210) but its actual distribution remains unknown. While there are no estimates on the storage in unconfined conditions, the artesian storage coefficient is estimated to be 0.0005

The aquifer water levels measured in 1990 (most recent year with most data) are shown in Figure 15. With the exception of one measurement in east-central Atascosa County, all data are from

Figure 8: ALTITUDE OF THE TOP OF THE CARRIZO SAND AQUIFER CONTOUR INTERVAL IN FEET (FROM TWDB REPORT 210)

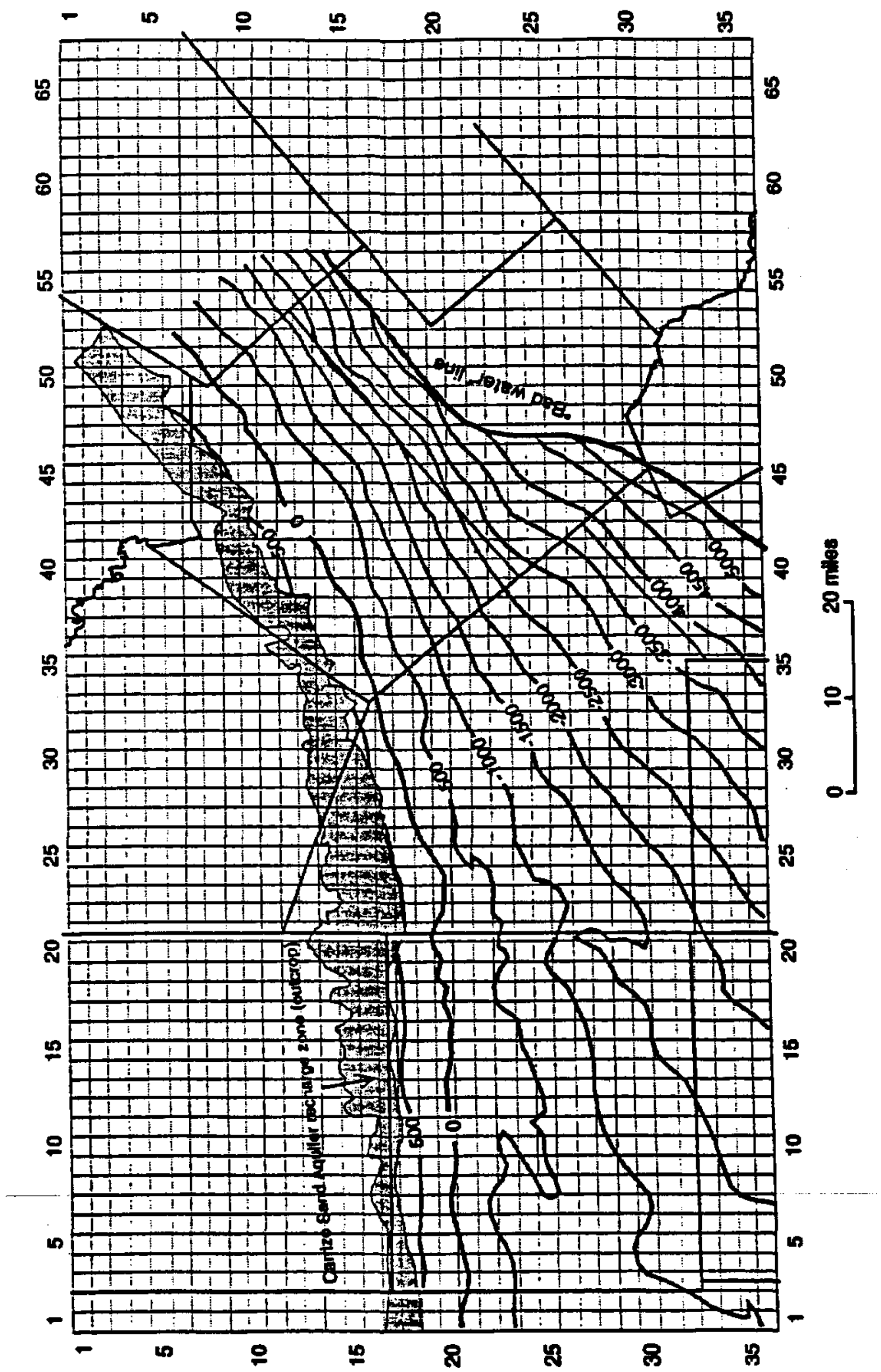


Figure 9: ALTITUDE OF THE BOTTOM OF THE CARRIZO SAND AQUIFER CONTOUR NTERVAL IN FEET (FROM TWDB REPORT 210)

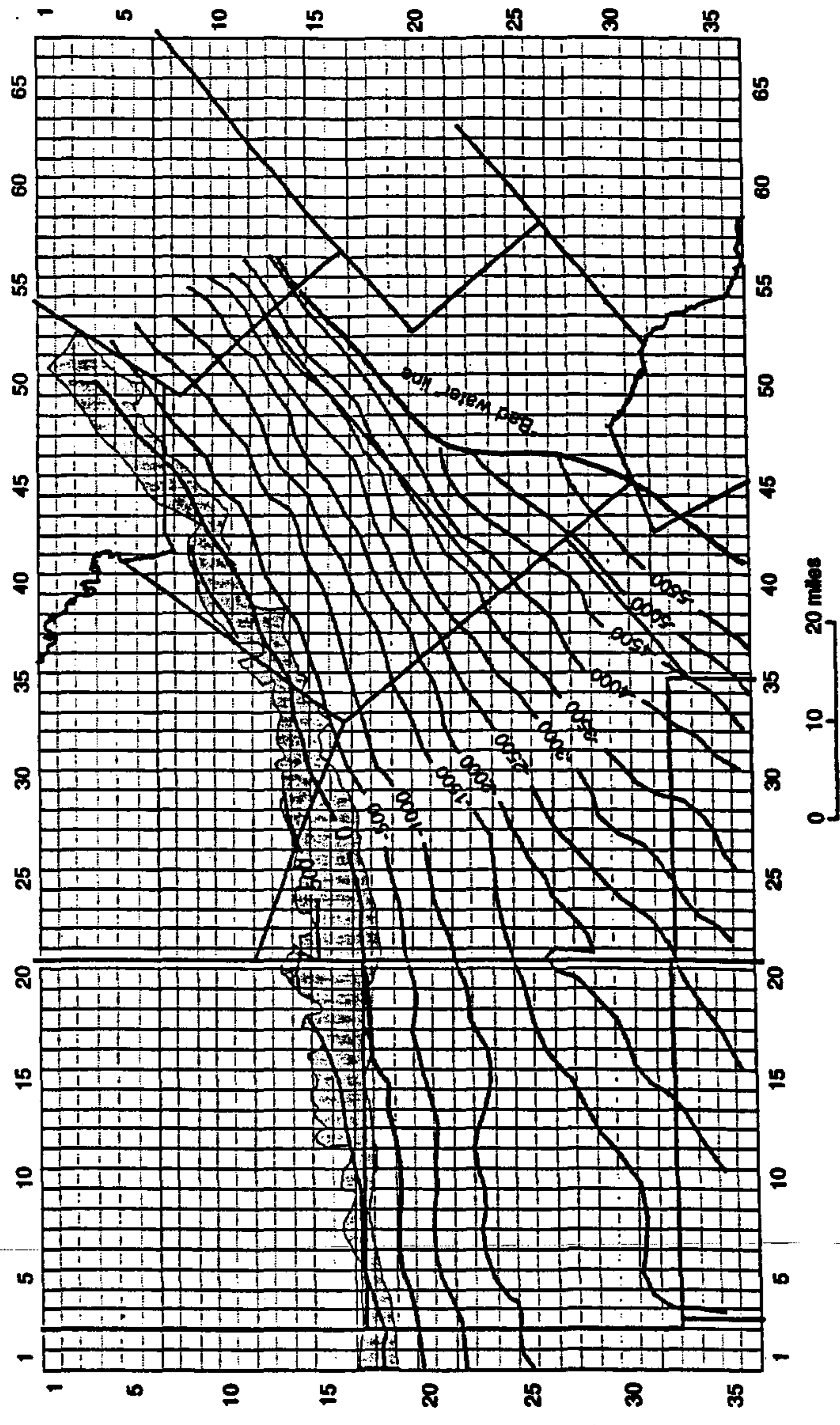


Figure 10: ALTITUDE OF WATER LEVELS IN THE CARRIZO SAND AQUIFER, 1970 CONTOUR INTERVAL 20 FEET (FROM TWDB REPORT 210)

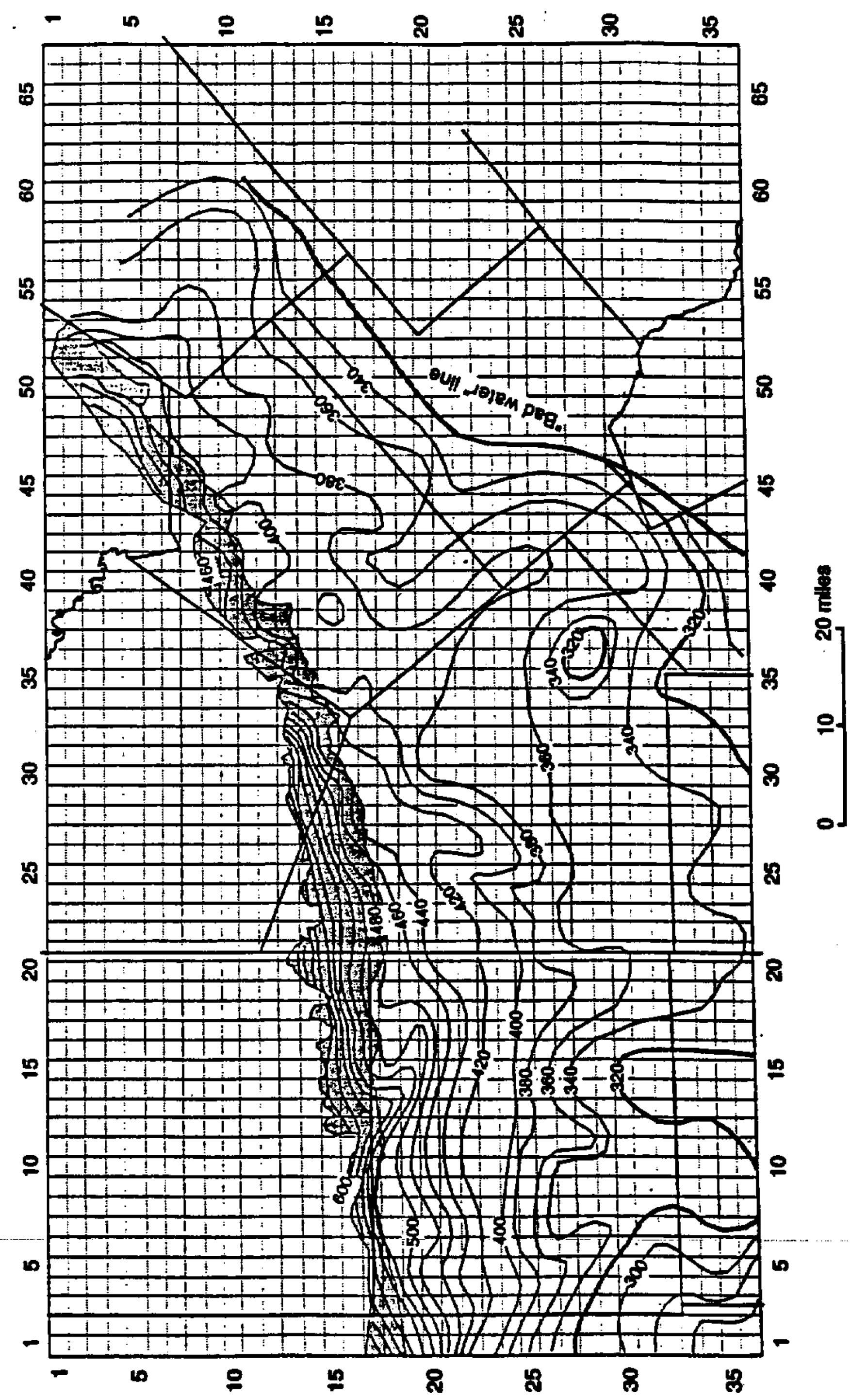


Figure 11: ALTITUDE OF WATER LEVELS IN THE CARRIZO SAND AQUIFER, 1990 WITH POINTS OF MEASUREMENT. CONTOUR INTERVAL 20 FEET.

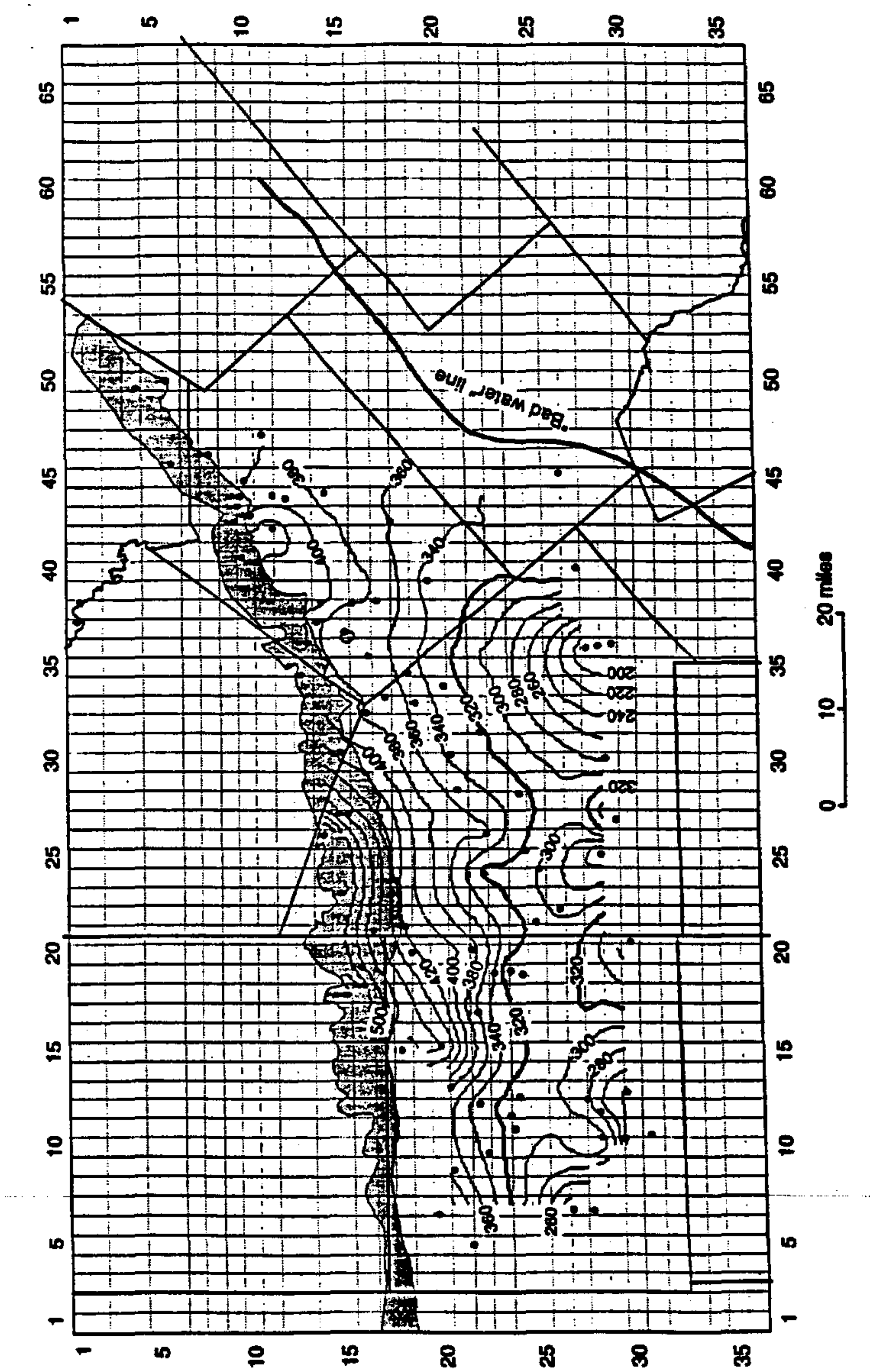
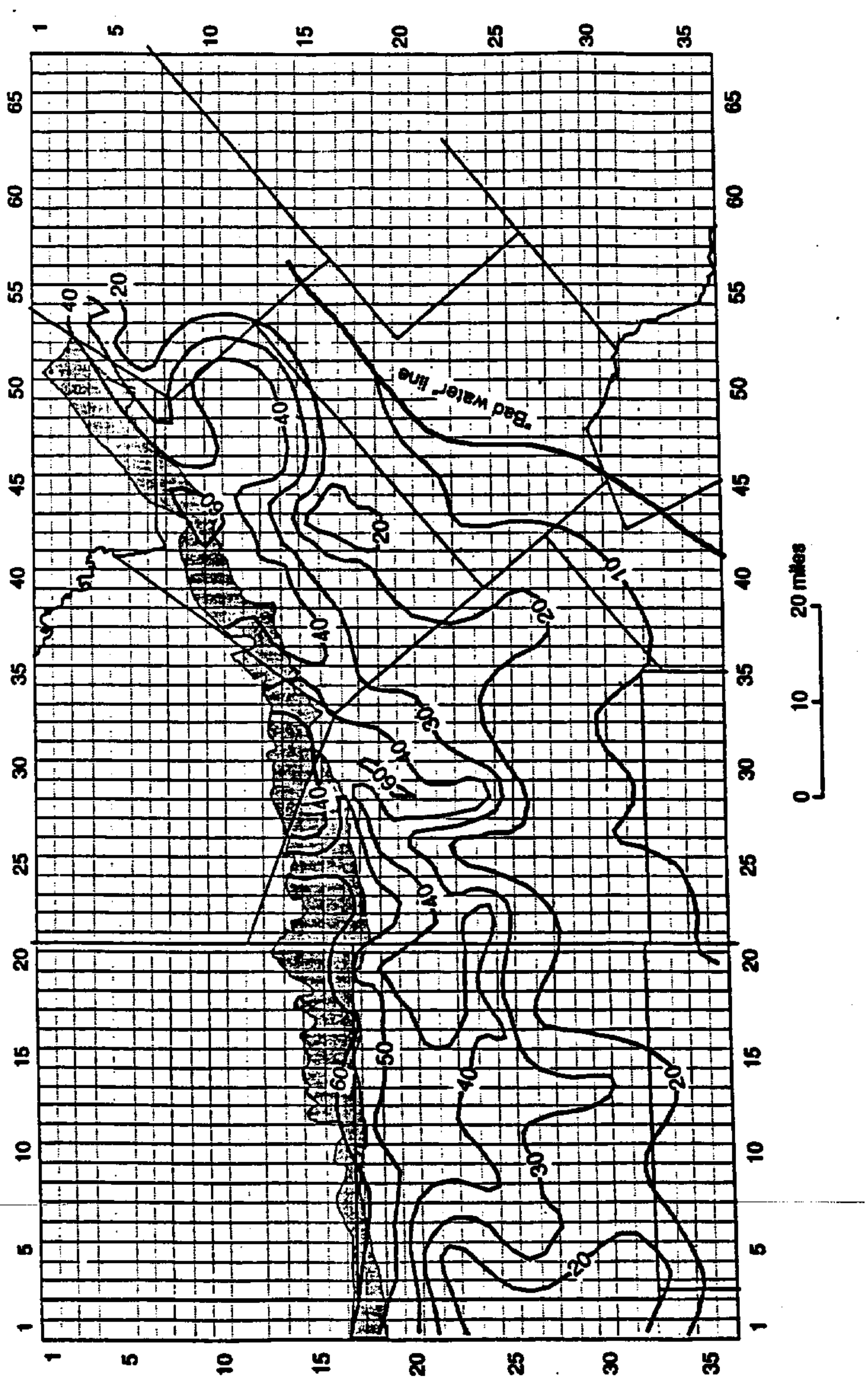


Figure 12: HYDRAULIC CONDUCTIVITY OF THE CARRIZO SAND AQUIFER CONTOUR LINE INERVAL 10 FEET/DAY (ADAPTED FROM TWDB REPORT 210)



wells in or very close to the aquifer recharge zone (outcrop). The amount and distribution of data is not sufficient for determining hydraulic gradients and, consequently, flow rates of fresh water in the aquifer. An attempt to estimate groundwater flow characteristics in the Queen City Sand aquifer was made by designing a preliminary, regional groundwater model (see Section 8).

According to TWDB (Bulletin 5710), "In most places the Queen City Sand aquifer yields only small amounts of water to domestic and stock wells. Nevertheless, moderate to relatively large yields of water of good quality are obtained in places in and near the area of outcrop where the sands are relatively massive and more permeable. For example, two wells, C-24 and C-25, supply enough water for the city of Stockdale, and well G-47, an irrigation well, yielded 800 gpm during a pumping test. In many areas where the Queen City exceeds a thickness of 300 feet, yields of 200 to 600 gpm may be expected from properly constructed wells."

The approximate position of the "bad water line" in the Queen City Sand, as shown in the Texas Water Commission Report 89-01 ("Ground-Water Quality of Texas", 1989), is given in Figure 13. Interpretations of electric logs indicate the Queen City aquifer does not contain fresh water in Karnes County, the southeastern part of Atascosa County, or the western (larger) half of Frio County.

5.4 Sparta Sand

The Sparta Sand aquifer conformably overlies the Weches, which separates it from the Queen City Sand, and crops out in a belt less than half a mile to more than 4 miles wide south or southeast of the Weches outcrop (Figure 2). The Sparta consists of sand, most of which is in the upper two-thirds, and clay. The thickness of the Sparta ranges from few tens of feet in the outcrop area to about 110 feet in the confined area. In Atascosa County, the dip of the Sparta is southeasterly at about 100 feet per mile, except in the south eastern part of the county where it is more than 150 feet per mile (TWDB Report 32). In most of Frio County the dip is southerly at about 30 feet per mile. Figures 16 and 17 show locations of deep wells that have information on Sparta Sand's top and bottom altitudes.

Aquifer parameters of the Sparta Sand are not available for the study area. Tests of three wells that tap the aquifer in La Salle County showed transmissivities between 1,000 and 3,500 gpd per foot. TWDB estimated an average transmissivity of the Sparta Sand aquifer to be 5,000 gpd per foot for the Winter Garden Area (Report 210). Its actual distribution in the study area remains unknown. While there are no estimates on the storage for water table conditions, the artesian storage coefficient is estimated to be 0.0001

Figure 18 shows eight wells with the information on water levels measured during 1990 as provided by AACOG. The amount and distribution of data are insufficient for estimating the piezometric surface, aquifer hydraulic gradient and groundwater flow rates.

Figure 13: ALTITUDE IN FEET OF THE TOP OF THE QUEEN CITY SAND AQUIFER WITH WELL POINTS (BASED ON THE WELL LOG DATA FROM TWDB REPORTS)

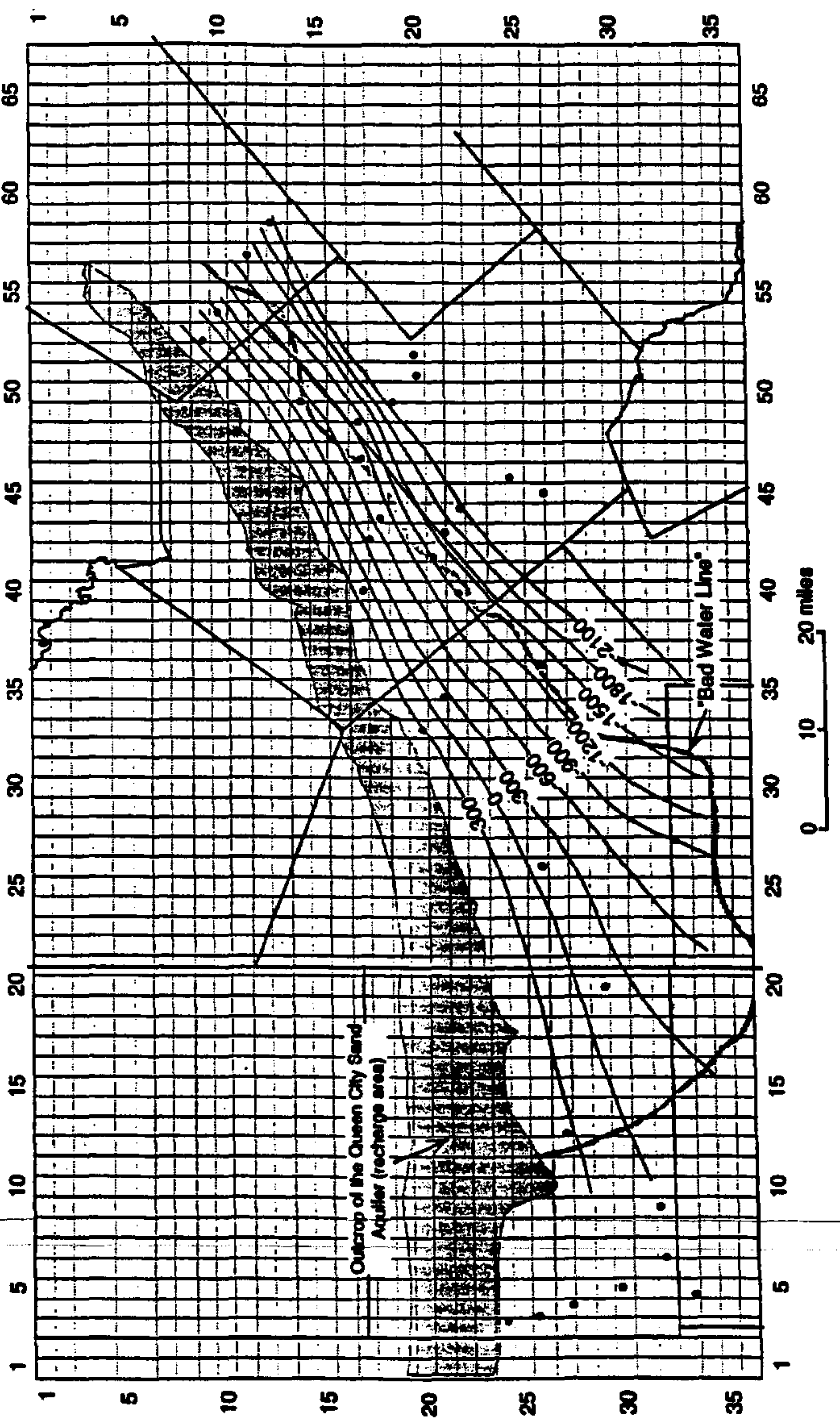
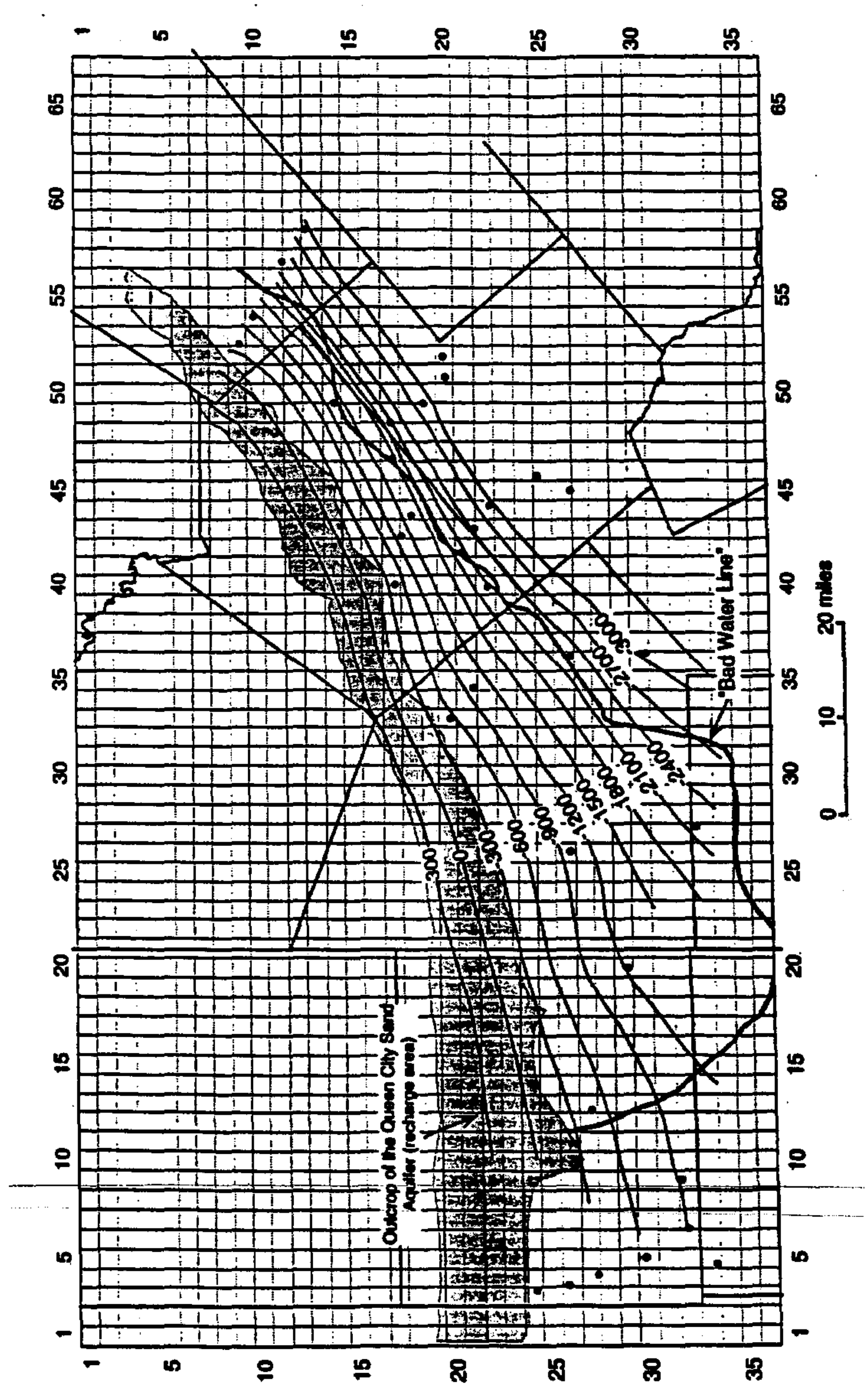


Figure 14: ALTITUDE IN FEET OF THE BOTTOM OF THE QUEEN CITY SAND AQUIFER WITH WELL POINTS (BASED ON THE WELL LOG DATA FROM TWDB REPORTS)



According to TWDB (Bulletin 5710), although the Sparta Sand aquifer is tapped by only a few wells in Wilson County, it yields small to moderate amounts of potable water in the southeastern half of the outcrop belt and for a mile or more downdip from the surface contact with the Cook Mountain Formation overlying it. In most of the area southeast of the Sparta-Cook Mountain surface contact, the water in the Sparta is under artesian pressure and wells tapping the Sparta flow in some low-lying areas. Although the Sparta is not used as a source of irrigation water in Wilson County, it seems likely that enough water to irrigate small tracts could be obtained from the formation.

The position of the "bad water line" in the Sparta Sand is similar to that of the Queen City Sand: aquifer groundwater is not potable for public supply or irrigation in the entire Karnes County, south-southeastern part of Wilson County and southeastern part of Atascosa County.

5.5 Catahoula Tuff

In the study area, the Catahoula Tuff is present only in Karnes County where it is one of the principal aquifers. The Catahoula unconformably overlaps the Frio Clay and the upper part of the Jackson Group (see Figure 2). The formation crops out in a belt that ranges in width from about 3 miles in the northeastern part of the county to about 10 miles in the southwestern part. The Catahoula Tuff consists predominantly of tuff, tuffaceous clay, sandy clay, bentonitic clay, and discontinuous lenses of sandstone. The formation also contains thin beds of sulfur enriched lignite and a few beds of limestone. According to TWDB (Bulletin 6007), "The exact thickness of the Catahoula in the subsurface was not determined because it cannot be distinguished on electric logs from the underlying Frio Clay, which is included with it on the geologic sections". Figures 19 to 21 show locations of deep wells with logs and approximate altitudes of the Catahoula top and bottom. As can be seen from the figures, there are no data on the aquifer thickness in its outcrop area. Thickness estimates by the TWDB of over 1,500 to 2,000 feet in the far southeastern part of the county may be inaccurate.

Aquifer pumping tests of two water wells at Karnes City yielded values of transmissivity of 1,400 to 2,100 gpd/ft, and a coefficient of storage of 0.00004. Values of hydraulic conductivity for these tests were not available.

Figure 22 shows water levels registered in 1990 (year with most data available) for (only) 6 wells in the Catahoula Tuff aquifer as provided by AACOG. Only one of the wells is in the aquifer's confined part, so the data are insufficient for determining the aquifer's piezometric surface, hydraulic gradients, and for calculations of groundwater flow rates.

The Catahoula Tuff is one of the principal aquifers in Karnes County and the only shallow source of fresh to slightly saline water in its area of outcrop (the Carrizo Sand aquifer is the first next available source of water supply in northern/western parts of the Karnes County at depths of more than 3,000 feet below the surface). Most of the municipal supply for Karnes City and part of the

Figure 15: ALTITUDE OF WATER IN THE QUEEN CITY SAND AQUIFER, 1990. (WELL ID/WATER LEVEL ALTITUDE)

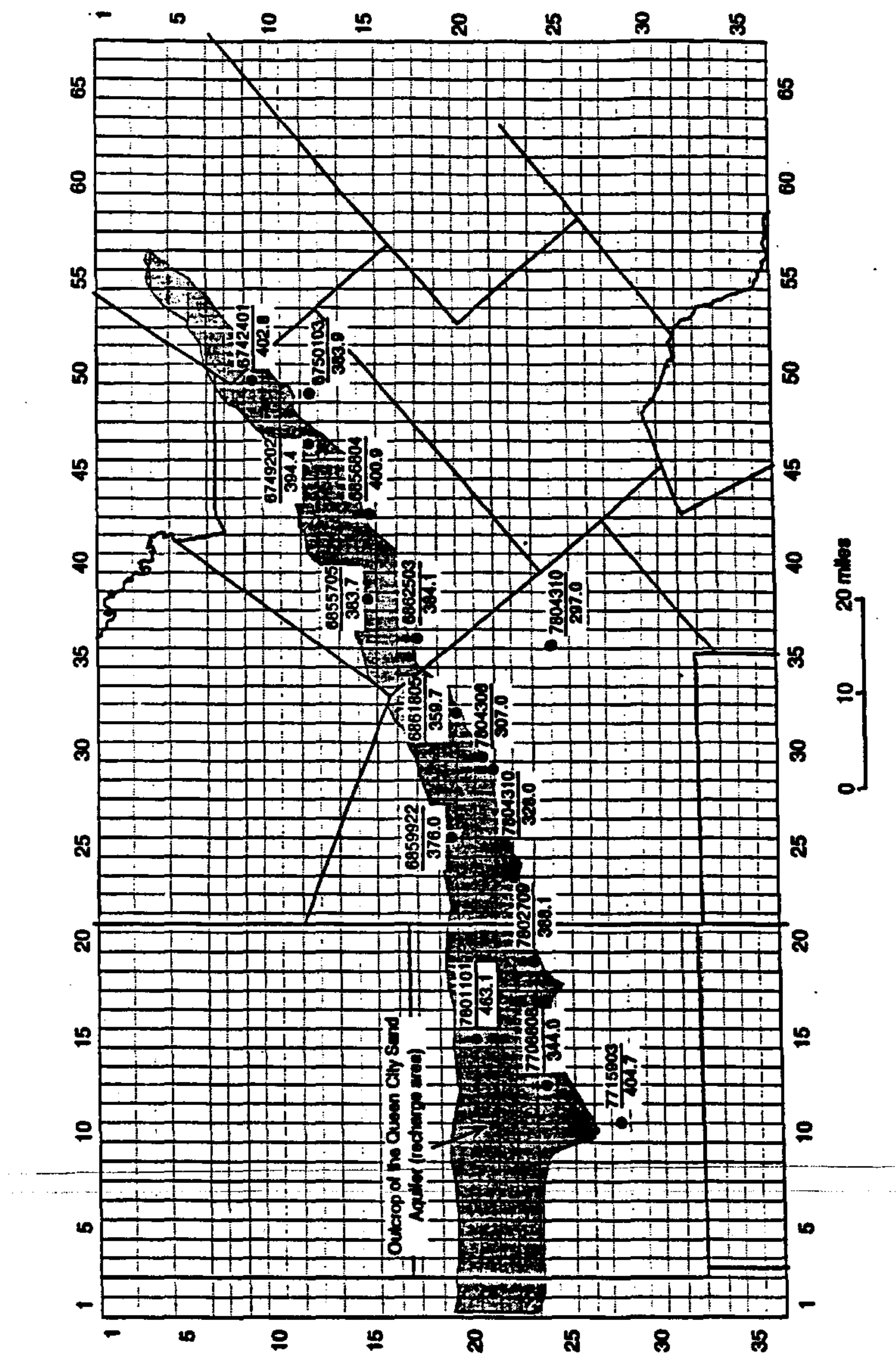


Figure 16: ALTITUDE IN FEET OF THE TOP OF THE SPARTA SAND AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS

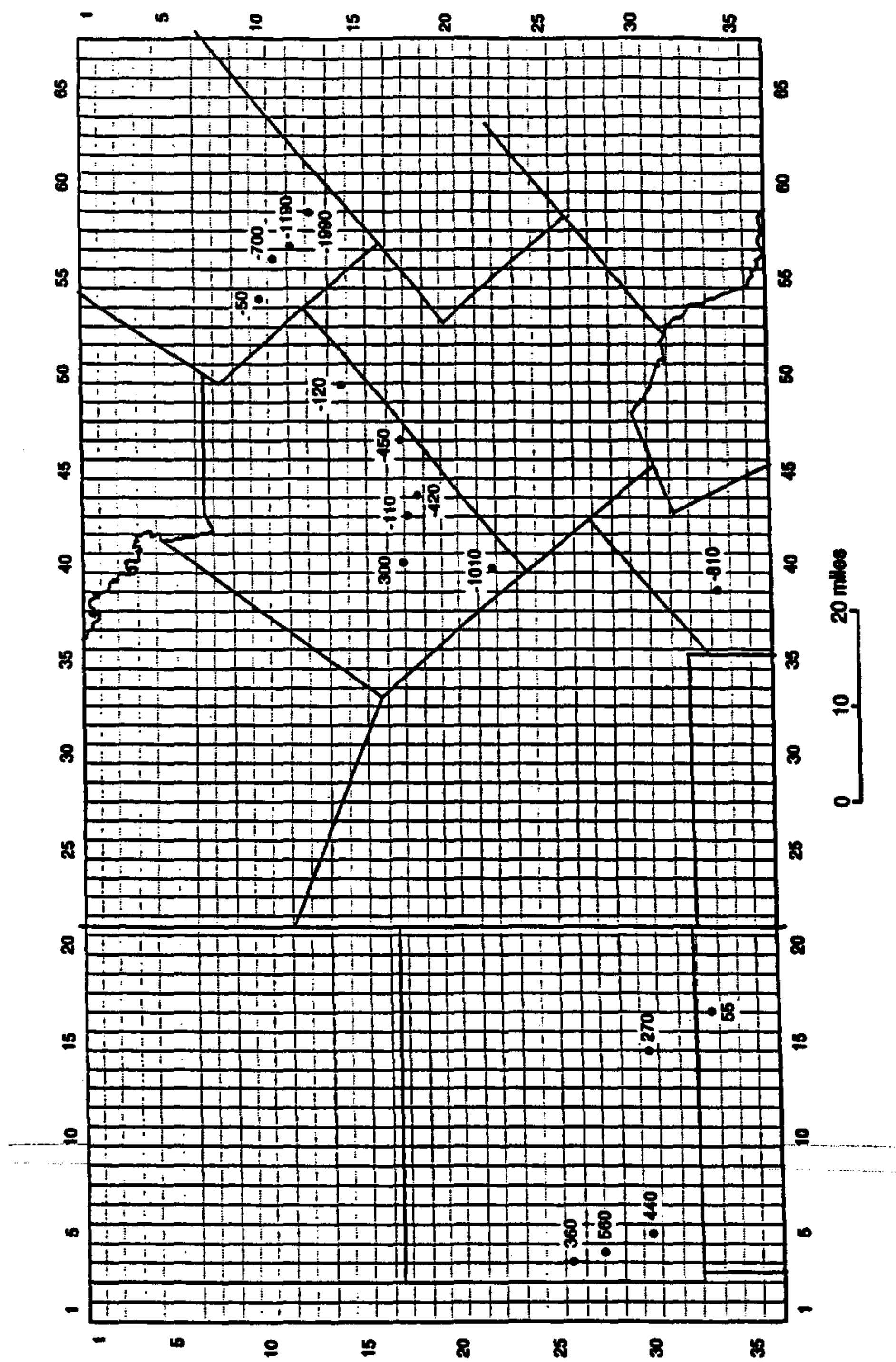


Figure 17: ALTITUDE IN FEET OF THE BOTTOM OF THE SPARTA SAND AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS

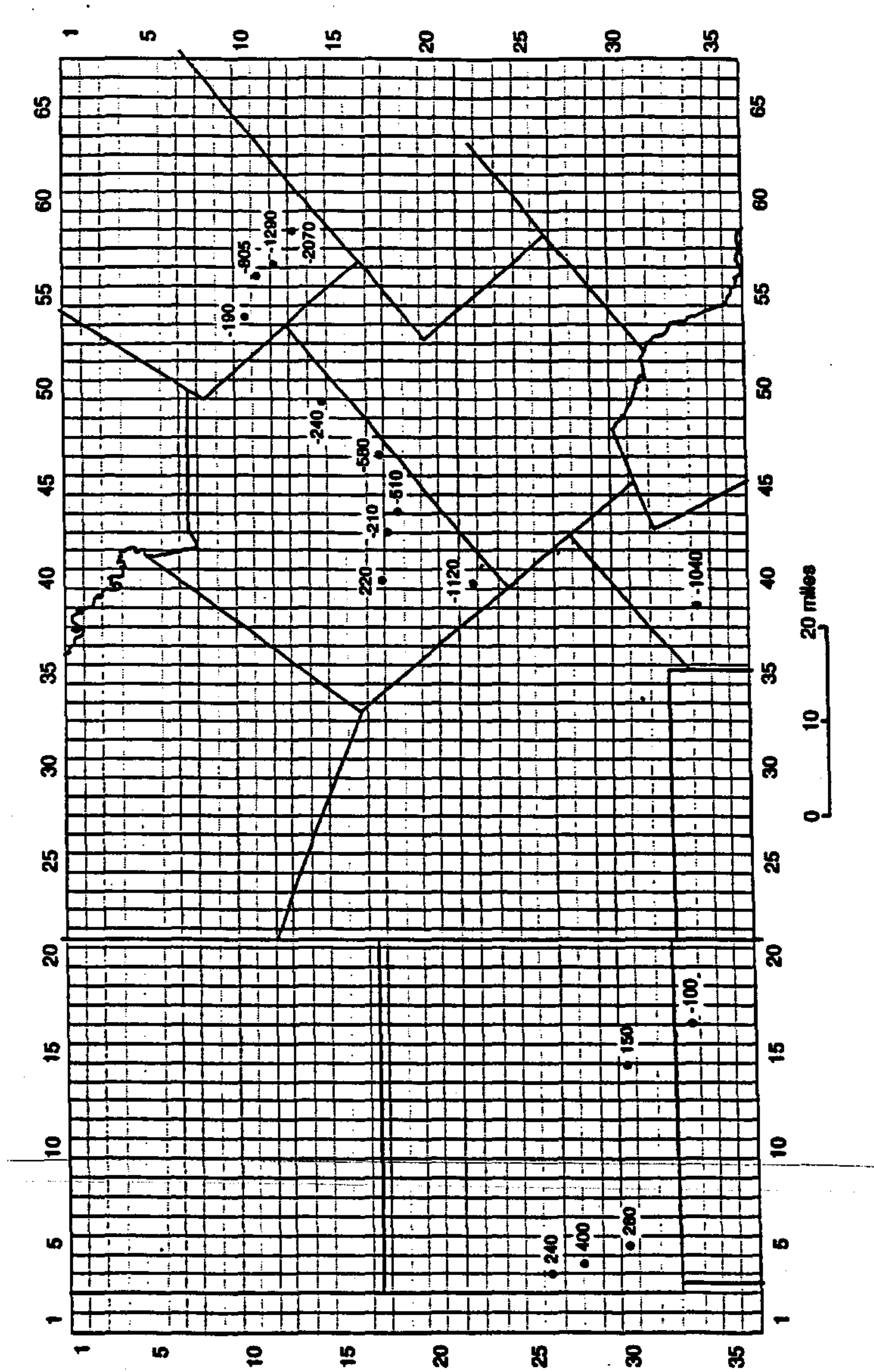


Figure 18: ALTITUDE OF WATER LEVELS IN THE SPARTA SAND, 1990. (WELL ID/WATER LEVEL ALTITUDE)

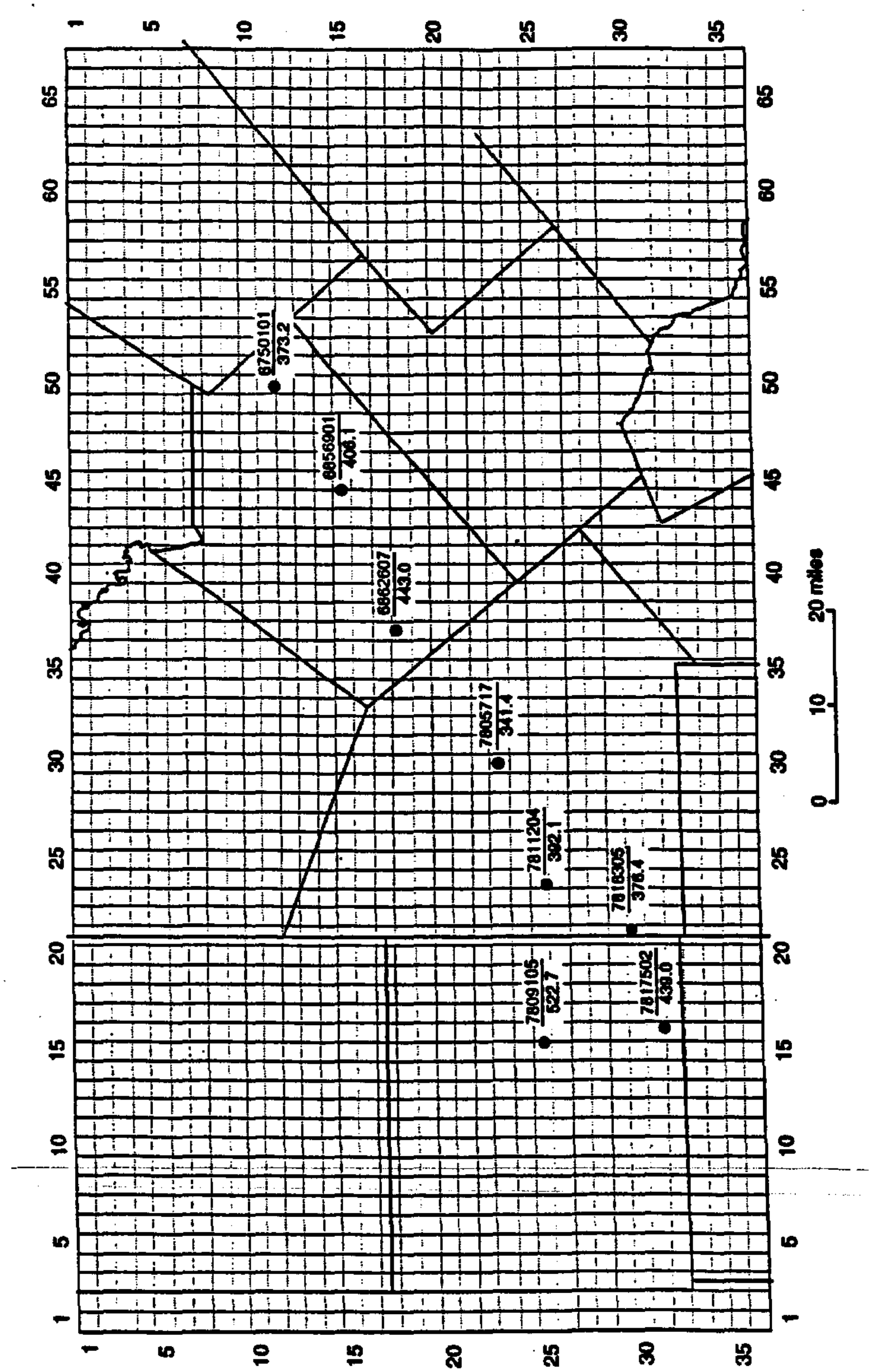


Figure 19: WELLS WITH LOGS USED TO DETERMINE THE TOP AND THE BOTTOM OF THE CATAHOULA TUFF AQUIFER (FROM TWDB BULLETINS 6007 AND 6518)

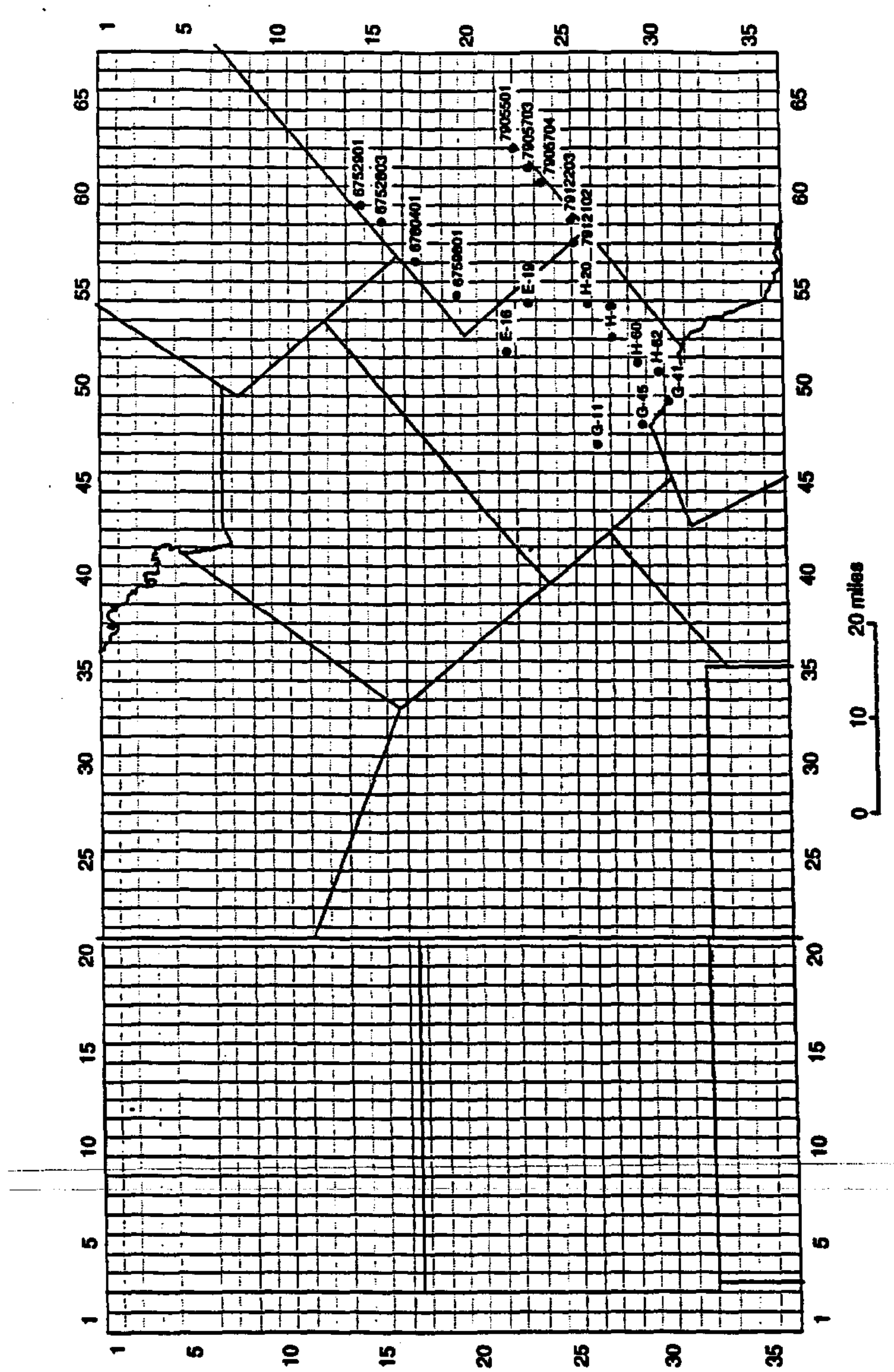


Figure 20: ALTITUDE IN FEET OF THE TOP OF THE CATAHOULA TUFF AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS

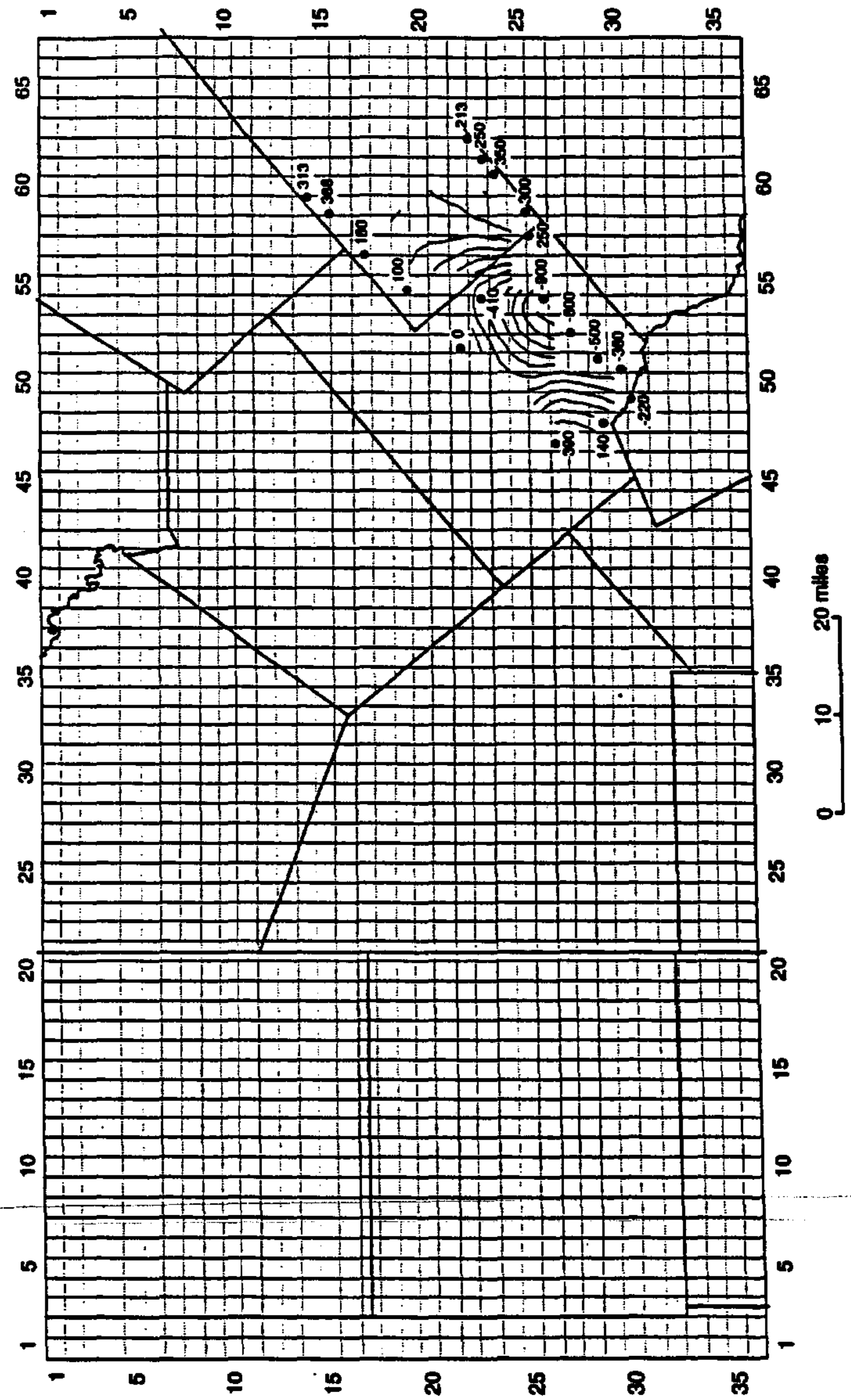
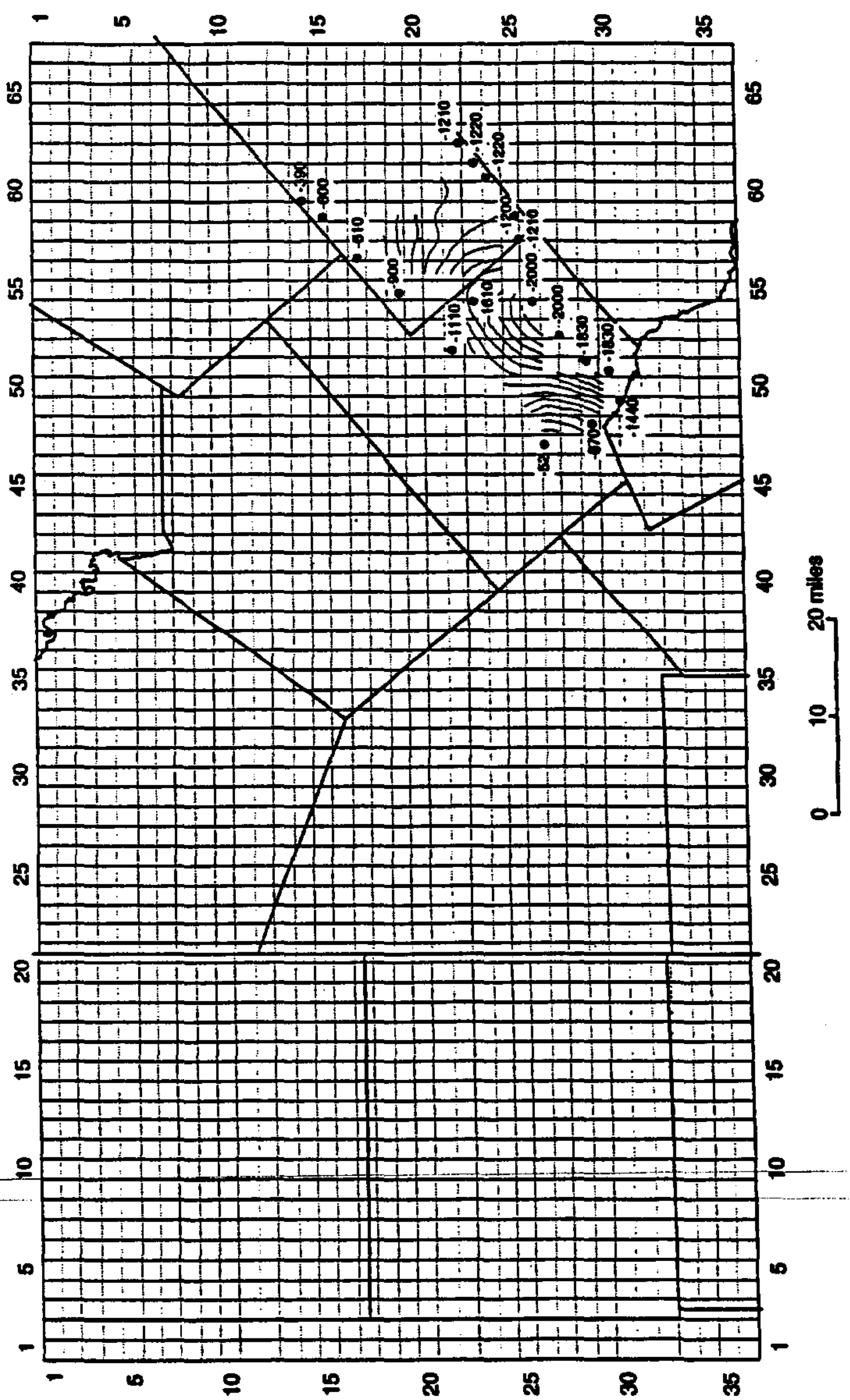


Figure 21: ALTITUDE IN FEET OF THE BOTTOM OF THE CATAHOULA TUFF AQUIFER BASED ON THE WELL LOG DATA FROM TWDB REPORTS



supply for Kenedy is obtained from wells tapping the Catahoula Tuff.

5.6 Oakville Sandstone

The Oakville Sandstone, the principal aquifer in Karnes County, unconformably overlies and partly overlaps the Catahoula Tuff. In some areas, the contacts of the Catahoula and the Oakville cannot be distinguished by electric logs because relatively thick beds of sand near the top of the Catahoula are similar to those in the Oakville (Bulletin 6007). The outcrop, 8 miles wide in the northeastern part of the county, broadens to 11 miles along the San Antonio River, and narrows to 7 miles in the southern part of the county (Figure 2).

According to TWDB, the base of the Oakville dips gulfward an average of 85 feet per mile. Where the full section is present, the Oakville ranges in thickness from about 500 feet in southern Karnes County to 800 feet in the east-central part of the county.

In Karnes County, the Oakville is composed of cross-bedded medium-to-fine-grained sand and sandstone, and sandy, ashy, and bentonitic clay beds. It yields large quantities of fresh to slightly saline water to some irrigation wells and to the municipal wells at Runge and Kenedy. Small quantities of fresh to slightly saline water are obtained from many domestic and stock wells. The thin beds of sand yield only small supplies of moderately saline water about 5 miles southwest of Kenedy (Bulletin 6007).

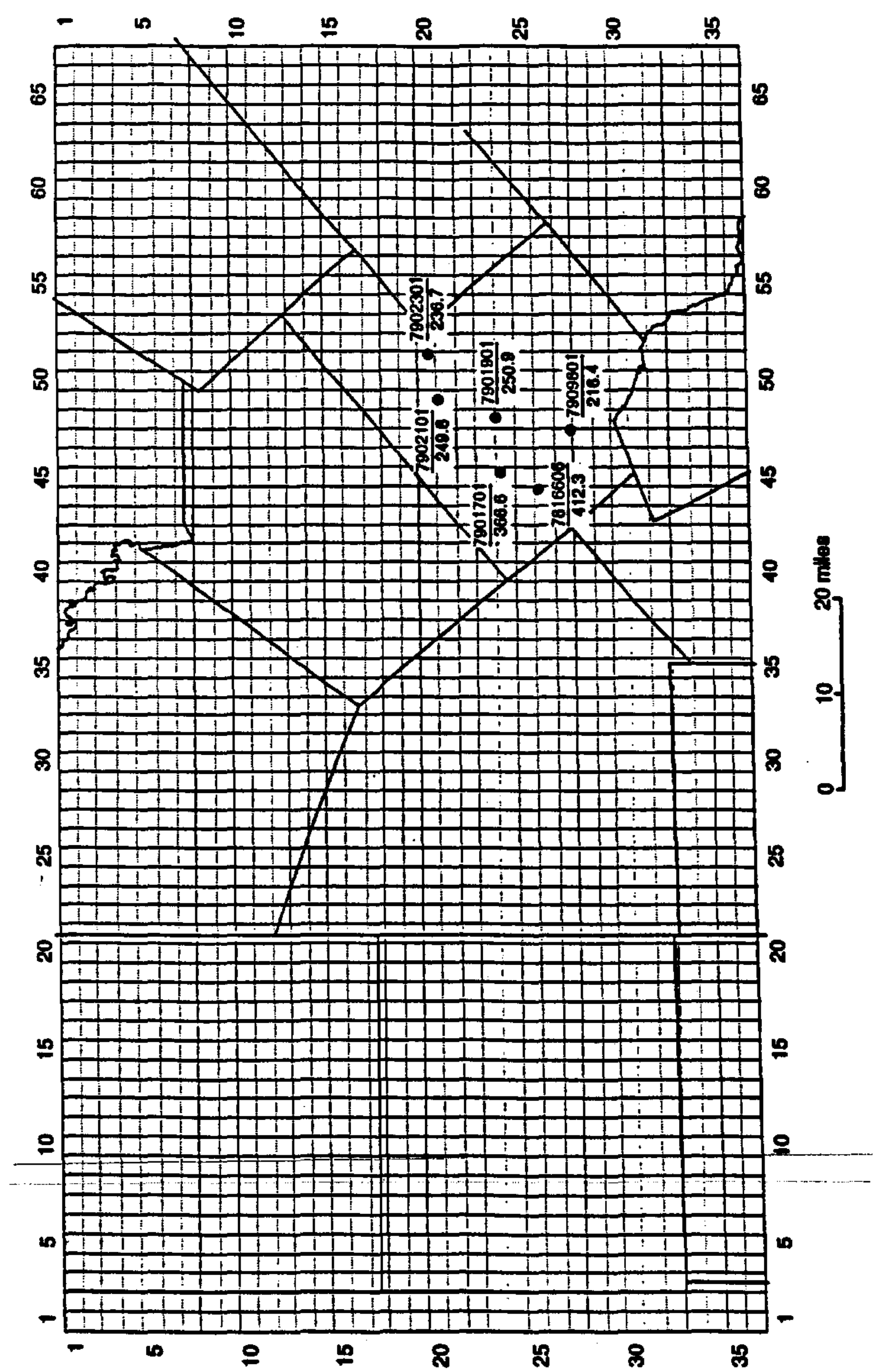
According to TWDB (Bulletin 6007), transmissivity of the Oakville Sandstone aquifer is determined by the well pumping tests at 4 locations in the Karnes County: United Gas Pipeline Co. (southeast part of the county near Goliad Co. line), City of Runge, City of Kenedy, and at well of Mrs. Ernest Yanta (one mile north of Runge). The values obtained are (in gpd/ft) 5,000 ; 10,000 ; 14,000 ; and 8,000 respectively. Coefficients of storage are 0.000074, 0.00024, 0.00013 and 0.00011 respectively. The values of hydraulic conductivity are not provided.

Figure 23 shows groundwater levels in three wells measured in 1990 which is insufficient for determining aquifer's piezometric surface, hydraulic gradients, and for calculations of groundwater flow rates at this time.

6.0 GROUNDWATER RECHARGE

Recharge into the study area aquifers is from the infiltration of precipitation over their outcrop (exposed) areas (see Figure 2). In addition, some inter-leakage may occur between the aquifers due to heavy pumping and changes of their piezometric (pressure) surfaces. Leakage into the Carrizo aquifer is known to occur in the regions of intensive irrigation in Dimmit, Frio, and Zavala Counties where water of higher mineral content in other formations leaks through confining beds or

Figure 22: ALTITUDE OF WATER LEVELS IN THE CATAHOULA TUFF AQUIFER, 1990. (WELL ID/WATER LEVEL ALTITUDE)



percolates down well bores of poorly constructed and abandoned wells (TWDB Report 210). However, the real nature and actual rate of leakage remains unknown in the study area since there are no data on quantitative relationships between hydraulic heads of neighboring aquifers and hydraulic conductivities of confining beds. This needs to assessed in the future.

According to TWDB Report 32, the average recharge rate of the Carrizo Sand in Frio and Atascosa Counties is equivalent to the infiltration of an average of 1.8 inches of precipitation per year on 153,600 acres (240 square miles, 622 square kilometers) of outcrop area. This corresponds to about 13,000 acre-feet per year of recharge in Atascosa County, and 10,000 acre-feet per year in Frio County. The estimates of recharge are based on the velocities of movement of the groundwater as calculated from Carbon-14 age determinations of the water and from velocities determined from hydraulic gradient, hydraulic conductivity, and porosity data. Approximately 26,000 acre-feet per year is the estimated recharge rate in Wilson County as reported by TWDB (Report 210). The outcrop area of the Carrizo in Wilson county is approximately 94 square miles. The total recharge to the Carrizo Sand aquifer in the study area, as estimated by TWDB, is 49,000 acre-feet per year.

In this study, the recharge to the area aquifers is calculated based on the average annual precipitation in the 1983-1994 period, and the average annual temperature as determined from data provided by AACOG. Figures 24 and 25 show locations of rain measuring stations in the study area used in the analysis, and the contour map of the average annual precipitation in inches.

One of the commonly applied equations, proposed by Turc, is used for the calculation of annual evapotranspiration in the study area ("Handbook on the principles of hydrology", Donald M. Gray, Editor-in-Chief, WIC, 1970):

$$E = P/ [0.9 + (P/It)^2]^{1/2}$$

where E is annual evapotranspiration (mm), P is annual gross precipitation (mm), $I_t = 300 + 25T + 0.05T^3$, T is mean air temperature (°C).

Evapotranspiration is calculated for the precipitation zones shown in Figure 25 using the same average annual temperature of 20.9 °C (69.6 °F). (Unlike precipitation, the average annual temperature is fairly constant in the study area: between 69.1 and 71.2 °F.) The infiltration rate is then determined as the difference between the gross annual precipitation and the calculated evapotranspiration. The obtained infiltration rates are further adjusted for the land cover as determined by the analysis of a Landsat TM image (see Figure 25a). It is assumed that infiltration over forested areas is 10% less than over agricultural land. The calculated infiltration rates range from 1.8 inches/year in the western-most part of Frio County to 4.6 inches/year per unit area in northeastern Wilson County. Knowing that the Carrizo outcrops at 334 square miles in the study area, the total calculated annual recharge (adjusted for land use) is approximately 53,000 acre-feet. This value is very close to 49,000 acre-feet estimated by TWDB.

Figure 23: ALTITUDE OF WATER LEVELS IN THE OAKVILLE SANDSTONE AQUIFER, 1990. (WELL ID/WATER LEVEL ALTITUDE)

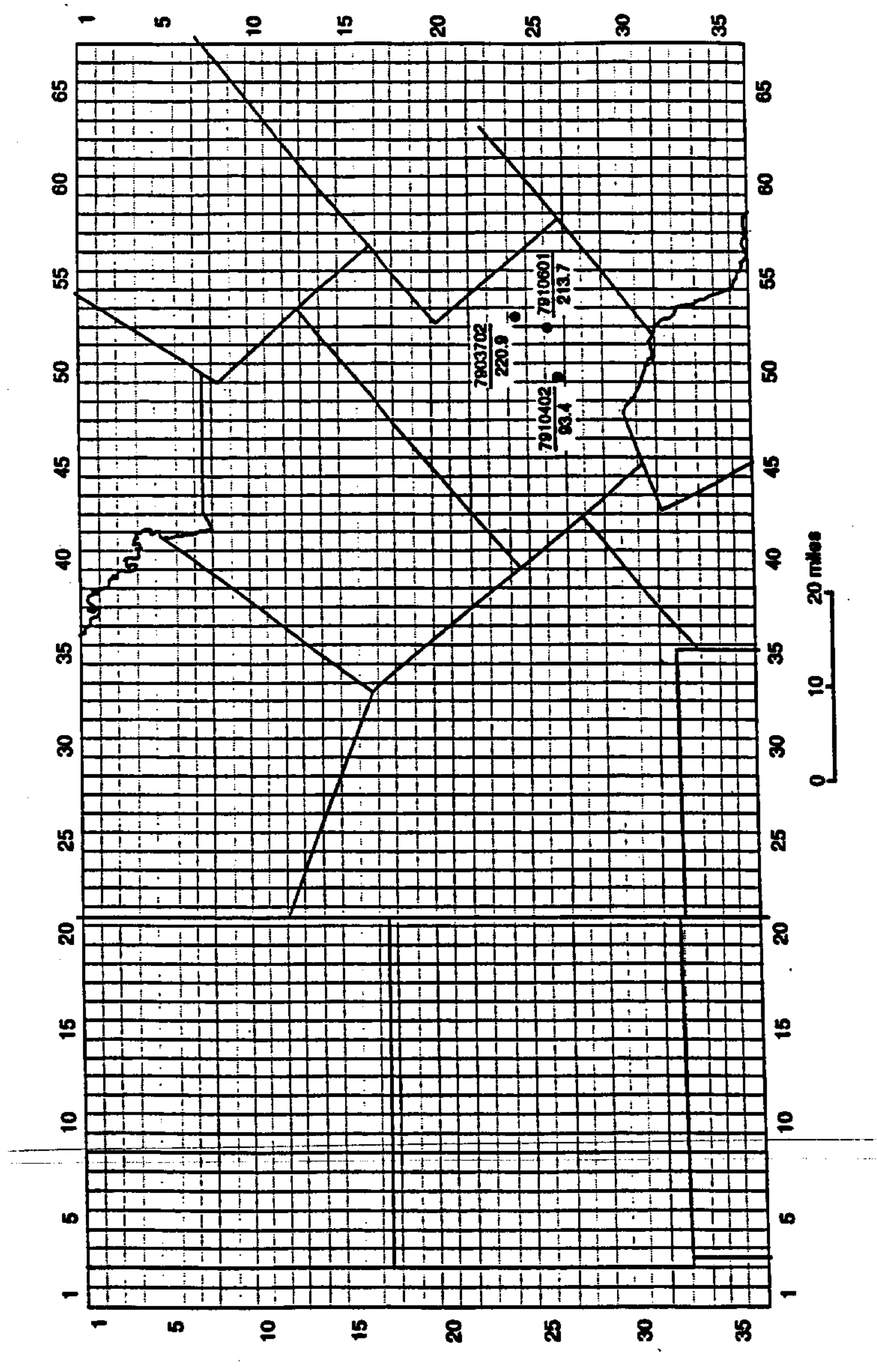


Figure 24: PRECIPITATION GAUGING STATIONS USED FOR CONTOURING AVERAGE ANNUAL PRECIPITATION IN THE STUDY AREA

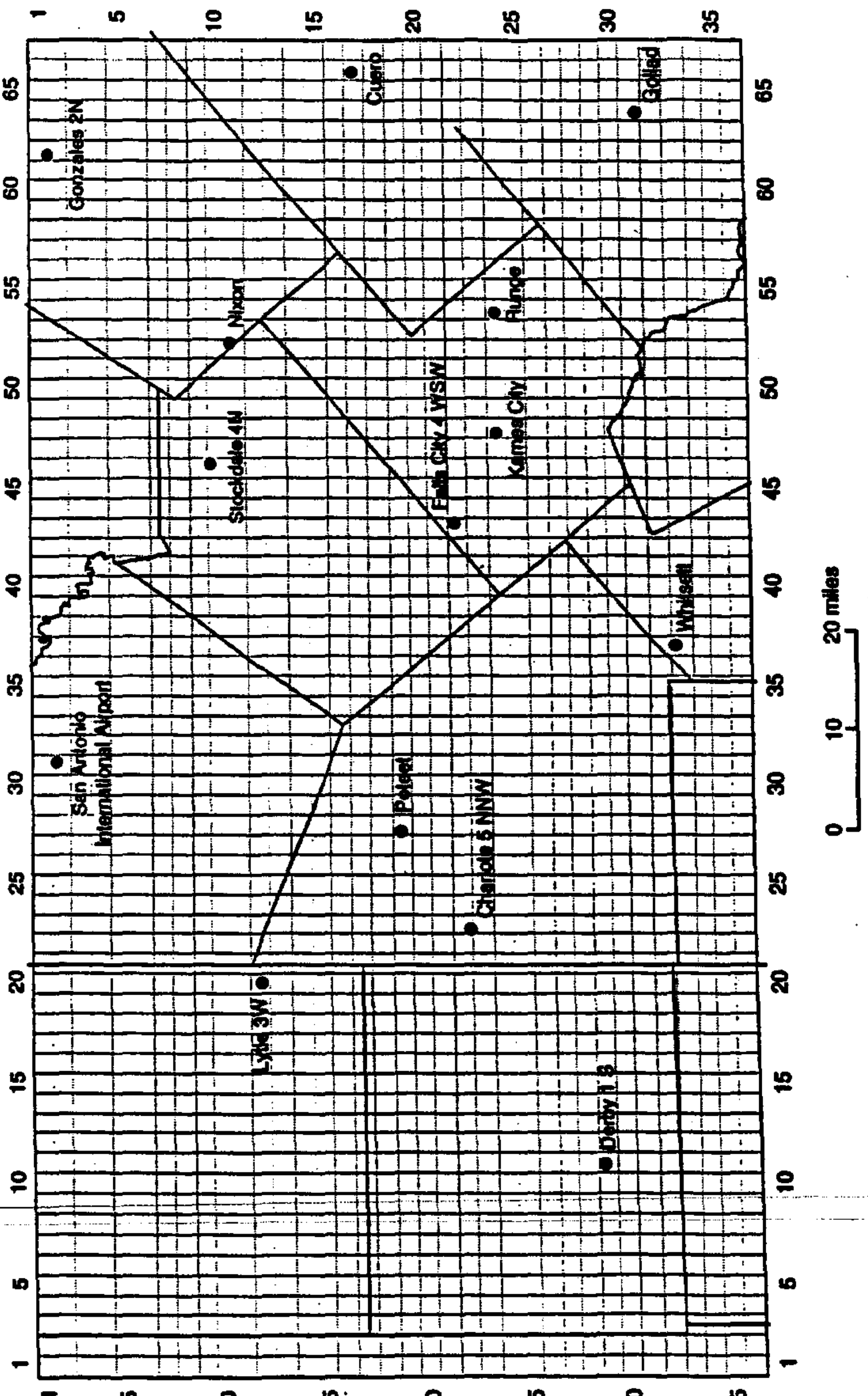
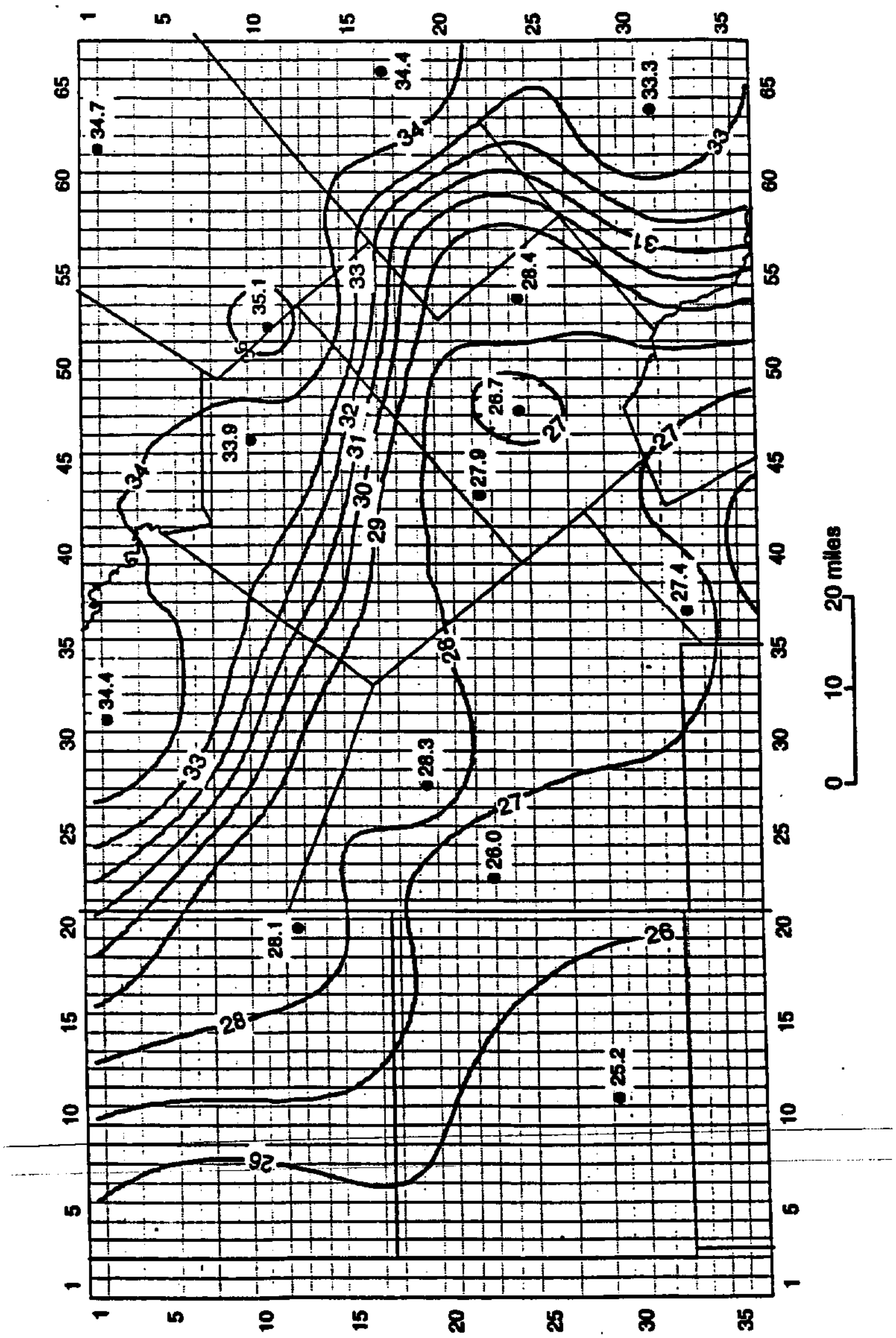


Figure 25: AVERAGE ANNUAL PRECIPITATION, 1993-1994 (CONTOUR INTERVAL IN INCHES)



7.0 GROUNDWATER PUMPAGE

Figures 26 through 32 show groundwater withdrawal capacity (not the actual withdrawal) from the area aquifers according to data collected by AACOG for this study. The total pumping rate capacity of all wells tapping individual aquifers within a 2x2 mile cell, based on data provided by AACOG, is assigned to the cell centroid as a number or is classified into intervals. In the AACOG's database, all wells are classified into four categories according to usage: municipal (public water supply), irrigation, industrial, and "other". The majority of the wells in the data base are without reported capacity.

A significant amount of data are available only for the Carrizo Sand aquifer. A coordinated effort from the following state and federal agencies may be necessary to build an accurate, updated groundwater wells data base: Texas Water Development Board (TWDB), Evergreen Underground Water District (EUWD), Texas Natural Resources Conservation Commission (TNRCC), Texas Railroad Commission (TRC), Bureau of Economic Geology (BEG), United States Geological Survey (USGS).

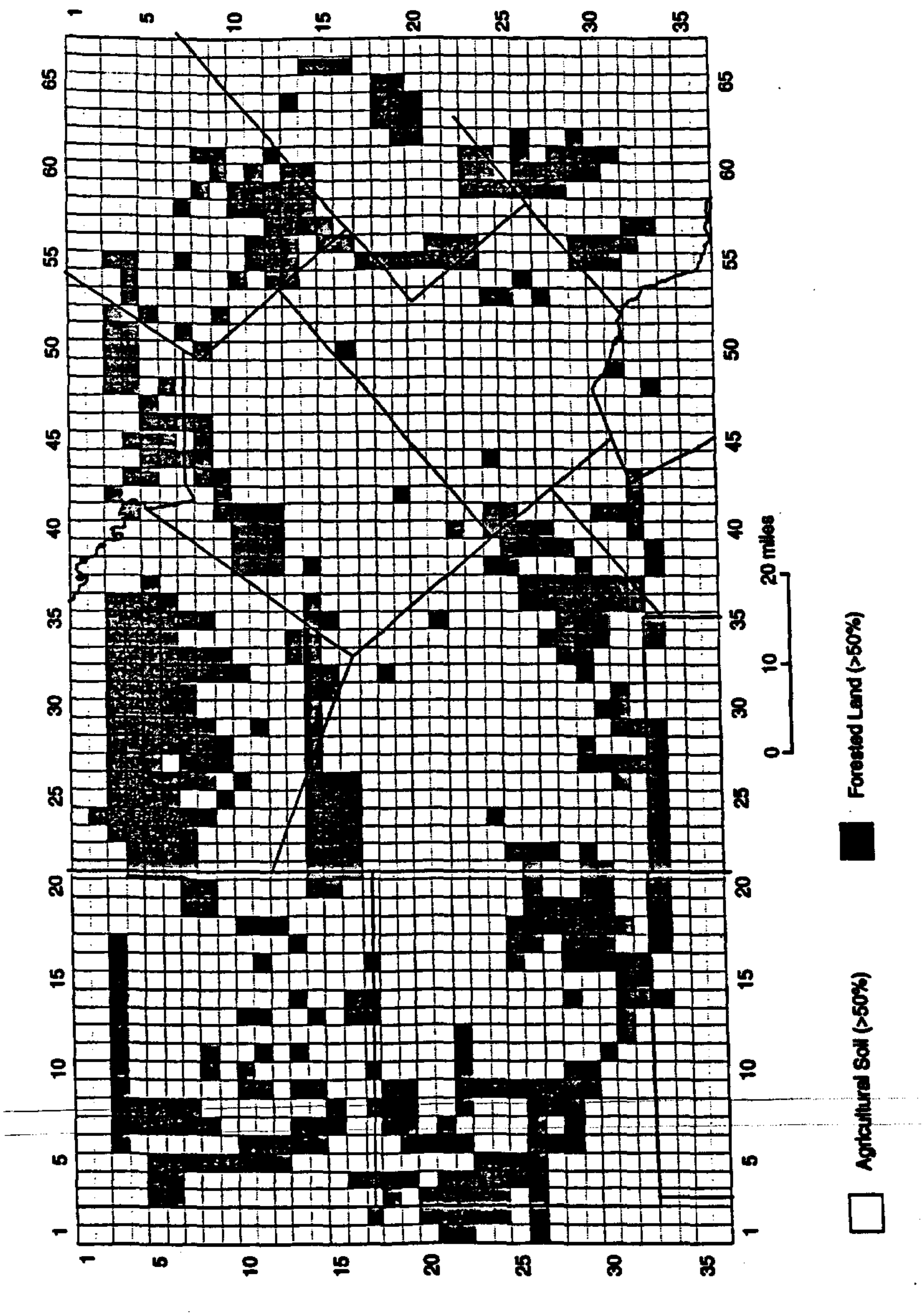
In addition, every effort should be made to gather information directly from all identified water purveying entities in the study area, as well as from individual farmers/ranchers. This information should include data on both well (pump) **capacity** and actual **average duration** of pumping during day/season/year. This would enable calculations of the actual groundwater withdrawal from the area aquifers.

7.1 Carrizo Sand

As already mentioned, according to TWDB's regional study of the Carrizo aquifer (Report 210), the average rate of recharge to the Carrizo aquifer in the Winter Garden Area (which is much larger than the study area and extends through the varying precipitation zones) is about 100,000 acre-feet per year or 89 million gallons per day. The approximate average annual pumpage from large wells (irrigation, public supply, and industrial) during the period 1963-1969 was estimated at about 162,500 acre-feet (243 mgd). TWDB also estimated that during that period an approximate leakage from other aquifers (due to heavy pumping of the Carrizo and related increase of its piezometric pressures) of about 9,500 acre-feet per year (8.5 mgd) occurred. These numbers indicate that 145 mgd of groundwater was removed from the aquifer storage and was not recharged (i.e. withdrawal of groundwater greatly exceeded the recharge of the aquifer).

Figure 28 shows the pumpage capacity (not the actual pumping rates) per 2x2 mile cell from the Carrizo based on the reported capacity of wells/pumps in the data base provided by AACOG. There are 373 cells with some pumpage from the Carrizo. The rates vary from less than 100 gpm to over 11,000 gpm in the northeastern part of Frio County. Again, the actual groundwater withdrawal

Figure 25a: CLASSIFICATION OF LAND USE AS DETERMINED FROM THE LANDSAT TM IMAGE



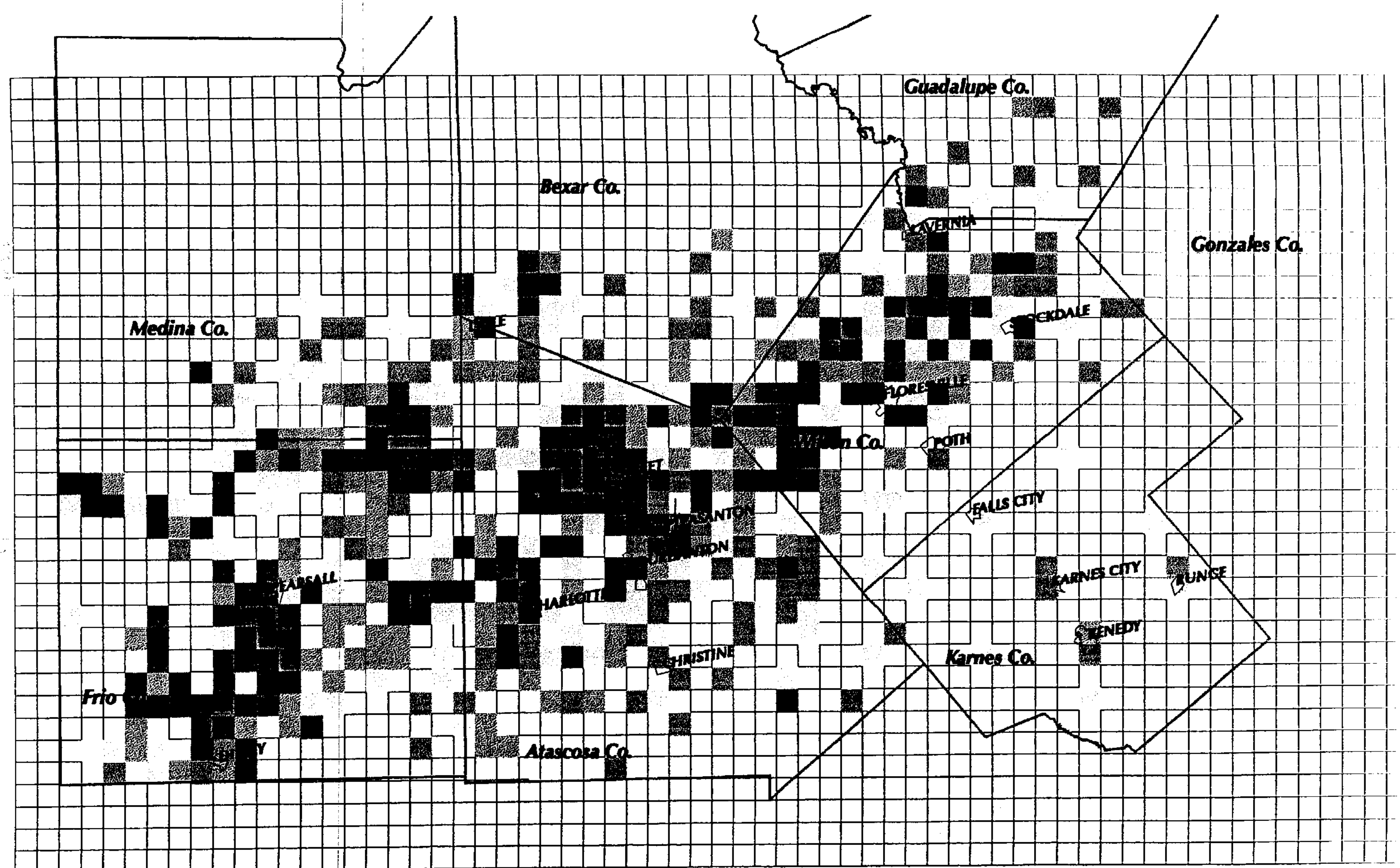


Figure 26
Pumping Rate in Gallons per Minute per 2x2 Mile Cell From All Aquifers Combined

- No Pumping
- Less than 1000 GPM
- 1000 - 1499 GPM
- 1500 - 2200 GPM
- 2201 - 3500 GPM
- Over 3500 GPM

N

Scale : 1 inch = 9 mi.

Regional Data Center

Alamo Area Council of Governments

from the Carrizo can not be accurately determined at this point since there is no data base available which would include **active** wells and their **actual** pumping rates in real time (day/season/year).

Altogether, 1,368 wells tapping the Carrizo are included in the AACOG data base. Roughly 80% were completed after World War II, and there are practically no wells completed after 1988 in the base. The total reported capacity of all wells (not the actual withdrawal) is 933,848 gpm or 1,345 million gallons per day. Assuming that all reported wells are active, and that an average duration of pumping is 2, 4 and 6 hours a day, the following values of groundwater withdrawal are obtained: 112, 224 and 336 MGD respectively. As mentioned earlier, TWDB estimates that in the period 1963-1969 the total pumpage from the Carrizo in the entire Winter Garden Area (which is several times larger than the study area of this report) was 243 MGD. Clearly additional efforts are needed to collect more detailed information.

7.2 Wilcox Group

Figure 27 shows the capacity of groundwater pumpage (not the actual pumping rates) per 2x2 mile cell for water wells tapping the Wilcox Group aquifer. There are 56 "active" cells with the total capacity of 39,953 gpm. Practically all active cells are located in the aquifer's outcrop (recharge) area which is outside the four-county area. This may be indicative of underdevelopment of the Wilcox in its confined part. The main reason for this is the availability of groundwater from the shallower and more productive Carrizo which makes groundwater withdrawal less expensive.

7.3 Queen City Sand

Figure 29 shows pumping capacity of wells completed in the Queen City Sand aquifer per 2x2 mile cell. Out of the 174 individual wells, 50 cells were reported with a total pumping capacity of 29,278 gpm. Pumping capacity for the other wells is needed.

7.4 Sparta Sand

Figure 30 shows pumping capacity from the Sparta Sand aquifer per 2x2 mile cell. Of the 42 individual wells in the Sparta Sand, only 5 cells are "reported as active" with a total pumping capacity of 825 gpm. More data could be gathered for the Sparta Sand.

7.5 Catahoula Tuff

Figure 31 shows pumping capacity from the Catahoula Tuff aquifer per 2x2 mile cell. Only 2 cells are "active" with a total pumping capacity of 670 gpm. There are 17 individual wells in the database provided by AACOG.

7.6 Oakville Sandstone

Figure 32 shows pumping capacity from the Oakville Sandstone aquifer per 2x2 mile cell. Of the 9 wells, only 3 cells are "active" with a total pumping capacity of 2,048 gpm.

8.0 PRELIMINARY REGIONAL GROUNDWATER MODEL

A modified version of MODFLOW was used to simulate natural groundwater flow in the Carrizo Sand aquifer and the Queen City Sand aquifer. Other aquifers could not be modeled because of the lack of data available. The extended memory version of MODFLOW for 80486 computers ("MODFLOW/EM") is distributed by Scientific Software Group and compiled by Maximal Engineering Software, Inc. MODFLOW ("A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model") was developed at the United States Geological Survey by McDonald and Harbaugh (1988) and is considered to be the most reliable, validated and utilized groundwater flow model available.

The software package called "Processing Modflow" (PM) by Chiang and Kinzelbach (1992-93) was used for data control, simulation and analysis of model results. The PM's graphical post-processor allows numeric and visual control of simulation results in the form of contour maps. It was also used to convert MODFLOW's binary output files into ASCII format and produce contour maps. Generated graphic plots were saved in HPGL (Hewlett-Packard Graphic Language) format and then processed on a Macintosh computer using "Canvas" graphics software by Deneba Software, Inc.

A discussion of the results from modeling the Carrizo aquifer is presented below. While no model is perfect, some meaningful information can often be obtained.

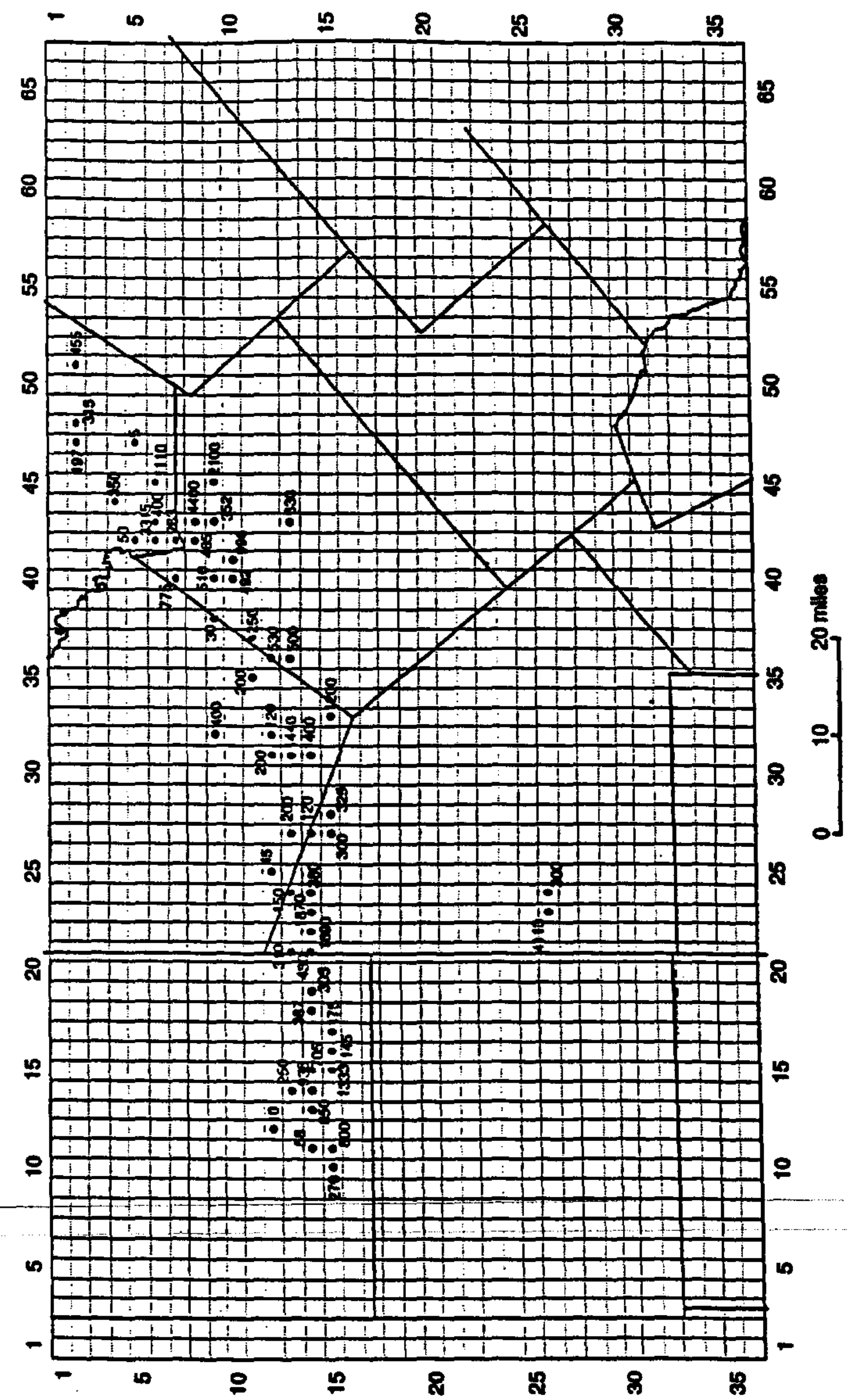
8.1 Carrizo Aquifer

8.1.1 Grid and Boundary Conditions

The model covers an area of 134 x 72 miles and has 67 columns and 36 rows in a uniform mesh (Figure 33). Cell size is 2x2 miles. Vertical dimension of the cells, i.e. aquifer saturated thickness, is dictated by altitude of the aquifer bottom and elevation of the groundwater table in the outcrop area, and altitude of the aquifer top in the confined area. Maps of the Carrizo Sand top and bottom altitudes are used for the model input (Figures 8 and 9).

A combination of water level maps in 1970 and 1990 (Figures 10 and 11) was used to set the boundary conditions since data for 1990 were not available for southern part of Frio and Atascosa Counties, all of Karnes County, and a large portion of Wilson County. Although the Carrizo Sand aquifer does not have real physical boundaries within the study area, it was assumed that its top and

Figure 27: PUMPING RATES IN GALLONS PER MINUTE PER 2X2 MILE CELL FROM THE WILCOX AQUIFER



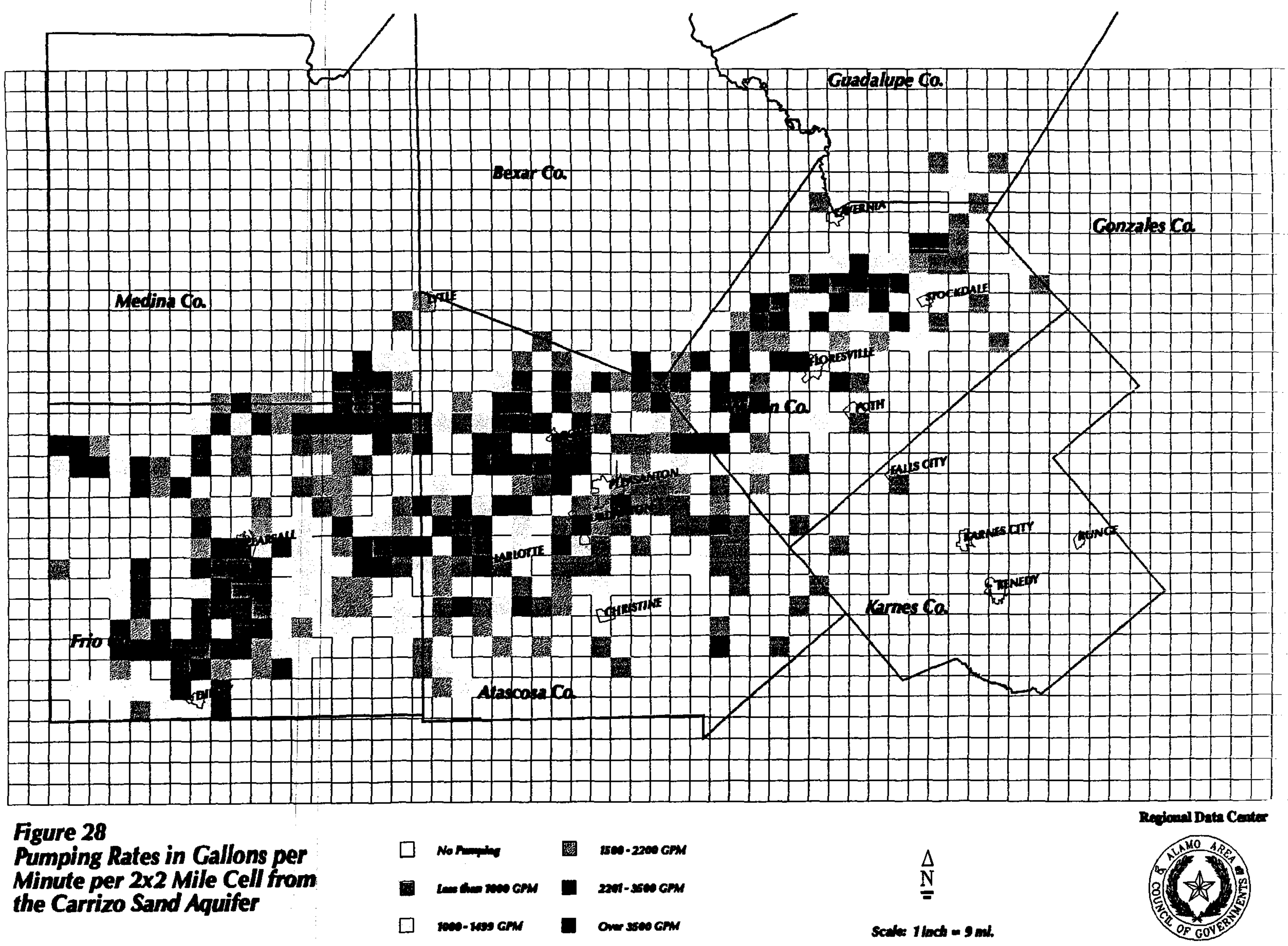


Figure 28
Pumping Rates in Gallons per Minute per 2x2 Mile Cell from the Carrizo Sand Aquifer

bottom are impermeable in the confined flow portion. No attempts (except in the outcrop area) were made to simulate probable leakage into the aquifer from the underlying Wilcox Group or overlying Reklaw Formation. This approach was taken mainly because no data were available on the hydraulic nature of these contacts and distribution of heads in Wilcox and Reklaw. All other model boundaries are arbitrary, i.e. *hydraulic*:

- **northern boundary** along the aquifer outcrop is assigned known (assumed) flux in the form of recharge. Contact between the Carrizo Sand and the Wilcox Group is modeled as impermeable (no-flow boundary) but the boundary cells were assigned additional recharge to simulate possible inflow of water from the Wilcox.
- **western and northwestern boundaries** are modeled as stream lines based on the 1970 map of water levels in the Carrizo. It is likely that these no-flow boundaries have changed since 1970 but there are no data available for 1990 (see Figure 11).
- **eastern boundary** is set along the "bad water line" position of which is given in TWDB Report 210. This boundary is modeled as either no-flow boundary (case 1) or boundary with the known (assumed) head. Case 1 is commonly used in order to study any possible influence of additional pumping on the boundary, i.e. to "prevent" inflow of mineralized groundwater into the active model area. Case 2 is hydraulically justified if a distribution of the piezometric head along the boundary is known. This is not the case for 1990 and the head distribution for 1970 was used after an assumed general decline of 20 to 40 feet.

8.1.2 Hydrogeologic Properties and Model Calibration

The model was calibrated in steady state flow conditions by adjusting the following hydrogeologic parameters: hydraulic conductivity (very slightly in order to maintain consistence with TWDB map in Figure 12), specific yield, and distribution of head along the southern boundary with the assumed head distribution. Recharge flux assigned to each active cell in the outcrop area was also changed during calibration. However, these changes were within a few percent to maintain consistency with the TWDB estimates (see Section 6). The recharge values are based on infiltration rates estimated using the Turc formula for evapotranspiration (Section 6), aerial distribution of gross annual precipitation in the study area (Figure 25), and land cover (Figure 25a; forested areas were given 10% lower recharge rates than agricultural soil).

Hydraulic conductivity distribution is adopted from the TWDB Report 210 (Figure 12) and changed very little during model calibration.

Specific yield, the least sensitive parameter in the calibration, was estimated at 0.2 in the outcrop area (unconfined conditions), and 0.0005 throughout the rest of the model (confined conditions), corresponding to the value range given in TWDB reports.

Boundary head distribution along the southern model boundary (and along the "bad water line" in case two) was, as expected, the most sensitive parameter during model calibration. The actual

Figure 29: PUMPING RATES IN GALLONS PER MINUTE PER 2X2 MILE CELL FROM THE QUEEN CITY SAND AQUIFER

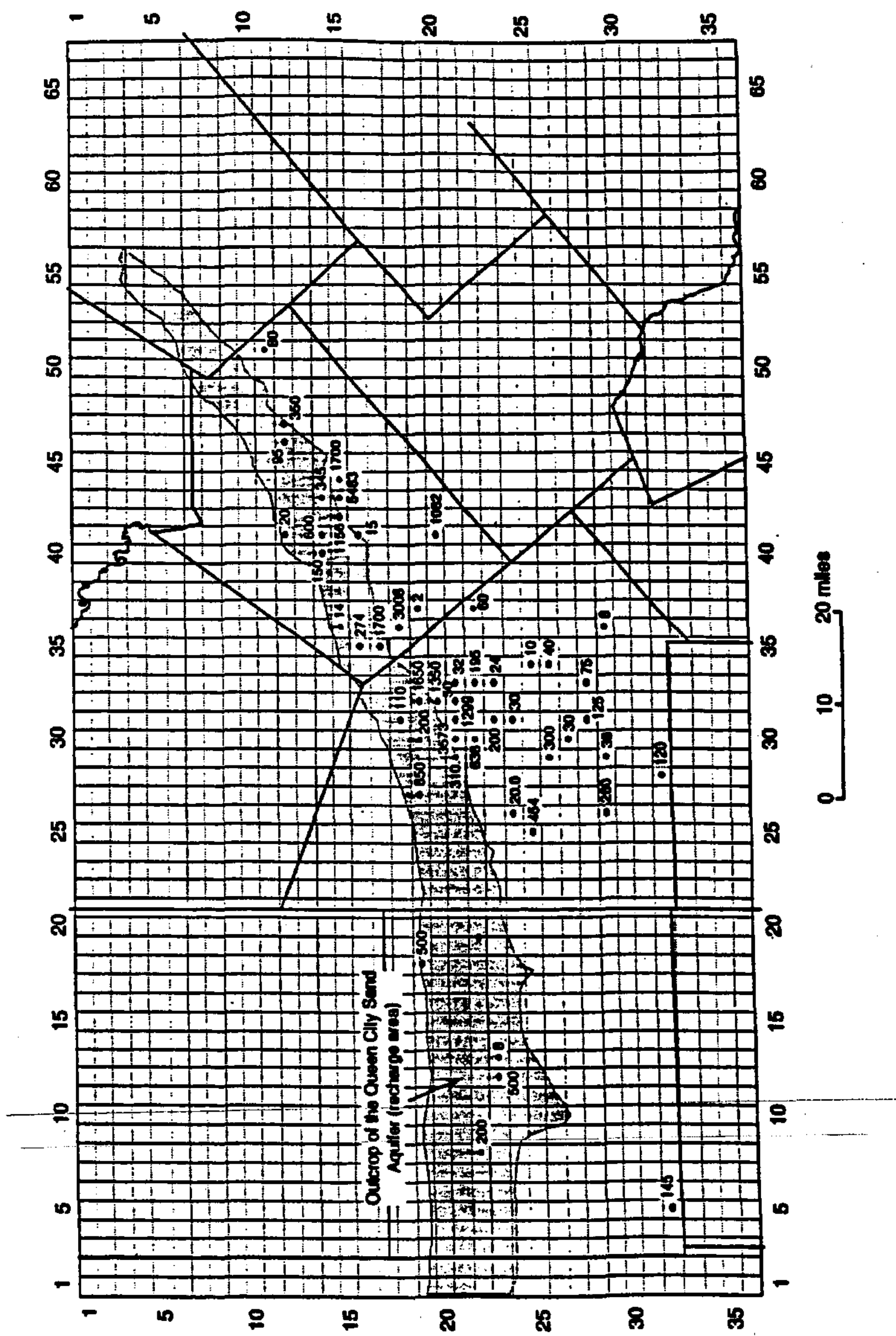


Figure 30: PUMPING RATES IN GALLONS PER MINUTE PER 2X2 MILE CELL FROM THE SPARTA SAND AQUIFER

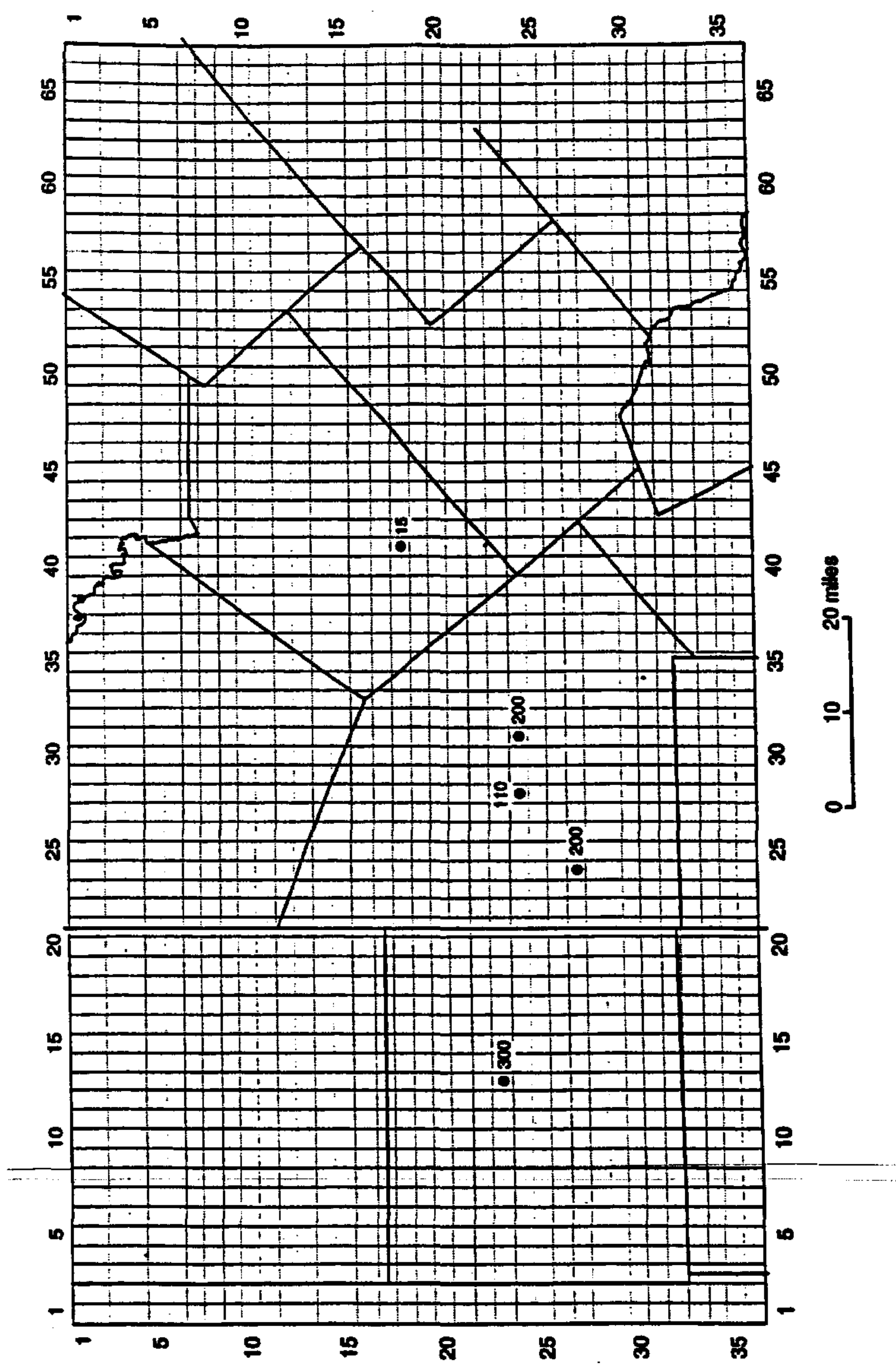


Figure 31: PUMPING RATES IN GALLONS PER MINUTE PER 2X2 MILE CELL FROM THE CATAHOULA TUFF AQUIFER

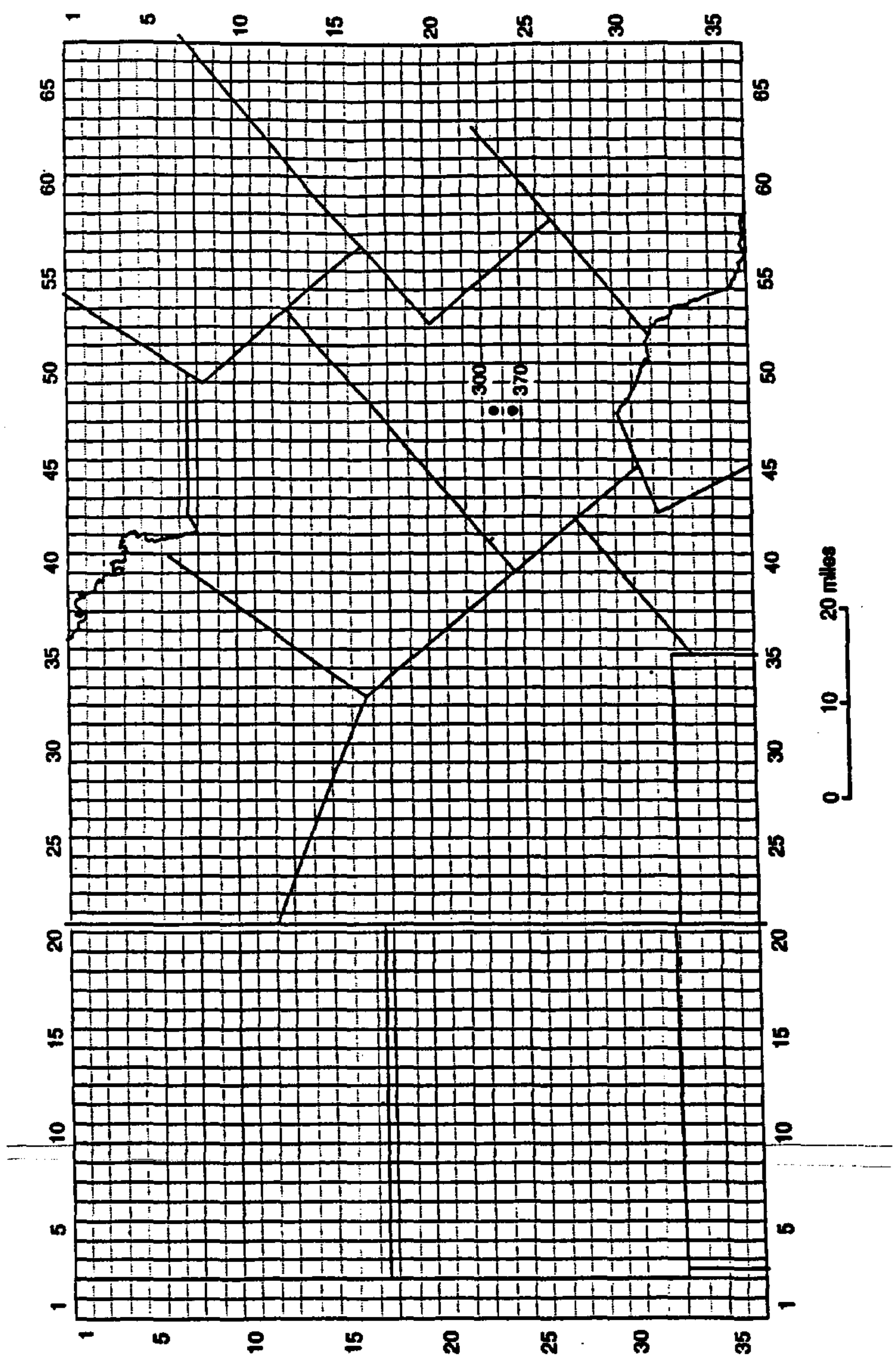
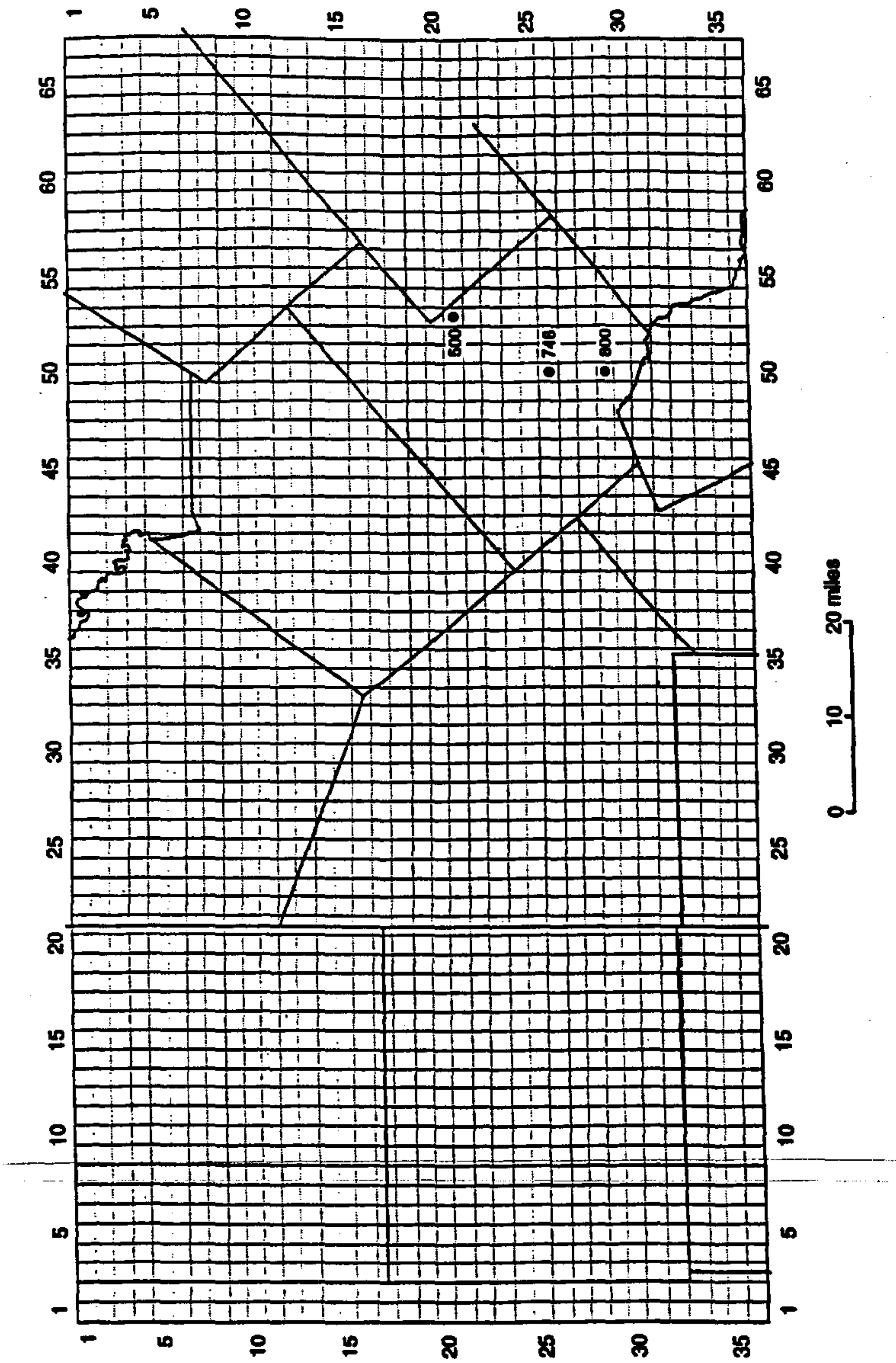


Figure 32: PUMPING RATES IN GALLONS PER MINUTE PER 2X2 MILE CELL FROM THE OAKVILLE SANDSTONE AQUIFER



distribution remains unknown for 1990 because of the lack of data (see Figure 11). Changing assumed heads along the southern model boundary (boundaries in case two) even slightly (20 to 30 feet) completely changes the resulting piezometric head throughout the model area. This indicates the great importance of appropriate data collection for the entire study area.

Porosity of the Carrizo Sand was assumed to be 25 percent. Together with the specific yield, it was the least sensitive parameter during the model calibration.

Pumping rates of all wells per 2x2 mile area (Figure 28) was another very sensitive parameter during model calibration. As explained in Section 7, the actual withdrawal of groundwater from the Carrizo is practically impossible to determine based on the available data. During calibration it was assumed that all existing wells were pumping, with intervals of one hour, from 1 to 12 hours per day. None of the scenarios, for both cases (eastern boundary) produced groundwater levels in the Carrizo that would resemble actual data measured in the field in 1990. The closest, though still not satisfactory, was pumping of 3 hours per day. This amount of pumping still highly underestimates drawdowns in Wilson County and in southeastern part of Atascosa County. Any increased pumping does not significantly change the situation in these two areas but causes large drawdowns in Frio County.

According to the model, the Carrizo can provide significantly more groundwater in almost all of Atascosa and Wilson Counties for the next 20 years without depleting water levels more than 40 feet. However, the actual situation in the field shows a completely different picture. Large present drawdowns in central and southeastern Atascosa County can be simulated by the model only if pumping rates are assigned some extremely high values such as 20,000 gpm or more per cell for more than 3 to 6 hours a day. Care has to be taken in using results generated from the model. The model indicates, in general, that drawdown can continue in most parts of the Carrizo as long as "good management" and tracking is employed. The model also shows that much more data should be collected and organized into corresponding GIS layers that would be directly linked with the model.

9.0 SUGGESTED FURTHER STUDY

In general, enough information was collected to determine that large amounts of groundwater exists throughout the four county area. A continuing development of GIS layers/data bases is needed to more "fully" evaluate groundwater resources and develop operational groundwater models for their management. The following activities are suggested:

- Update/modify water wells GIS layer that will contain the following information: locations of all active water wells, aquifer pumped, well screen depths, obtain actual pumping rate, historic pumping rate (if available), year of completion. Municipal wells supplying large amounts of water to all centralized systems in the study area should be additionally classified as priority wells.

Figure 33: CARRIZO SAND AQUIFER MODEL BOUNDARY CONDITIONS

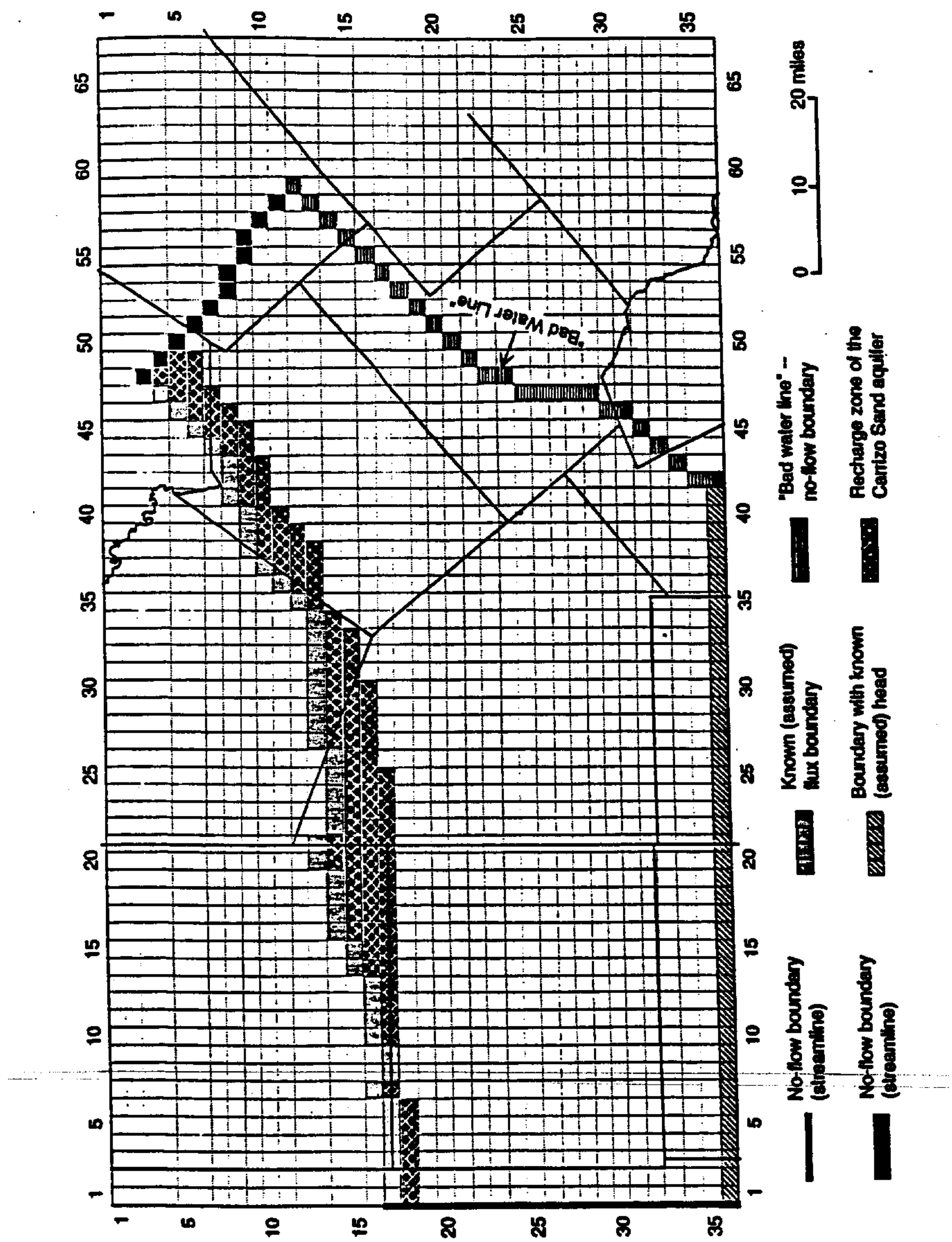
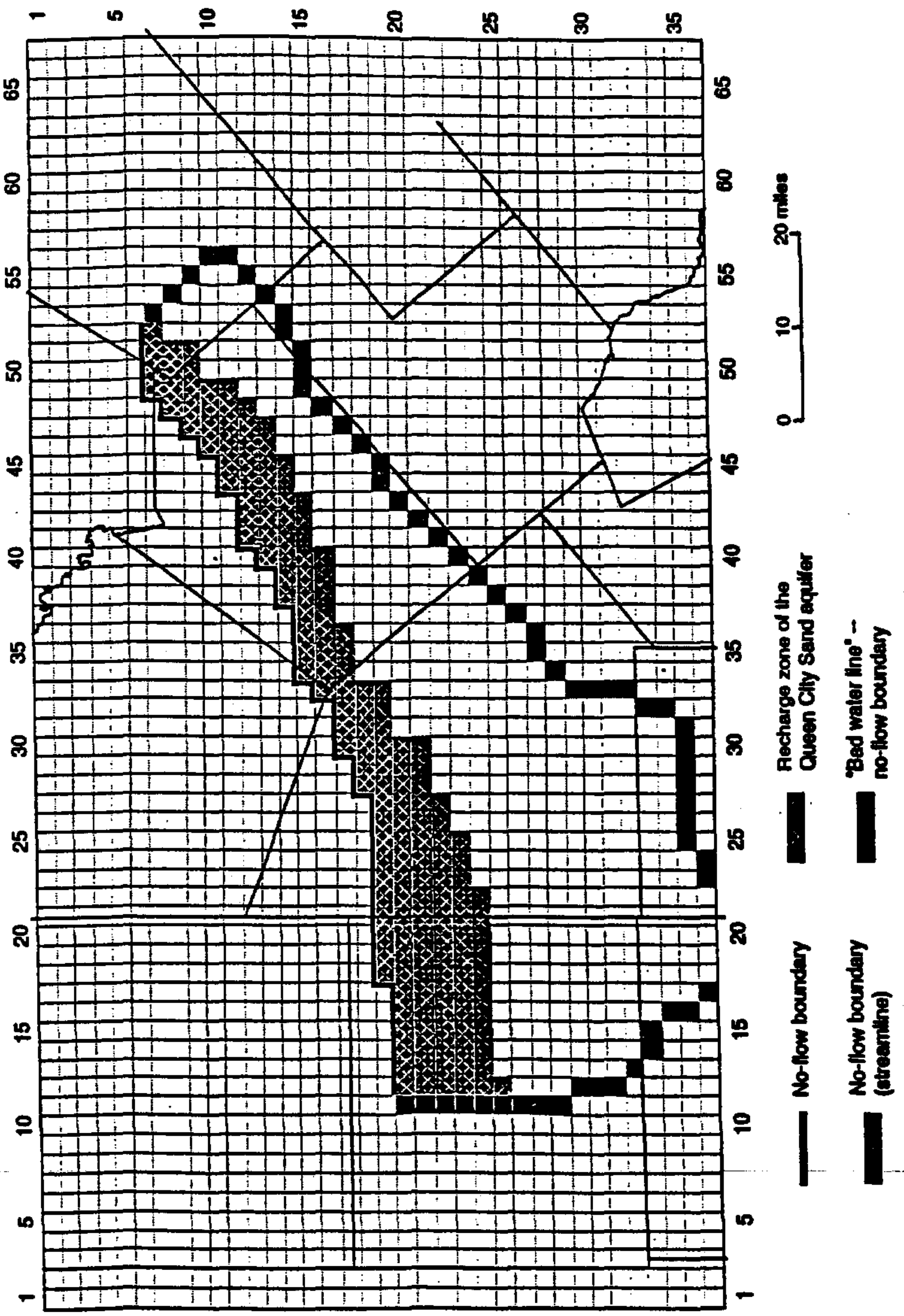


Figure 34: QUEEN CITY SAND AQUIFER MODEL BOUNDARY CONDITIONS



- Develop a GIS layer containing information on the projected water use for all municipalities and water purveying entities. This layer would be used for studying various groundwater withdrawal scenarios with respect to public and other supply needs after completion of operational groundwater models.

- Significantly expand the network of wells for monitoring groundwater levels (piezometric heads) . The network should cover all four counties and all important aquifers. Data collected would be of crucial importance for developing operational groundwater models.

- Develop a GIS layer of land use/land cover with respect to seasons. This layer should be compatible with the groundwater model grids and would be used for a detail classification of the infiltration potential in the recharge zones of the area aquifers.

- Develop a GIS layer of the specific surface runoff (cubic feet per second per square mile) for the major drainage basins in the study area. This layer should enable determination of the surface outflow from the aquifers recharge areas and would be used as another factor in estimating groundwater recharge.

- Get more top/bottom elevations of all identified aquifers with the exception of the Carrizo Sand aquifer which has a sufficient amount of data available. The thickness of particular aquifers is essential for evaluating the groundwater potential.

- Obtain hydrogeologic (aquifer) parameters, such as hydraulic conductivity, transmissivity and storage, for all identified aquifers, and build a GIS layer that could be imported directly into the operational groundwater models as new data become available. Judging from the available "ground water reports" published by TWDB, a massive effort is needed to collect these data. The Carrizo Sand aquifer is the only one with significant data coverage as presented in the TWDB Report 210.

APPENDIX B - Detailed Summary of Economic Analysis

1.0 CALCULATIONS FOR EACH ALTERNATIVE

Calculations were performed to estimate the present value of the stream of future expenditures required for the implementation of each alternative. Computer outputs were then generated which display the projected cost per year with estimated inflationary effects (1995 dollar analysis), present value per year, cumulative present value per year, and cumulative present value net of residual (terminal, or salvage value) for each year.

A year-by-year display of the calculation results for each of the three alternatives are shown below in Figure B-1. For each alternative, the table shows, in 1995 dollars, the following items on an annual basis over the 26-year analysis period:

1. The estimated amount for each expense element.
2. The total of all expense elements ("TOTAL ANNUAL OUTLAYS").
3. The present value of all expense elements ("NET PRESENT VALUE").
4. The present value of all expense elements through indicated year ("CUMULATIVE NET PRESENT VALUE").
5. The cumulative present value of costs through given year less present value of residual for given year ("CUMULATIVE NET DISCOUNTED PV").
6. The annualized cost (equivalent uniform annual amount for the 26-year period of analysis).

1.1 Net Present Value (NPV)

NPV is calculated for each alternative. The alternative with the lowest NPV is the preferred option. The NPV is calculated for an alternative discounting the value of the costs for each year and summing over the years for a total or net value. NPV analysis shows that all life-cycle costs need to be considered, i.e., initial outlays alone do not provide enough information to support a decision.

1.2 Equivalent Uniform Annual Cost (EUAC)

The NPV method assumes that all alternatives have equal lives or lives greater than the period of analysis. It is not unusual, however, for the lives of alternatives to differ. When this occurs, all of the alternatives must be compared on a common basis of time to make valid comparisons. The EUAC method allows us to make such comparisons.

The EUAC is an approach for evaluating alternatives with unequal economic lives that are less than the minimum requirement time period. It converts each option into an equivalent alternative having uniform recurring costs. The conversion is such that the total NPV costs of the actual alternative and its equivalent are the same. The alternatives can then be compared. The best alternative corresponds to the best actual alternative, which is the best economic choice for the project. Assuming that the alternatives are equally effective over their lives, the one with the lowest EUAC is the most economical choice.

Figure B-1: ECONPACK OUTPUT FOR KARNES AND WILSON COUNTIES

FILENAME: AACOGKW
DATE GENERATED: 03 JAN 1996
TIME GENERATED: 14:28:11
VERSION: PC V4.0

E X E C U T I V E   S U M M A R Y   R E P O R T   PAGE 001

PROJECT TITLE : ACCOG PEP
DISCOUNT RATE : 7.63%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1996
BASE YEAR : 1995

PROJECT OBJECTIVE : Economic development and economic analysis of water quality/quantity for Atascosa, Frio, Karnes, and Wilson Counties

RESULTS AND RECOMMENDATIONS:

ALTERNATIVE NAME	NPV	EUAC
1 Region A	$12,836,821	$1,135,384
2 Autonomous-Falls Cit	$999,934	$88,441
3 Autonomous-Floresvil	$7,100,861	$628,053
4 Autonomous-Karnes Ci	$2,425,471	$214,526
5 Autonomous-Kenedy	$7,016,540	$620,595
6 Autonomous-Runge	$1,584,464	$140,141
7 Autonomous-Poth	$4,614,082	$408,103
8 Autonomous-Stockdale	$3,274,706	$289,639

ACTION OFFICER: Susan Bittick/Jon Cole
ORGANIZATION : CESWF-PL-E

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 001

ALTERNATIVE 1: Region A

YEAR	Construction Costs (01)	Planning and Design (02)	Regional O&M (03)	Local O&M (04)	TOTAL ANNUAL OUTLAYS
1996	$0	$1,769,540	$0	$0	$1,769,540
1997	$1,607,122	$0	$0	$0	$1,607,122
1998	$1,655,336	$0	$0	$0	$1,655,336
1999	$1,704,996	$0	$0	$0	$1,704,996
2000	$0	$0	$391,835	$428,688	$820,523
2001	$0	$0	$403,590	$441,549	$845,139
2002	$0	$0	$415,697	$454,795	$870,492
2003	$0	$0	$428,168	$468,439	$896,607
2004	$0	$0	$441,013	$482,492	$923,505
2005	$0	$0	$454,244	$496,967	$951,211
2006	$0	$0	$467,871	$511,876	$979,747
2007	$0	$0	$481,907	$527,232	$1,009,139
2008	$0	$0	$496,364	$543,049	$1,039,413
2009	$0	$0	$511,255	$559,341	$1,070,596
2010	$0	$0	$526,593	$576,121	$1,102,714
2011	$0	$0	$542,391	$593,404	$1,135,795
2012	$0	$0	$558,662	$611,207	$1,169,869
2013	$0	$0	$575,422	$629,543	$1,204,965
2014	$0	$0	$592,685	$648,429	$1,241,114
2015	$0	$0	$610,466	$667,882	$1,278,348
2016	$0	$0	$628,780	$687,918	$1,316,698
2017	$0	$0	$647,643	$708,556	$1,356,199
2018	$0	$0	$667,072	$729,813	$1,396,885
2019	$0	$0	$687,084	$751,707	$1,438,791
2020	$0	$0	$707,697	$774,258	$1,481,955
2021	$0	$0	$728,928	$797,486	$1,526,414
%NPV	28.85	11.90	28.30	30.96	
	$3,703,002	$1,527,544	$3,632,322	$3,973,953	

DISCOUNTING				
CONVENTION	E-O-Y	E-O-Y	E-O-Y	E-O-Y

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 002

ALTERNATIVE 1: Region A

YEAR	END OF YEAR DISCOUNT FACTORS	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	0.863	$1,527,544	$1,527,544	$3,885,374	-$2,357,830
1997	0.802	$1,288,988	$2,816,532	$3,569,505	-$752,973
1998	0.745	$1,233,539	$4,050,071	$3,273,622	$776,449
1999	0.692	$1,180,475	$5,230,546	$2,996,589	$2,233,957
2000	0.643	$527,825	$5,758,371	$2,737,333	$3,021,038
2001	0.598	$505,119	$6,263,490	$2,494,838	$3,768,652
2002	0.555	$483,391	$6,746,881	$2,268,140	$4,478,741
2003	0.516	$462,597	$7,209,478	$2,056,329	$5,153,149
2004	0.479	$442,696	$7,652,174	$1,858,544	$5,793,630
2005	0.445	$423,652	$8,075,826	$1,673,971	$6,401,855
2006	0.414	$405,428	$8,481,254	$1,501,838	$6,979,416
2007	0.384	$387,988	$8,869,242	$1,341,416	$7,527,826
2008	0.357	$371,297	$9,240,539	$1,192,018	$8,048,521
2009	0.332	$355,325	$9,595,864	$1,052,991	$8,542,873
2010	0.308	$340,039	$9,935,903	$923,719	$9,012,184
2011	0.287	$325,412	$10,261,315	$803,621	$9,457,694
2012	0.266	$311,413	$10,572,728	$692,146	$9,880,582
2013	0.247	$298,017	$10,870,745	$588,774	$10,281,971
2014	0.230	$285,197	$11,155,942	$493,016	$10,662,926
2015	0.214	$272,928	$11,428,870	$404,406	$11,024,464
2016	0.198	$261,187	$11,690,057	$322,508	$11,367,549
2017	0.184	$249,952	$11,940,009	$246,908	$11,693,101
2018	0.171	$239,200	$12,179,209	$177,215	$12,001,994
2019	0.159	$228,910	$12,408,119	$113,061	$12,295,058
2020	0.148	$219,063	$12,627,182	$54,099	$12,573,083
2021	0.137	$209,639	$12,836,821	$0	$12,836,821
%NPV				0.00	
				$0	
DISCOUNTING CONVENTION				E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $1,135,384 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2, 3 AND 4 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 2: Autonomous-Falls City

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
----	-------------	-------------	-------------	-------------	-------------
1996	$0	$105,060	$0	$105,060	0.863
1997	$271,590	$0	$0	$271,590	0.802
1998	$0	$0	$61,225	$61,225	0.745
1999	$0	$0	$63,062	$63,062	0.692
2000	$0	$0	$64,954	$64,954	0.643
2001	$0	$0	$66,903	$66,903	0.598
2002	$0	$0	$68,910	$68,910	0.555
2003	$0	$0	$70,977	$70,977	0.516
2004	$0	$0	$73,106	$73,106	0.479
2005	$0	$0	$75,300	$75,300	0.445
2006	$0	$0	$77,559	$77,559	0.414
2007	$0	$0	$79,885	$79,885	0.384
2008	$0	$0	$82,282	$82,282	0.357
2009	$0	$0	$84,750	$84,750	0.332
2010	$0	$0	$87,293	$87,293	0.308
2011	$0	$0	$89,912	$89,912	0.287
2012	$0	$0	$92,609	$92,609	0.266
2013	$0	$0	$95,387	$95,387	0.247
2014	$0	$0	$98,249	$98,249	0.230
2015	$0	$0	$101,196	$101,196	0.214
2016	$0	$0	$104,232	$104,232	0.198
2017	$0	$0	$107,359	$107,359	0.184
2018	$0	$0	$110,580	$110,580	0.171
2019	$0	$0	$113,897	$113,897	0.159
2020	$0	$0	$117,314	$117,314	0.148
2021	$0	$0	$120,834	$120,834	0.137
	-------------	-------------	-------------		
%NPV	21.78	9.07	69.15		
	$217,828	$90,692	$691,414		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

LIFE CYCLE COST REPORT PAGE 004

ALTERNATIVE 2: Autonomous-Falls City

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$90,692	$90,692	$218,865	-$128,173
1997	$217,828	$308,520	$201,072	$107,448
1998	$45,625	$354,145	$184,405	$169,740
1999	$43,662	$397,807	$168,800	$229,007
2000	$41,784	$439,591	$154,196	$285,395
2001	$39,986	$479,577	$140,536	$339,041
2002	$38,266	$517,843	$127,766	$390,077
2003	$36,620	$554,463	$115,834	$438,629
2004	$35,045	$589,508	$104,693	$484,815
2005	$33,537	$623,045	$94,296	$528,749
2006	$32,094	$655,139	$84,599	$570,540
2007	$30,714	$685,853	$75,563	$610,290
2008	$29,393	$715,246	$67,147	$648,099
2009	$28,128	$743,374	$59,316	$684,058
2010	$26,918	$770,292	$52,034	$718,258
2011	$25,760	$796,052	$45,268	$750,784
2012	$24,652	$820,704	$38,989	$781,715
2013	$23,592	$844,296	$33,166	$811,130
2014	$22,577	$866,873	$27,772	$839,101
2015	$21,606	$888,479	$22,780	$865,699
2016	$20,676	$909,155	$18,167	$890,988
2017	$19,787	$928,942	$13,908	$915,034
2018	$18,935	$947,877	$9,983	$937,894
2019	$18,121	$965,998	$6,369	$959,629
2020	$17,341	$983,339	$3,047	$980,292
2021	$16,595	$999,934	$0	$999,934
%NPV			0.00 $0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $88,441 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 005

ALTERNATIVE 3: Autonomous-Floresville

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$147,290	$0	$147,290	0.863
1997	$369,193	$0	$0	$369,193	0.802
1998	$0	$0	$568,218	$568,218	0.745
1999	$0	$0	$585,265	$585,265	0.692
2000	$0	$0	$602,823	$602,823	0.643
2001	$0	$0	$620,907	$620,907	0.598
2002	$0	$0	$639,534	$639,534	0.555
2003	$0	$0	$658,720	$658,720	0.516
2004	$0	$0	$678,482	$678,482	0.479
2005	$0	$0	$698,837	$698,837	0.445
2006	$0	$0	$719,802	$719,802	0.414
2007	$0	$0	$741,396	$741,396	0.384
2008	$0	$0	$763,638	$763,638	0.357
2009	$0	$0	$786,547	$786,547	0.332
2010	$0	$249,275	$810,143	$1,059,418	0.308
2011	$641,883	$0	$834,447	$1,476,330	0.287
2012	$0	$0	$859,481	$859,481	0.266
2013	$0	$0	$885,265	$885,265	0.247
2014	$0	$0	$911,823	$911,823	0.230
2015	$0	$0	$939,178	$939,178	0.214
2016	$0	$0	$967,353	$967,353	0.198
2017	$0	$0	$996,374	$996,374	0.184
2018	$0	$0	$1,026,265	$1,026,265	0.171
2019	$0	$0	$1,057,053	$1,057,053	0.159
2020	$0	$0	$1,088,765	$1,088,765	0.148
2021	$0	$0	$1,121,427	$1,121,427	0.137
%NPV	6.76	2.87	90.37		
	$480,013	$204,015	$6,416,833		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 006

ALTERNATIVE 3: Autonomous-Floresville

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$127,147	$127,147	$639,497	-$512,350
1997	$296,110	$423,257	$587,508	-$164,251
1998	$423,430	$846,687	$538,808	$307,879
1999	$405,215	$1,251,902	$493,211	$758,691
2000	$387,784	$1,639,686	$450,540	$1,189,146
2001	$371,102	$2,010,788	$410,628	$1,600,160
2002	$355,138	$2,365,926	$373,315	$1,992,611
2003	$339,861	$2,705,787	$338,453	$2,367,334
2004	$325,241	$3,031,028	$305,900	$2,725,128
2005	$311,250	$3,342,278	$275,520	$3,066,758
2006	$297,860	$3,640,138	$247,189	$3,392,949
2007	$285,047	$3,925,185	$220,785	$3,704,400
2008	$272,785	$4,197,970	$196,195	$4,001,775
2009	$261,050	$4,459,020	$173,313	$4,285,707
2010	$326,689	$4,785,709	$152,036	$4,633,673
2011	$422,977	$5,208,686	$132,269	$5,076,417
2012	$228,789	$5,437,475	$113,921	$5,323,554
2013	$218,947	$5,656,422	$96,907	$5,559,515
2014	$209,529	$5,865,951	$81,146	$5,784,805
2015	$200,515	$6,066,466	$66,562	$5,999,904
2016	$191,890	$6,258,356	$53,082	$6,205,274
2017	$183,635	$6,441,991	$40,639	$6,401,352
2018	$175,735	$6,617,726	$29,168	$6,588,558
2019	$168,176	$6,785,902	$18,609	$6,767,293
2020	$160,941	$6,946,843	$8,904	$6,937,939
2021	$154,018	$7,100,861	$0	$7,100,861
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $628,053 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 007

ALTERNATIVE 4: Autonomous-Karnes City

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$107,120	$0	$107,120	0.863
1997	$275,834	$0	$0	$275,834	0.802
1998	$0	$0	$186,551	$186,551	0.745
1999	$0	$0	$192,148	$192,148	0.692
2000	$0	$2,319	$197,912	$200,231	0.643
2001	$5,970	$0	$203,850	$209,820	0.598
2002	$0	$0	$209,965	$209,965	0.555
2003	$0	$0	$216,264	$216,264	0.516
2004	$0	$0	$222,752	$222,752	0.479
2005	$0	$0	$229,435	$229,435	0.445
2006	$0	$0	$236,318	$236,318	0.414
2007	$0	$0	$243,407	$243,407	0.384
2008	$0	$0	$250,710	$250,710	0.357
2009	$0	$0	$258,231	$258,231	0.332
2010	$0	$0	$265,978	$265,978	0.308
2011	$0	$0	$273,957	$273,957	0.287
2012	$0	$0	$282,176	$282,176	0.266
2013	$0	$0	$290,641	$290,641	0.247
2014	$0	$0	$299,360	$299,360	0.230
2015	$0	$0	$308,341	$308,341	0.214
2016	$0	$0	$317,591	$317,591	0.198
2017	$0	$0	$327,119	$327,119	0.184
2018	$0	$0	$336,933	$336,933	0.171
2019	$0	$0	$347,041	$347,041	0.159
2020	$0	$0	$357,452	$357,452	0.148
2021	$0	$0	$368,175	$368,175	0.137
%NPV	9.27	3.87	86.86		
	$224,800	$93,962	$2,106,709		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T

ALTERNATIVE 4: Autonomous-Karnes City

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$92,471	$92,471	$226,560	-$134,089
1997	$221,232	$313,703	$208,141	$105,562
1998	$139,016	$452,719	$190,888	$261,831
1999	$133,036	$585,755	$174,734	$411,021
2000	$128,804	$714,559	$159,617	$554,942
2001	$125,404	$839,963	$145,476	$694,487
2002	$116,595	$956,558	$132,257	$824,301
2003	$111,580	$1,068,138	$119,907	$948,231
2004	$106,780	$1,174,918	$108,373	$1,066,545
2005	$102,186	$1,277,104	$97,611	$1,179,493
2006	$97,790	$1,374,894	$87,574	$1,287,320
2007	$93,584	$1,468,478	$78,219	$1,390,259
2008	$89,558	$1,558,036	$69,508	$1,488,528
2009	$85,705	$1,643,741	$61,401	$1,582,340
2010	$82,019	$1,725,760	$53,863	$1,671,897

2011	$78,490	$1,804,250	$46,860	$1,757,390
2012	$75,114	$1,879,364	$40,360	$1,839,004
2013	$71,883	$1,951,247	$34,332	$1,916,915
2014	$68,790	$2,020,037	$28,748	$1,991,289
2015	$65,831	$2,085,868	$23,581	$2,062,287
2016	$62,999	$2,148,867	$18,806	$2,130,061
2017	$60,289	$2,209,156	$14,397	$2,194,759
2018	$57,696	$2,266,852	$10,334	$2,256,518
2019	$55,214	$2,322,066	$6,593	$2,315,473
2020	$52,839	$2,374,905	$3,155	$2,371,750
2021	$50,566	$2,425,471	$0	$2,425,471

%NPV			0.00	
			$0	
DISCOUNTING				
CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $214,526 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 5: Autonomous-Kenedy

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$424,360	$0	$424,360	0.863
1997	$1,092,727	$0	$0	$1,092,727	0.802
1998	$0	$0	$511,090	$511,090	0.745
1999	$0	$0	$526,423	$526,423	0.692
2000	$0	$0	$542,216	$542,216	0.643
2001	$0	$0	$558,482	$558,482	0.598
2002	$0	$0	$575,237	$575,237	0.555
2003	$0	$0	$592,494	$592,494	0.516
2004	$0	$0	$610,269	$610,269	0.479
2005	$0	$0	$628,577	$628,577	0.445
2006	$0	$0	$647,434	$647,434	0.414
2007	$0	$0	$666,857	$666,857	0.384
2008	$0	$0	$686,863	$686,863	0.357
2009	$0	$0	$707,468	$707,468	0.332
2010	$0	$0	$728,693	$728,693	0.308
2011	$0	$0	$750,553	$750,553	0.287
2012	$0	$0	$773,070	$773,070	0.266
2013	$0	$0	$796,262	$796,262	0.247
2014	$0	$0	$820,150	$820,150	0.230
2015	$0	$0	$844,754	$844,754	0.214
2016	$0	$0	$870,097	$870,097	0.198
2017	$0	$0	$896,200	$896,200	0.184
2018	$0	$0	$923,086	$923,086	0.171
2019	$0	$0	$950,778	$950,778	0.159
2020	$0	$4,188	$979,302	$983,490	0.148
2021	$10,783	$0	$1,008,681	$1,019,464	0.137
%NPV	12.51	5.23	82.26		
	$877,900	$366,945	$5,771,695		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 5: Autonomous-Kenedy

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$366,326	$366,326	$884,866	-$518,540
1997	$876,419	$1,242,745	$812,929	$429,816
1998	$380,859	$1,623,604	$745,544	$878,060
1999	$364,475	$1,988,079	$682,452	$1,305,627
2000	$348,796	$2,336,875	$623,408	$1,713,467
2001	$333,792	$2,670,667	$568,181	$2,102,486
2002	$319,433	$2,990,100	$516,552	$2,473,548
2003	$305,692	$3,295,792	$468,314	$2,827,478
2004	$292,542	$3,588,334	$423,270	$3,165,064
2005	$279,957	$3,868,291	$381,235	$3,487,056
2006	$267,914	$4,136,205	$342,033	$3,794,172
2007	$256,389	$4,392,594	$305,498	$4,087,096
2008	$245,360	$4,637,954	$271,474	$4,366,480
2009	$234,805	$4,872,759	$239,811	$4,632,948
2010	$224,704	$5,097,463	$210,370	$4,887,093
2011	$215,038	$5,312,501	$183,019	$5,129,482
2012	$205,787	$5,518,288	$157,631	$5,360,657
2013	$196,935	$5,715,223	$134,089	$5,581,134
2014	$188,463	$5,903,686	$112,281	$5,791,405
2015	$180,356	$6,084,042	$92,101	$5,991,941
2016	$172,597	$6,256,639	$73,449	$6,183,190
2017	$165,173	$6,421,812	$56,231	$6,365,581
2018	$158,067	$6,579,879	$40,359	$6,539,520
2019	$151,268	$6,731,147	$25,749	$6,705,398
2020	$145,379	$6,876,526	$12,321	$6,864,205
2021	$140,014	$7,016,540	$0	$7,016,540
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $620,595 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 6: Autonomous-Runge

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$96,820	$0	$96,820	0.863
1997	$249,311	$0	$0	$249,311	0.802
1998	$0	$0	$112,223	$112,223	0.745
1999	$0	$0	$115,590	$115,590	0.692
2000	$0	$0	$119,057	$119,057	0.643
2001	$0	$0	$122,629	$122,629	0.598
2002	$0	$0	$126,308	$126,308	0.555
2003	$0	$0	$130,097	$130,097	0.516
2004	$0	$0	$134,000	$134,000	0.479
2005	$0	$0	$138,020	$138,020	0.445
2006	$0	$0	$142,161	$142,161	0.414
2007	$0	$0	$146,426	$146,426	0.384
2008	$0	$0	$150,818	$150,818	0.357
2009	$0	$0	$155,343	$155,343	0.332
2010	$0	$0	$160,003	$160,003	0.308
2011	$0	$0	$164,803	$164,803	0.287
2012	$0	$0	$169,747	$169,747	0.266
2013	$0	$0	$174,840	$174,840	0.247
2014	$0	$0	$180,085	$180,085	0.230
2015	$0	$0	$185,488	$185,488	0.214
2016	$0	$0	$191,052	$191,052	0.198
2017	$0	$0	$196,784	$196,784	0.184
2018	$0	$0	$202,687	$202,687	0.171
2019	$0	$0	$208,768	$208,768	0.159
2020	$0	$67,001	$215,031	$282,032	0.148
2021	$172,527	$0	$221,482	$394,009	0.137
%NPV	14.12	5.90	79.98		
	$223,655	$93,483	$1,267,326		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 6: Autonomous-Runge

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$83,579	$83,579	$269,307	-$185,728
1997	$199,960	$283,539	$247,413	$36,126
1998	$83,627	$367,166	$226,905	$140,261
1999	$80,030	$447,196	$207,703	$239,493
2000	$76,587	$523,783	$189,733	$334,050
2001	$73,293	$597,076	$172,925	$424,151
2002	$70,140	$667,216	$157,212	$510,004
2003	$67,123	$734,339	$142,530	$591,809
2004	$64,235	$798,574	$128,821	$669,753
2005	$61,472	$860,046	$116,028	$744,018
2006	$58,827	$918,873	$104,097	$814,776
2007	$56,297	$975,170	$92,978	$882,192
2008	$53,875	$1,029,045	$82,622	$946,423
2009	$51,557	$1,080,602	$72,986	$1,007,616
2010	$49,340	$1,129,942	$64,026	$1,065,916
2011	$47,217	$1,177,159	$55,701	$1,121,458
2012	$45,186	$1,222,345	$47,975	$1,174,370
2013	$43,242	$1,265,587	$40,810	$1,224,777
2014	$41,382	$1,306,969	$34,172	$1,272,797
2015	$39,602	$1,346,571	$28,031	$1,318,540
2016	$37,898	$1,384,469	$22,354	$1,362,115
2017	$36,268	$1,420,737	$17,114	$1,403,623
2018	$34,708	$1,455,445	$12,283	$1,443,162
2019	$33,215	$1,488,660	$7,837	$1,480,823
2020	$41,690	$1,530,350	$3,750	$1,526,600
2021	$54,114	$1,584,464	$0	$1,584,464
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $140,141 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 7: Autonomous-Poth

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$208,060	$0	$208,060	0.863
1997	$535,754	$0	$0	$535,754	0.802
1998	$0	$0	$354,153	$354,153	0.745
1999	$0	$0	$364,777	$364,777	0.692
2000	$0	$0	$375,721	$375,721	0.643
2001	$0	$0	$386,992	$386,992	0.598
2002	$0	$0	$398,602	$398,602	0.555
2003	$0	$0	$410,560	$410,560	0.516
2004	$0	$0	$422,877	$422,877	0.479
2005	$0	$0	$435,563	$435,563	0.445
2006	$0	$0	$448,630	$448,630	0.414
2007	$0	$0	$462,089	$462,089	0.384
2008	$0	$0	$475,952	$475,952	0.357
2009	$0	$0	$490,230	$490,230	0.332
2010	$0	$3,116	$504,937	$508,053	0.308
2011	$8,024	$0	$520,085	$528,109	0.287
2012	$0	$0	$535,688	$535,688	0.266
2013	$0	$0	$551,759	$551,759	0.247
2014	$0	$0	$568,311	$568,311	0.230
2015	$0	$0	$585,361	$585,361	0.214
2016	$0	$0	$602,921	$602,921	0.198
2017	$0	$0	$621,009	$621,009	0.184
2018	$0	$0	$639,639	$639,639	0.171
2019	$0	$0	$658,829	$658,829	0.159
2020	$0	$4,188	$678,593	$682,781	0.148
2021	$10,783	$0	$698,951	$709,734	0.137
%NPV	9.39	3.93	86.68		
	$433,480	$181,186	$3,999,416		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 014

ALTERNATIVE 7: Autonomous-Poth

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$179,606	$179,606	$440,296	-$260,690
1997	$429,700	$609,306	$404,501	$204,805
1998	$263,911	$873,217	$370,971	$502,246
1999	$252,558	$1,125,775	$339,577	$786,198
2000	$241,694	$1,367,469	$310,198	$1,057,271
2001	$231,296	$1,598,765	$282,718	$1,316,047
2002	$221,347	$1,820,112	$257,029	$1,563,083
2003	$211,825	$2,031,937	$233,026	$1,798,911
2004	$202,713	$2,234,650	$210,613	$2,024,037
2005	$193,992	$2,428,642	$189,697	$2,238,945
2006	$185,647	$2,614,289	$170,190	$2,444,099
2007	$177,661	$2,791,950	$152,011	$2,639,939
2008	$170,019	$2,961,969	$135,081	$2,826,888
2009	$162,705	$3,124,674	$119,326	$3,005,348
2010	$156,667	$3,281,341	$104,677	$3,176,664
2011	$151,306	$3,432,647	$91,067	$3,341,580
2012	$142,597	$3,575,244	$78,435	$3,496,809
2013	$136,463	$3,711,707	$66,721	$3,644,986
2014	$130,593	$3,842,300	$55,869	$3,786,431
2015	$124,975	$3,967,275	$45,828	$3,921,447
2016	$119,599	$4,086,874	$36,547	$4,050,327
2017	$114,454	$4,201,328	$27,980	$4,173,348
2018	$109,530	$4,310,858	$20,082	$4,290,776
2019	$104,819	$4,415,677	$12,812	$4,402,865
2020	$100,929	$4,516,606	$6,131	$4,510,475
2021	$97,476	$4,614,082	$0	$4,614,082
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $408,103 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 8: Autonomous-Stockdale

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$70,040	$0	$70,040	0.863
1997	$180,353	$0	$0	$180,353	0.802
1998	$0	$0	$271,816	$271,816	0.745
1999	$0	$0	$279,970	$279,970	0.692
2000	$0	$0	$288,369	$288,369	0.643
2001	$0	$0	$297,021	$297,021	0.598
2002	$0	$0	$305,931	$305,931	0.555
2003	$0	$0	$315,109	$315,109	0.516
2004	$0	$0	$324,562	$324,562	0.479
2005	$0	$0	$334,299	$334,299	0.445
2006	$0	$0	$344,328	$344,328	0.414
2007	$0	$0	$354,658	$354,658	0.384
2008	$0	$0	$365,298	$365,298	0.357
2009	$0	$0	$376,257	$376,257	0.332
2010	$0	$0	$387,544	$387,544	0.308
2011	$0	$0	$399,171	$399,171	0.287
2012	$0	$0	$411,146	$411,146	0.266
2013	$0	$0	$423,480	$423,480	0.247
2014	$0	$0	$436,185	$436,185	0.230
2015	$0	$0	$449,270	$449,270	0.214
2016	$0	$0	$462,748	$462,748	0.198
2017	$0	$0	$476,631	$476,631	0.184
2018	$0	$0	$490,930	$490,930	0.171
2019	$0	$0	$505,658	$505,658	0.159
2020	$0	$0	$520,827	$520,827	0.148
2021	$0	$0	$536,452	$536,452	0.137
%NPV	4.42	1.85	93.74		
	$144,652	$60,462	$3,069,592		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 8: Autonomous-Stockdale

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
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1996	$60,462	$60,462	$145,340	-$84,878
1997	$144,652	$205,114	$133,525	$71,589
1998	$202,554	$407,668	$122,456	$285,212
1999	$193,841	$601,509	$112,094	$489,415
2000	$185,502	$787,011	$102,396	$684,615
2001	$177,522	$964,533	$93,324	$871,209
2002	$169,886	$1,134,419	$84,844	$1,049,575
2003	$162,578	$1,296,997	$76,921	$1,220,076
2004	$155,584	$1,452,581	$69,523	$1,383,058
2005	$148,891	$1,601,472	$62,618	$1,538,854
2006	$142,486	$1,743,958	$56,179	$1,687,779
2007	$136,357	$1,880,315	$50,178	$1,830,137
2008	$130,491	$2,010,806	$44,590	$1,966,216
2009	$124,877	$2,135,683	$39,389	$2,096,294
2010	$119,506	$2,255,189	$34,554	$2,220,635
2011	$114,365	$2,369,554	$30,061	$2,339,493
2012	$109,445	$2,478,999	$25,891	$2,453,108
2013	$104,737	$2,583,736	$22,024	$2,561,712
2014	$100,231	$2,683,967	$18,442	$2,665,525
2015	$95,920	$2,779,887	$15,128	$2,764,759
2016	$91,793	$2,871,680	$12,064	$2,859,616
2017	$87,845	$2,959,525	$9,236	$2,950,289
2018	$84,066	$3,043,591	$6,629	$3,036,962
2019	$80,449	$3,124,040	$4,229	$3,119,811
2020	$76,989	$3,201,029	$2,024	$3,199,005
2021	$73,677	$3,274,706	$0	$3,274,706

%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $289,639 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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E X E C U T I V E   S U M M A R Y   R E P O R T   PAGE 001

PROJECT TITLE : Meantime
DISCOUNT RATE : 7.63%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1996
BASE YEAR : 1995

PROJECT OBJECTIVE : Economic development and economic analysis of water quality/quantity for Karnes and Wilson Counties

RESULTS AND RECOMMENDATIONS:

ALTERNATIVE NAME	NPV	EUAC
1 Meantime-Falls City	$495,301	$43,808
2 Meantime-Floresville	$2,132,589	$188,622
3 Meantime-Karnes City	$882,815	$78,082
4 Meantime-Kenedy	$2,373,602	$209,939
5 Meantime-Runge	$529,374	$46,821
6 Meantime-Poth	$1,683,688	$148,917
7 Meantime-Stockdale	$1,034,342	$91,484

ACTION OFFICER: Susan Bittick/Jon Cole
ORGANIZATION : CESWF-PL-E

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ALTERNATIVE 1: Meantime-Falls City

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$105,060	$57,711	$162,771	0.863
1997	$271,590	$0	$59,442	$331,032	0.802
1998	$0	$0	$61,225	$61,225	0.745
1999	$0	$0	$63,062	$63,062	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	43.98	18.31	37.71		
	$217,828	$90,692	$186,781		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 1: Meantime-Falls City

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
----	-------------	-------------	-------------	-------------
1996	$140,511	$140,511	$218,865	-$78,354
1997	$265,503	$406,014	$201,072	$204,942
1998	$45,625	$451,639	$184,405	$267,234
1999	$43,662	$495,301	$168,800	$326,501
2000	$0	$495,301	$154,196	$341,105
2001	$0	$495,301	$140,536	$354,765
2002	$0	$495,301	$127,766	$367,535
2003	$0	$495,301	$115,834	$379,467
2004	$0	$495,301	$104,693	$390,608
2005	$0	$495,301	$94,296	$401,005
2006	$0	$495,301	$84,599	$410,702
2007	$0	$495,301	$75,563	$419,738
2008	$0	$495,301	$67,147	$428,154
2009	$0	$495,301	$59,316	$435,985
2010	$0	$495,301	$52,034	$443,267
2011	$0	$495,301	$45,268	$450,033
2012	$0	$495,301	$38,989	$456,312
2013	$0	$495,301	$33,166	$462,135
2014	$0	$495,301	$27,772	$467,529
2015	$0	$495,301	$22,780	$472,521
2016	$0	$495,301	$18,167	$477,134
2017	$0	$495,301	$13,908	$481,393
2018	$0	$495,301	$9,983	$485,318
2019	$0	$495,301	$6,369	$488,932
2020	$0	$495,301	$3,047	$492,254
2021	$0	$495,301	$0	$495,301

%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $43,808 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 2: Meantime-Floresville

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$139,050	$535,600	$674,650	0.863
1997	$347,975	$0	$551,668	$899,643	0.802
1998	$0	$0	$568,218	$568,218	0.745
1999	$0	$0	$585,265	$585,265	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	13.09	5.63	81.28		
	$279,093	$120,034	$1,733,462		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 004

ALTERNATIVE 2: Meantime-Floresville

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
----	-------------	-------------	-------------	-------------
1996	$582,387	$582,387	$280,421	$301,966
1997	$721,557	$1,303,944	$257,624	$1,046,320
1998	$423,430	$1,727,374	$236,269	$1,491,105
1999	$405,215	$2,132,589	$216,275	$1,916,314
2000	$0	$2,132,589	$197,563	$1,935,026
2001	$0	$2,132,589	$180,061	$1,952,528
2002	$0	$2,132,589	$163,700	$1,968,889
2003	$0	$2,132,589	$148,413	$1,984,176
2004	$0	$2,132,589	$134,138	$1,998,451
2005	$0	$2,132,589	$120,816	$2,011,773
2006	$0	$2,132,589	$108,393	$2,024,196
2007	$0	$2,132,589	$96,815	$2,035,774
2008	$0	$2,132,589	$86,032	$2,046,557
2009	$0	$2,132,589	$75,998	$2,056,591
2010	$0	$2,132,589	$66,668	$2,065,921
2011	$0	$2,132,589	$58,000	$2,074,589
2012	$0	$2,132,589	$49,955	$2,082,634
2013	$0	$2,132,589	$42,494	$2,090,095
2014	$0	$2,132,589	$35,583	$2,097,006
2015	$0	$2,132,589	$29,187	$2,103,402
2016	$0	$2,132,589	$23,277	$2,109,312
2017	$0	$2,132,589	$17,820	$2,114,769
2018	$0	$2,132,589	$12,790	$2,119,799
2019	$0	$2,132,589	$8,160	$2,124,429
2020	$0	$2,132,589	$3,904	$2,128,685
2021	$0	$2,132,589	$0	$2,132,589

%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $188,622 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 3: Meantime-Karnes City

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$107,120	$175,843	$282,963	0.863
1997	$275,834	$0	$181,118	$456,952	0.802
1998	$0	$0	$186,551	$186,551	0.745
1999	$0	$0	$192,148	$192,148	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	25.06	10.47	64.47		
	$221,232	$92,471	$569,112		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 3: Meantime-Karnes City

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$244,266	$244,266	$222,285	$21,981
1997	$366,497	$610,763	$204,214	$406,549
1998	$139,016	$749,779	$187,286	$562,493
1999	$133,036	$882,815	$171,437	$711,378
2000	$0	$882,815	$156,605	$726,210
2001	$0	$882,815	$142,732	$740,083
2002	$0	$882,815	$129,762	$753,053
2003	$0	$882,815	$117,644	$765,171
2004	$0	$882,815	$106,329	$776,486
2005	$0	$882,815	$95,769	$787,046
2006	$0	$882,815	$85,921	$796,894
2007	$0	$882,815	$76,743	$806,072
2008	$0	$882,815	$68,196	$814,619
2009	$0	$882,815	$60,242	$822,573
2010	$0	$882,815	$52,847	$829,968
2011	$0	$882,815	$45,976	$836,839
2012	$0	$882,815	$39,598	$843,217
2013	$0	$882,815	$33,684	$849,131
2014	$0	$882,815	$28,206	$854,609
2015	$0	$882,815	$23,136	$859,679
2016	$0	$882,815	$18,451	$864,364
2017	$0	$882,815	$14,126	$868,689
2018	$0	$882,815	$10,139	$872,676
2019	$0	$882,815	$6,468	$876,347
2020	$0	$882,815	$3,095	$879,720
2021	$0	$882,815	$0	$882,815
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $78,082 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 4: Meantime-Kenedy

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$278,100	$481,752	$759,852	0.863
1997	$716,107	$0	$496,204	$1,212,311	0.802
1998	$0	$0	$511,090	$511,090	0.745
1999	$0	$0	$526,423	$526,423	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	24.20	10.11	65.69		
	$574,352	$240,068	$1,559,182		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 4: Meantime-Kenedy

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$655,937	$655,937	$577,087	$78,850
1997	$972,331	$1,628,268	$530,171	$1,098,097
1998	$380,859	$2,009,127	$486,224	$1,522,903
1999	$364,475	$2,373,602	$445,077	$1,928,525
2000	$0	$2,373,602	$406,570	$1,967,032
2001	$0	$2,373,602	$370,553	$2,003,049
2002	$0	$2,373,602	$336,882	$2,036,720
2003	$0	$2,373,602	$305,422	$2,068,180
2004	$0	$2,373,602	$276,046	$2,097,556
2005	$0	$2,373,602	$248,631	$2,124,971
2006	$0	$2,373,602	$223,065	$2,150,537
2007	$0	$2,373,602	$199,238	$2,174,364
2008	$0	$2,373,602	$177,048	$2,196,554
2009	$0	$2,373,602	$156,399	$2,217,203
2010	$0	$2,373,602	$137,198	$2,236,404
2011	$0	$2,373,602	$119,360	$2,254,242
2012	$0	$2,373,602	$102,803	$2,270,799
2013	$0	$2,373,602	$87,449	$2,286,153
2014	$0	$2,373,602	$73,227	$2,300,375
2015	$0	$2,373,602	$60,066	$2,313,536
2016	$0	$2,373,602	$47,901	$2,325,701
2017	$0	$2,373,602	$36,673	$2,336,929
2018	$0	$2,373,602	$26,321	$2,347,281
2019	$0	$2,373,602	$16,793	$2,356,809
2020	$0	$2,373,602	$8,035	$2,365,567
2021	$0	$2,373,602	$0	$2,373,602
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $209,939 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 5: Meantime-Runge

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$63,860	$105,781	$169,641	0.863
1997	$164,439	$0	$108,954	$273,393	0.802
1998	$0	$0	$112,223	$112,223	0.745
1999	$0	$0	$115,590	$115,590	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	24.91	10.41	64.67		
	$131,888	$55,127	$342,359		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 5: Meantime-Runge

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$146,442	$146,442	$132,516	$13,926
1997	$219,275	$365,717	$121,743	$243,974
1998	$83,627	$449,344	$111,651	$337,693
1999	$80,030	$529,374	$102,203	$427,171
2000	$0	$529,374	$93,361	$436,013
2001	$0	$529,374	$85,090	$444,284
2002	$0	$529,374	$77,358	$452,016
2003	$0	$529,374	$70,134	$459,240
2004	$0	$529,374	$63,388	$465,986
2005	$0	$529,374	$57,093	$472,281
2006	$0	$529,374	$51,222	$478,152
2007	$0	$529,374	$45,751	$483,623
2008	$0	$529,374	$40,655	$488,719
2009	$0	$529,374	$35,914	$493,460
2010	$0	$529,374	$31,505	$497,869
2011	$0	$529,374	$27,409	$501,965
2012	$0	$529,374	$23,607	$505,767
2013	$0	$529,374	$20,081	$509,293
2014	$0	$529,374	$16,815	$512,559
2015	$0	$529,374	$13,793	$515,581
2016	$0	$529,374	$11,000	$518,374
2017	$0	$529,374	$8,421	$520,953
2018	$0	$529,374	$6,044	$523,330
2019	$0	$529,374	$3,856	$525,518
2020	$0	$529,374	$1,845	$527,529
2021	$0	$529,374	$0	$529,374
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $46,821 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 6: Meantime-Poth

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$206,000	$333,823	$539,823	0.863
1997	$530,450	$0	$343,838	$874,288	0.802
1998	$0	$0	$354,153	$354,153	0.745
1999	$0	$0	$364,777	$364,777	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	25.27	10.56	64.17		
	$425,446	$177,828	$1,080,414		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 012

ALTERNATIVE 6: Meantime-Poth

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$465,999	$465,999	$427,472	$38,527
1997	$701,220	$1,167,219	$392,719	$774,500
1998	$263,911	$1,431,130	$360,166	$1,070,964
1999	$252,558	$1,683,688	$329,687	$1,354,001
2000	$0	$1,683,688	$301,163	$1,382,525
2001	$0	$1,683,688	$274,484	$1,409,204
2002	$0	$1,683,688	$249,542	$1,434,146
2003	$0	$1,683,688	$226,239	$1,457,449
2004	$0	$1,683,688	$204,478	$1,479,210
2005	$0	$1,683,688	$184,171	$1,499,517
2006	$0	$1,683,688	$165,233	$1,518,455
2007	$0	$1,683,688	$147,584	$1,536,104
2008	$0	$1,683,688	$131,147	$1,552,541
2009	$0	$1,683,688	$115,851	$1,567,837
2010	$0	$1,683,688	$101,628	$1,582,060
2011	$0	$1,683,688	$88,415	$1,595,273
2012	$0	$1,683,688	$76,150	$1,607,538
2013	$0	$1,683,688	$64,777	$1,618,911
2014	$0	$1,683,688	$54,242	$1,629,446
2015	$0	$1,683,688	$44,493	$1,639,195
2016	$0	$1,683,688	$35,483	$1,648,205
2017	$0	$1,683,688	$27,165	$1,656,523
2018	$0	$1,683,688	$19,497	$1,664,191
2019	$0	$1,683,688	$12,439	$1,671,249
2020	$0	$1,683,688	$5,952	$1,677,736
2021	$0	$1,683,688	$0	$1,683,688
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $148,917 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 013

ALTERNATIVE 7: Meantime-Stockdale

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$70,040	$256,213	$326,253	0.863
1997	$180,353	$0	$263,899	$444,252	0.802
1998	$0	$0	$271,816	$271,816	0.745
1999	$0	$0	$279,970	$279,970	0.692
2000	$0	$0	$0	$0	0.643
2001	$0	$0	$0	$0	0.598
2002	$0	$0	$0	$0	0.555
2003	$0	$0	$0	$0	0.516
2004	$0	$0	$0	$0	0.479
2005	$0	$0	$0	$0	0.445
2006	$0	$0	$0	$0	0.414
2007	$0	$0	$0	$0	0.384
2008	$0	$0	$0	$0	0.357
2009	$0	$0	$0	$0	0.332
2010	$0	$0	$0	$0	0.308
2011	$0	$0	$0	$0	0.287
2012	$0	$0	$0	$0	0.266
2013	$0	$0	$0	$0	0.247
2014	$0	$0	$0	$0	0.230
2015	$0	$0	$0	$0	0.214
2016	$0	$0	$0	$0	0.198
2017	$0	$0	$0	$0	0.184
2018	$0	$0	$0	$0	0.171
2019	$0	$0	$0	$0	0.159
2020	$0	$0	$0	$0	0.148
2021	$0	$0	$0	$0	0.137
%NPV	13.98	5.85	80.17		
	$144,652	$60,462	$829,228		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E C Y C L E C O S T R E P O R T PAGE 014

ALTERNATIVE 7: Meantime-Stockdale

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$281,636	$281,636	$145,340	$136,296
1997	$356,311	$637,947	$133,525	$504,422
1998	$202,554	$840,501	$122,456	$718,045
1999	$193,841	$1,034,342	$112,094	$922,248
2000	$0	$1,034,342	$102,396	$931,946
2001	$0	$1,034,342	$93,324	$941,018
2002	$0	$1,034,342	$84,844	$949,498
2003	$0	$1,034,342	$76,921	$957,421
2004	$0	$1,034,342	$69,523	$964,819
2005	$0	$1,034,342	$62,618	$971,724
2006	$0	$1,034,342	$56,179	$978,163
2007	$0	$1,034,342	$50,178	$984,164
2008	$0	$1,034,342	$44,590	$989,752
2009	$0	$1,034,342	$39,389	$994,953
2010	$0	$1,034,342	$34,554	$999,788
2011	$0	$1,034,342	$30,061	$1,004,281
2012	$0	$1,034,342	$25,891	$1,008,451
2013	$0	$1,034,342	$22,024	$1,012,318
2014	$0	$1,034,342	$18,442	$1,015,900
2015	$0	$1,034,342	$15,128	$1,019,214
2016	$0	$1,034,342	$12,064	$1,022,278
2017	$0	$1,034,342	$9,236	$1,025,106
2018	$0	$1,034,342	$6,629	$1,027,713
2019	$0	$1,034,342	$4,229	$1,030,113
2020	$0	$1,034,342	$2,024	$1,032,318
2021	$0	$1,034,342	$0	$1,034,342
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $91,484 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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PAGE 001

PROJECT TITLE : ACCOG 10"
DISCOUNT RATE : 7.63%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1996
BASE YEAR : 1995

PROJECT OBJECTIVE : Economic development and economic analysis of water quality/quantity for Karnes and Wilson Counties

RESULTS AND RECOMMENDATIONS:

ALTERNATIVE NAME	NPV	EUAC
1 Falls City 10"	$1,099,616	$97,258
2 Floresville 10"	$8,662,525	$766,178
3 Karnes City 10"	$2,875,563	$254,336
4 Kenedy 10"	$8,331,829	$736,929
5 Poth 10"	$5,581,602	$493,678

ACTION OFFICER: Susan Bittick/Jon Cole
ORGANIZATION : CESWF-PL-E

LIFE CYCLE COST REPORT PAGE 001

ALTERNATIVE 1: Falls City 10"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$105,060	$0	$105,060	0.863
1997	$180,353	$0	$0	$180,353	0.802
1998	$0	$0	$76,532	$76,532	0.745
1999	$0	$0	$78,828	$78,828	0.692
2000	$0	$0	$81,193	$81,193	0.643
2001	$0	$0	$83,629	$83,629	0.598
2002	$0	$0	$86,138	$86,138	0.555
2003	$0	$0	$88,722	$88,722	0.516
2004	$0	$0	$91,384	$91,384	0.479
2005	$0	$0	$94,125	$94,125	0.445
2006	$0	$0	$96,949	$96,949	0.414
2007	$0	$0	$99,857	$99,857	0.384
2008	$0	$0	$102,853	$102,853	0.357
2009	$0	$0	$105,939	$105,939	0.332
2010	$0	$0	$109,117	$109,117	0.308
2011	$0	$0	$112,390	$112,390	0.287
2012	$0	$0	$115,762	$115,762	0.266
2013	$0	$0	$119,235	$119,235	0.247
2014	$0	$0	$122,812	$122,812	0.230
2015	$0	$0	$126,496	$126,496	0.214
2016	$0	$0	$130,291	$130,291	0.198
2017	$0	$0	$134,200	$134,200	0.184
2018	$0	$0	$138,226	$138,226	0.171
2019	$0	$0	$142,373	$142,373	0.159
2020	$0	$0	$146,644	$146,644	0.148
2021	$0	$0	$151,043	$151,043	0.137
%NPV	13.15	8.25	78.60		
	$144,652	$90,692	$864,272		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 002

ALTERNATIVE 1: Falls City 10"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
----	-------------	-------------	-------------	-------------
1996	$90,692	$90,692	$145,340	-$54,648
1997	$144,652	$235,344	$133,525	$101,819
1998	$57,031	$292,375	$122,456	$169,919
1999	$54,578	$346,953	$112,094	$234,859
2000	$52,230	$399,183	$102,396	$296,787
2001	$49,983	$449,166	$93,324	$355,842
2002	$47,833	$496,999	$84,844	$412,155
2003	$45,775	$542,774	$76,921	$465,853
2004	$43,806	$586,580	$69,523	$517,057
2005	$41,922	$628,502	$62,618	$565,884
2006	$40,118	$668,620	$56,179	$612,441
2007	$38,393	$707,013	$50,178	$656,835
2008	$36,741	$743,754	$44,590	$699,164
2009	$35,160	$778,914	$39,389	$739,525
2010	$33,648	$812,562	$34,554	$778,008
2011	$32,200	$844,762	$30,061	$814,701
2012	$30,815	$875,577	$25,891	$849,686
2013	$29,490	$905,067	$22,024	$883,043
2014	$28,221	$933,288	$18,442	$914,846
2015	$27,007	$960,295	$15,128	$945,167
2016	$25,845	$986,140	$12,064	$974,076
2017	$24,734	$1,010,874	$9,236	$1,001,638
2018	$23,670	$1,034,544	$6,629	$1,027,915
2019	$22,651	$1,057,195	$4,229	$1,052,966
2020	$21,677	$1,078,872	$2,024	$1,076,848
2021	$20,744	$1,099,616	$0	$1,099,616

%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $97,258 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 003

ALTERNATIVE 2: Floresville 10"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$147,290	$0	$147,290	0.863
1997	$316,148	$0	$0	$316,148	0.802
1998	$0	$0	$710,273	$710,273	0.745
1999	$0	$0	$731,581	$731,581	0.692
2000	$0	$0	$753,528	$753,528	0.643
2001	$0	$0	$776,134	$776,134	0.598
2002	$0	$0	$799,418	$799,418	0.555
2003	$0	$0	$823,401	$823,401	0.516
2004	$0	$0	$848,103	$848,103	0.479
2005	$0	$0	$873,546	$873,546	0.445
2006	$0	$0	$899,752	$899,752	0.414
2007	$0	$0	$926,745	$926,745	0.384
2008	$0	$0	$954,547	$954,547	0.357
2009	$0	$0	$983,183	$983,183	0.332
2010	$0	$249,275	$1,012,679	$1,261,954	0.308
2011	$641,883	$0	$1,043,059	$1,684,942	0.287
2012	$0	$0	$1,074,351	$1,074,351	0.266
2013	$0	$0	$1,106,581	$1,106,581	0.247
2014	$0	$0	$1,139,779	$1,139,779	0.230
2015	$0	$0	$1,173,972	$1,173,972	0.214
2016	$0	$0	$1,209,191	$1,209,191	0.198
2017	$0	$0	$1,245,467	$1,245,467	0.184
2018	$0	$0	$1,282,831	$1,282,831	0.171
2019	$0	$0	$1,321,316	$1,321,316	0.159
2020	$0	$0	$1,360,956	$1,360,956	0.148
2021	$0	$0	$1,401,784	$1,401,784	0.137
%NPV	5.05	2.36	92.59		
	$437,469	$204,015	$8,021,041		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 004

ALTERNATIVE 2: Floresville 10"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$127,147	$127,147	$596,750	-$469,603
1997	$253,566	$380,713	$548,236	-$167,523
1998	$529,288	$910,001	$502,792	$407,209
1999	$506,519	$1,416,520	$460,243	$956,277
2000	$484,729	$1,901,249	$420,424	$1,480,825
2001	$463,878	$2,365,127	$383,179	$1,981,948
2002	$443,923	$2,809,050	$348,361	$2,460,689
2003	$424,826	$3,233,876	$315,829	$2,918,047
2004	$406,551	$3,640,427	$285,452	$3,354,975
2005	$389,062	$4,029,489	$257,103	$3,772,386
2006	$372,325	$4,401,814	$230,666	$4,171,148
2007	$356,309	$4,758,123	$206,027	$4,552,096
2008	$340,981	$5,099,104	$183,081	$4,916,023
2009	$326,313	$5,425,417	$161,728	$5,263,689
2010	$389,144	$5,814,561	$141,873	$5,672,688
2011	$482,745	$6,297,306	$123,427	$6,173,879
2012	$285,987	$6,583,293	$106,306	$6,476,987
2013	$273,684	$6,856,977	$90,429	$6,766,548
2014	$261,911	$7,118,888	$75,722	$7,043,166
2015	$250,644	$7,369,532	$62,112	$7,307,420
2016	$239,862	$7,609,394	$49,534	$7,559,860
2017	$229,544	$7,838,938	$37,922	$7,801,016
2018	$219,669	$8,058,607	$27,218	$8,031,389
2019	$210,220	$8,268,827	$17,365	$8,251,462
2020	$201,176	$8,470,003	$8,309	$8,461,694
2021	$192,522	$8,662,525	$0	$8,662,525
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $766,178 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E C Y C L E C O S T R E P O R T PAGE 005

ALTERNATIVE 3: Karnes City 10"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$107,120	$0	$107,120	0.863
1997	$180,353	$0	$0	$180,353	0.802
1998	$0	$0	$233,189	$233,189	0.745
1999	$0	$0	$240,185	$240,185	0.692
2000	$0	$2,319	$247,390	$249,709	0.643
2001	$5,970	$0	$254,812	$260,782	0.598
2002	$0	$0	$262,456	$262,456	0.555
2003	$0	$0	$270,330	$270,330	0.516
2004	$0	$0	$278,440	$278,440	0.479
2005	$0	$0	$286,793	$286,793	0.445
2006	$0	$0	$295,397	$295,397	0.414
2007	$0	$0	$304,259	$304,259	0.384
2008	$0	$0	$313,387	$313,387	0.357
2009	$0	$0	$322,788	$322,788	0.332
2010	$0	$0	$332,472	$332,472	0.308
2011	$0	$0	$342,446	$342,446	0.287
2012	$0	$0	$352,719	$352,719	0.266
2013	$0	$0	$363,301	$363,301	0.247
2014	$0	$0	$374,200	$374,200	0.230
2015	$0	$0	$385,426	$385,426	0.214
2016	$0	$0	$396,989	$396,989	0.198
2017	$0	$0	$408,898	$408,898	0.184
2018	$0	$0	$421,165	$421,165	0.171
2019	$0	$0	$433,800	$433,800	0.159
2020	$0	$0	$446,814	$446,814	0.148
2021	$0	$0	$460,219	$460,219	0.137
%NPV	5.15	3.27	91.58		
	$148,220	$93,962	$2,633,381		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 006

ALTERNATIVE 3: Karnes City 10"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$92,471	$92,471	$149,615	-$57,144
1997	$144,652	$237,123	$137,452	$99,671
1998	$173,770	$410,893	$126,058	$284,835
1999	$166,295	$577,188	$115,390	$461,798
2000	$160,632	$737,820	$105,407	$632,413
2001	$155,863	$893,683	$96,069	$797,614
2002	$145,744	$1,039,427	$87,340	$952,087
2003	$139,474	$1,178,901	$79,184	$1,099,717
2004	$133,474	$1,312,375	$71,567	$1,240,808
2005	$127,733	$1,440,108	$64,460	$1,375,648
2006	$122,238	$1,562,346	$57,832	$1,504,514
2007	$116,979	$1,679,325	$51,654	$1,627,671
2008	$111,947	$1,791,272	$45,901	$1,745,371
2009	$107,132	$1,898,404	$40,548	$1,857,856
2010	$102,523	$2,000,927	$35,570	$1,965,357
2011	$98,113	$2,099,040	$30,945	$2,068,095
2012	$93,892	$2,192,932	$26,653	$2,166,279
2013	$89,853	$2,282,785	$22,672	$2,260,113
2014	$85,988	$2,368,773	$18,985	$2,349,788
2015	$82,289	$2,451,062	$15,573	$2,435,489
2016	$78,749	$2,529,811	$12,419	$2,517,392
2017	$75,361	$2,605,172	$9,508	$2,595,664
2018	$72,119	$2,677,291	$6,824	$2,670,467
2019	$69,017	$2,746,308	$4,354	$2,741,954
2020	$66,048	$2,812,356	$2,083	$2,810,273
2021	$63,207	$2,875,563	$0	$2,875,563
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $254,336 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E C Y C L E C O S T R E P O R T PAGE 007

ALTERNATIVE 4: Kenedy 10"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$424,360	$0	$424,360	0.863
1997	$933,592	$0	$0	$933,592	0.802
1998	$0	$0	$638,863	$638,863	0.745
1999	$0	$0	$658,029	$658,029	0.692
2000	$0	$0	$677,770	$677,770	0.643
2001	$0	$0	$698,103	$698,103	0.598
2002	$0	$0	$719,046	$719,046	0.555
2003	$0	$0	$740,617	$740,617	0.516
2004	$0	$0	$762,836	$762,836	0.479
2005	$0	$0	$785,721	$785,721	0.445
2006	$0	$0	$809,292	$809,292	0.414
2007	$0	$0	$833,571	$833,571	0.384
2008	$0	$0	$858,578	$858,578	0.357
2009	$0	$0	$884,336	$884,336	0.332
2010	$0	$0	$910,866	$910,866	0.308
2011	$0	$0	$938,192	$938,192	0.287
2012	$0	$0	$966,337	$966,337	0.266
2013	$0	$0	$995,327	$995,327	0.247
2014	$0	$0	$1,025,187	$1,025,187	0.230
2015	$0	$0	$1,055,943	$1,055,943	0.214
2016	$0	$0	$1,087,621	$1,087,621	0.198
2017	$0	$0	$1,120,250	$1,120,250	0.184
2018	$0	$0	$1,153,857	$1,153,857	0.171
2019	$0	$0	$1,188,473	$1,188,473	0.159
2020	$0	$4,188	$1,224,127	$1,228,315	0.148
2021	$10,783	$0	$1,260,851	$1,271,634	0.137
%NPV	9.00	4.40	86.59		
	$750,266	$366,945	$7,214,618		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 4: Kenedy 10"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$366,326	$366,326	$756,625	-$390,299
1997	$748,785	$1,115,111	$695,113	$419,998
1998	$476,074	$1,591,185	$637,494	$953,691
1999	$455,594	$2,046,779	$583,546	$1,463,233
2000	$435,996	$2,482,775	$533,059	$1,949,716
2001	$417,240	$2,900,015	$485,836	$2,414,179
2002	$399,291	$3,299,306	$441,690	$2,857,616
2003	$382,115	$3,681,421	$400,442	$3,280,979
2004	$365,677	$4,047,098	$361,927	$3,685,171
2005	$349,946	$4,397,044	$325,983	$4,071,061
2006	$334,892	$4,731,936	$292,463	$4,439,473
2007	$320,486	$5,052,422	$261,223	$4,791,199
2008	$306,700	$5,359,122	$232,130	$5,126,992
2009	$293,506	$5,652,628	$205,056	$5,447,572

2010	$280,880	$5,933,508	$179,882	$5,753,626
2011	$268,797	$6,202,305	$156,494	$6,045,811
2012	$257,234	$6,459,539	$134,786	$6,324,753
2013	$246,169	$6,705,708	$114,656	$6,591,052
2014	$235,579	$6,941,287	$96,008	$6,845,279
2015	$225,445	$7,166,732	$78,753	$7,087,979
2016	$215,747	$7,382,479	$62,804	$7,319,675
2017	$206,466	$7,588,945	$48,082	$7,540,863
2018	$197,584	$7,786,529	$34,510	$7,752,019
2019	$189,084	$7,975,613	$22,017	$7,953,596
2020	$181,569	$8,157,182	$10,535	$8,146,647
2021	$174,647	$8,331,829	$0	$8,331,829

%NPV			0.00	
			$0	
DISCOUNTING				
CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $736,929 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 5: Poth 10"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$208,060	$0	$208,060	0.863
1997	$495,440	$0	$0	$495,440	0.802
1998	$0	$0	$442,691	$442,691	0.745
1999	$0	$0	$455,972	$455,972	0.692
2000	$0	$0	$469,651	$469,651	0.643
2001	$0	$0	$483,740	$483,740	0.598
2002	$0	$0	$498,253	$498,253	0.555
2003	$0	$0	$513,200	$513,200	0.516
2004	$0	$0	$528,596	$528,596	0.479
2005	$0	$0	$544,454	$544,454	0.445
2006	$0	$0	$560,788	$560,788	0.414
2007	$0	$0	$577,611	$577,611	0.384
2008	$0	$0	$594,940	$594,940	0.357
2009	$0	$0	$612,788	$612,788	0.332
2010	$0	$3,116	$631,172	$634,288	0.308
2011	$8,024	$0	$650,107	$658,131	0.287
2012	$0	$0	$669,610	$669,610	0.266
2013	$0	$0	$689,698	$689,698	0.247
2014	$0	$0	$710,389	$710,389	0.230
2015	$0	$0	$731,701	$731,701	0.214
2016	$0	$0	$753,652	$753,652	0.198
2017	$0	$0	$776,261	$776,261	0.184
2018	$0	$0	$799,549	$799,549	0.171
2019	$0	$0	$823,536	$823,536	0.159
2020	$0	$4,188	$848,242	$852,430	0.148
2021	$10,783	$0	$873,689	$884,472	0.137
%NPV	7.19	3.25	89.57		
	$401,147	$181,186	$4,999,269		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 010

ALTERNATIVE 5: Poth 10"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$179,606	$179,606	$407,808	-$228,202
1997	$397,367	$576,973	$374,654	$202,319
1998	$329,889	$906,862	$343,598	$563,264
1999	$315,698	$1,222,560	$314,521	$908,039
2000	$302,117	$1,524,677	$287,310	$1,237,367
2001	$289,121	$1,813,798	$261,857	$1,551,941
2002	$276,683	$2,090,481	$238,063	$1,852,418
2003	$264,781	$2,355,262	$215,832	$2,139,430
2004	$253,391	$2,608,653	$195,072	$2,413,581
2005	$242,490	$2,851,143	$175,699	$2,675,444
2006	$232,059	$3,083,202	$157,632	$2,925,570
2007	$222,076	$3,305,278	$140,795	$3,164,483
2008	$212,523	$3,517,801	$125,114	$3,392,687
2009	$203,381	$3,721,182	$110,522	$3,610,660
2010	$195,593	$3,916,775	$96,953	$3,819,822
2011	$188,558	$4,105,333	$84,348	$4,020,985
2012	$178,247	$4,283,580	$72,647	$4,210,933
2013	$170,579	$4,454,159	$61,798	$4,392,361
2014	$163,241	$4,617,400	$51,747	$4,565,653
2015	$156,219	$4,773,619	$42,446	$4,731,173
2016	$149,499	$4,923,118	$33,850	$4,889,268
2017	$143,068	$5,066,186	$25,915	$5,040,271
2018	$136,913	$5,203,099	$18,600	$5,184,499
2019	$131,023	$5,334,122	$11,867	$5,322,255
2020	$126,006	$5,460,128	$5,678	$5,454,450
2021	$121,474	$5,581,602	$0	$5,581,602
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $493,678 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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E X E C U T I V E   S U M M A R Y   R E P O R T   PAGE 001

PROJECT TITLE : ACCOG 14"
DISCOUNT RATE : 7.63%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1996
BASE YEAR : 1995

PROJECT OBJECTIVE : Economic development and economic analysis of water quality/quantity for Karnes and Wilson Counties

RESULTS AND RECOMMENDATIONS:

ALTERNATIVE NAME	NPV	EUAC
1 Falls City 14"	$1,118,165	$98,898
2 Floresville 14"	$8,683,797	$768,059
3 Karnes City 14"	$2,929,169	$259,077
4 Kenedy 14"	$8,421,173	$744,831
5 Poth 14"	$5,624,827	$497,501

ACTION OFFICER: Susan Bittick/Jon Cole
ORGANIZATION : CESWF-PL-E

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 001

ALTERNATIVE 1: Falls City 14"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$105,060	$0	$105,060	0.863
1997	$203,481	$0	$0	$203,481	0.802
1998	$0	$0	$76,532	$76,532	0.745
1999	$0	$0	$78,828	$78,828	0.692
2000	$0	$0	$81,193	$81,193	0.643
2001	$0	$0	$83,629	$83,629	0.598
2002	$0	$0	$86,138	$86,138	0.555
2003	$0	$0	$88,722	$88,722	0.516
2004	$0	$0	$91,384	$91,384	0.479
2005	$0	$0	$94,125	$94,125	0.445
2006	$0	$0	$96,949	$96,949	0.414
2007	$0	$0	$99,857	$99,857	0.384
2008	$0	$0	$102,853	$102,853	0.357
2009	$0	$0	$105,939	$105,939	0.332
2010	$0	$0	$109,117	$109,117	0.308
2011	$0	$0	$112,390	$112,390	0.287
2012	$0	$0	$115,762	$115,762	0.266
2013	$0	$0	$119,235	$119,235	0.247
2014	$0	$0	$122,812	$122,812	0.230
2015	$0	$0	$126,496	$126,496	0.214
2016	$0	$0	$130,291	$130,291	0.198
2017	$0	$0	$134,200	$134,200	0.184
2018	$0	$0	$138,226	$138,226	0.171
2019	$0	$0	$142,373	$142,373	0.159
2020	$0	$0	$146,644	$146,644	0.148
2021	$0	$0	$151,043	$151,043	0.137
%NPV	14.60	8.11	77.29		
	$163,201	$90,692	$864,272		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 002

ALTERNATIVE 1: Falls City 14"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$90,692	$90,692	$163,978	-$73,286
1997	$163,201	$253,893	$150,647	$103,246
1998	$57,031	$310,924	$138,160	$172,764
1999	$54,578	$365,502	$126,468	$239,034
2000	$52,230	$417,732	$115,526	$302,206
2001	$49,983	$467,715	$105,292	$362,423
2002	$47,833	$515,548	$95,724	$419,824
2003	$45,775	$561,323	$86,785	$474,538
2004	$43,806	$605,129	$78,438	$526,691
2005	$41,922	$647,051	$70,648	$576,403
2006	$40,118	$687,169	$63,383	$623,786
2007	$38,393	$725,562	$56,613	$668,949
2008	$36,741	$762,303	$50,308	$711,995
2009	$35,160	$797,463	$44,440	$753,023
2010	$33,648	$831,111	$38,985	$792,126
2011	$32,200	$863,311	$33,916	$829,395
2012	$30,815	$894,126	$29,211	$864,915
2013	$29,490	$923,616	$24,849	$898,767
2014	$28,221	$951,837	$20,807	$931,030
2015	$27,007	$978,844	$17,068	$961,776
2016	$25,845	$1,004,689	$13,611	$991,078
2017	$24,734	$1,029,423	$10,420	$1,019,003
2018	$23,670	$1,053,093	$7,479	$1,045,614
2019	$22,651	$1,075,744	$4,772	$1,070,972
2020	$21,677	$1,097,421	$2,283	$1,095,138
2021	$20,744	$1,118,165	$0	$1,118,165
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $98,898 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

LIFE CYCLE COST REPORT PAGE 003

ALTERNATIVE 2: Floresville 14"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$147,290	$0	$147,290	0.863
1997	$342,671	$0	$0	$342,671	0.802
1998	$0	$0	$710,273	$710,273	0.745
1999	$0	$0	$731,581	$731,581	0.692
2000	$0	$0	$753,528	$753,528	0.643
2001	$0	$0	$776,134	$776,134	0.598
2002	$0	$0	$799,418	$799,418	0.555
2003	$0	$0	$823,401	$823,401	0.516
2004	$0	$0	$848,103	$848,103	0.479
2005	$0	$0	$873,546	$873,546	0.445
2006	$0	$0	$899,752	$899,752	0.414
2007	$0	$0	$926,745	$926,745	0.384
2008	$0	$0	$954,547	$954,547	0.357
2009	$0	$0	$983,183	$983,183	0.332
2010	$0	$249,275	$1,012,679	$1,261,954	0.308
2011	$641,883	$0	$1,043,059	$1,684,942	0.287
2012	$0	$0	$1,074,351	$1,074,351	0.266
2013	$0	$0	$1,106,581	$1,106,581	0.247
2014	$0	$0	$1,139,779	$1,139,779	0.230
2015	$0	$0	$1,173,972	$1,173,972	0.214
2016	$0	$0	$1,209,191	$1,209,191	0.198
2017	$0	$0	$1,245,467	$1,245,467	0.184
2018	$0	$0	$1,282,831	$1,282,831	0.171
2019	$0	$0	$1,321,316	$1,321,316	0.159
2020	$0	$0	$1,360,956	$1,360,956	0.148
2021	$0	$0	$1,401,784	$1,401,784	0.137
%NPV	5.28	2.35	92.37		
	$458,741	$204,015	$8,021,041		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

LIFE CYCLE COST REPORT PAGE 004

ALTERNATIVE 2: Floresville 14"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$127,147	$127,147	$618,124	-$490,977
1997	$274,838	$401,985	$567,872	-$165,887
1998	$529,288	$931,273	$520,800	$410,473
1999	$506,519	$1,437,792	$476,727	$961,065
2000	$484,729	$1,922,521	$435,482	$1,487,039
2001	$463,878	$2,386,399	$396,903	$1,989,496
2002	$443,923	$2,830,322	$360,838	$2,469,484
2003	$424,826	$3,255,148	$327,141	$2,928,007
2004	$406,551	$3,661,699	$295,676	$3,366,023
2005	$389,062	$4,050,761	$266,312	$3,784,449
2006	$372,325	$4,423,086	$238,927	$4,184,159
2007	$356,309	$4,779,395	$213,406	$4,565,989
2008	$340,981	$5,120,376	$189,638	$4,930,738
2009	$326,313	$5,446,689	$167,520	$5,279,169
2010	$389,144	$5,835,833	$146,954	$5,688,879
2011	$482,745	$6,318,578	$127,848	$6,190,730
2012	$285,987	$6,604,565	$110,113	$6,494,452
2013	$273,684	$6,878,249	$93,668	$6,784,581
2014	$261,911	$7,140,160	$78,434	$7,061,726
2015	$250,644	$7,390,804	$64,337	$7,326,467
2016	$239,862	$7,630,666	$51,308	$7,579,358
2017	$229,544	$7,860,210	$39,281	$7,820,929
2018	$219,669	$8,079,879	$28,193	$8,051,686
2019	$210,220	$8,290,099	$17,987	$8,272,112
2020	$201,176	$8,491,275	$8,607	$8,482,668
2021	$192,522	$8,683,797	$0	$8,683,797
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $768,059 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 005

ALTERNATIVE 3: Karnes City 14"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$107,120	$0	$107,120	0.863
1997	$247,190	$0	$0	$247,190	0.802
1998	$0	$0	$233,189	$233,189	0.745
1999	$0	$0	$240,185	$240,185	0.692
2000	$0	$2,319	$247,390	$249,709	0.643
2001	$5,970	$0	$254,812	$260,782	0.598
2002	$0	$0	$262,456	$262,456	0.555
2003	$0	$0	$270,330	$270,330	0.516
2004	$0	$0	$278,440	$278,440	0.479
2005	$0	$0	$286,793	$286,793	0.445
2006	$0	$0	$295,397	$295,397	0.414
2007	$0	$0	$304,259	$304,259	0.384
2008	$0	$0	$313,387	$313,387	0.357
2009	$0	$0	$322,788	$322,788	0.332
2010	$0	$0	$332,472	$332,472	0.308
2011	$0	$0	$342,446	$342,446	0.287
2012	$0	$0	$352,719	$352,719	0.266
2013	$0	$0	$363,301	$363,301	0.247
2014	$0	$0	$374,200	$374,200	0.230
2015	$0	$0	$385,426	$385,426	0.214
2016	$0	$0	$396,989	$396,989	0.198
2017	$0	$0	$408,898	$408,898	0.184
2018	$0	$0	$421,165	$421,165	0.171
2019	$0	$0	$433,800	$433,800	0.159
2020	$0	$0	$446,814	$446,814	0.148
2021	$0	$0	$460,219	$460,219	0.137
%NPV	6.89	3.21	89.90		
	$201,826	$93,962	$2,633,381		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 006

ALTERNATIVE 3: Karnes City 14"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$92,471	$92,471	$203,476	-$111,005
1997	$198,258	$290,729	$186,934	$103,795
1998	$173,770	$464,499	$171,439	$293,060
1999	$166,295	$630,794	$156,931	$473,863
2000	$160,632	$791,426	$143,354	$648,072
2001	$155,863	$947,289	$130,654	$816,635
2002	$145,744	$1,093,033	$118,782	$974,251
2003	$139,474	$1,232,507	$107,690	$1,124,817
2004	$133,474	$1,365,981	$97,332	$1,268,649
2005	$127,733	$1,493,714	$87,666	$1,406,048
2006	$122,238	$1,615,952	$78,651	$1,537,301
2007	$116,979	$1,732,931	$70,250	$1,662,681
2008	$111,947	$1,844,878	$62,426	$1,782,452
2009	$107,132	$1,952,010	$55,145	$1,896,865
2010	$102,523	$2,054,533	$48,375	$2,006,158
2011	$98,113	$2,152,646	$42,085	$2,110,561
2012	$93,892	$2,246,538	$36,248	$2,210,290
2013	$89,853	$2,336,391	$30,834	$2,305,557
2014	$85,988	$2,422,379	$25,819	$2,396,560
2015	$82,289	$2,504,668	$21,179	$2,483,489
2016	$78,749	$2,583,417	$16,890	$2,566,527
2017	$75,361	$2,658,778	$12,931	$2,645,847
2018	$72,119	$2,730,897	$9,281	$2,721,616
2019	$69,017	$2,799,914	$5,921	$2,793,993
2020	$66,048	$2,865,962	$2,833	$2,863,129
2021	$63,207	$2,929,169	$0	$2,929,169
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $259,077 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

L I F E   C Y C L E   C O S T   R E P O R T   PAGE 007

ALTERNATIVE 4: Kenedy 14"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$424,360	$0	$424,360	0.863
1997	$1,044,986	$0	$0	$1,044,986	0.802
1998	$0	$0	$638,863	$638,863	0.745
1999	$0	$0	$658,029	$658,029	0.692
2000	$0	$0	$677,770	$677,770	0.643
2001	$0	$0	$698,103	$698,103	0.598
2002	$0	$0	$719,046	$719,046	0.555
2003	$0	$0	$740,617	$740,617	0.516
2004	$0	$0	$762,836	$762,836	0.479
2005	$0	$0	$785,721	$785,721	0.445
2006	$0	$0	$809,292	$809,292	0.414
2007	$0	$0	$833,571	$833,571	0.384
2008	$0	$0	$858,578	$858,578	0.357
2009	$0	$0	$884,336	$884,336	0.332
2010	$0	$0	$910,866	$910,866	0.308
2011	$0	$0	$938,192	$938,192	0.287
2012	$0	$0	$966,337	$966,337	0.266
2013	$0	$0	$995,327	$995,327	0.247
2014	$0	$0	$1,025,187	$1,025,187	0.230
2015	$0	$0	$1,055,943	$1,055,943	0.214
2016	$0	$0	$1,087,621	$1,087,621	0.198
2017	$0	$0	$1,120,250	$1,120,250	0.184
2018	$0	$0	$1,153,857	$1,153,857	0.171
2019	$0	$0	$1,188,473	$1,188,473	0.159
2020	$0	$4,188	$1,224,127	$1,228,315	0.148
2021	$10,783	$0	$1,260,851	$1,271,634	0.137
%NPV	9.97	4.36	85.67		
	$839,610	$366,945	$7,214,618		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 4: Kenedy 14"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$366,326	$366,326	$846,394	-$480,068
1997	$838,129	$1,204,455	$777,584	$426,871
1998	$476,074	$1,680,529	$713,129	$967,400
1999	$455,594	$2,136,123	$652,780	$1,483,343
2000	$435,996	$2,572,119	$596,303	$1,975,816
2001	$417,240	$2,989,359	$543,478	$2,445,881
2002	$399,291	$3,388,650	$494,094	$2,894,556
2003	$382,115	$3,770,765	$447,953	$3,322,812
2004	$365,677	$4,136,442	$404,867	$3,731,575
2005	$349,946	$4,486,388	$364,659	$4,121,729
2006	$334,892	$4,821,280	$327,162	$4,494,118
2007	$320,486	$5,141,766	$292,215	$4,849,551
2008	$306,700	$5,448,466	$259,670	$5,188,796
2009	$293,506	$5,741,972	$229,385	$5,512,587
2010	$280,880	$6,022,852	$201,224	$5,821,628
2011	$268,797	$6,291,649	$175,062	$6,116,587
2012	$257,234	$6,548,883	$150,778	$6,398,105
2013	$246,169	$6,795,052	$128,259	$6,666,793
2014	$235,579	$7,030,631	$107,399	$6,923,232
2015	$225,445	$7,256,076	$88,096	$7,167,980
2016	$215,747	$7,471,823	$70,255	$7,401,568
2017	$206,466	$7,678,289	$53,787	$7,624,502
2018	$197,584	$7,875,873	$38,605	$7,837,268
2019	$189,084	$8,064,957	$24,629	$8,040,328
2020	$181,569	$8,246,526	$11,785	$8,234,741
2021	$174,647	$8,421,173	$0	$8,421,173
%NPV			0.00 $0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $744,831 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

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ALTERNATIVE 5: Poth 14"

YEAR	Construction Costs (01)	Planning and Design (02)	Local O&M (03)	TOTAL ANNUAL OUTLAYS	END OF YEAR DISCOUNT FACTORS
1996	$0	$208,060	$0	$208,060	0.863
1997	$549,334	$0	$0	$549,334	0.802
1998	$0	$0	$442,691	$442,691	0.745
1999	$0	$0	$455,972	$455,972	0.692
2000	$0	$0	$469,651	$469,651	0.643
2001	$0	$0	$483,740	$483,740	0.598
2002	$0	$0	$498,253	$498,253	0.555
2003	$0	$0	$513,200	$513,200	0.516
2004	$0	$0	$528,596	$528,596	0.479
2005	$0	$0	$544,454	$544,454	0.445
2006	$0	$0	$560,788	$560,788	0.414
2007	$0	$0	$577,611	$577,611	0.384
2008	$0	$0	$594,940	$594,940	0.357
2009	$0	$0	$612,788	$612,788	0.332
2010	$0	$3,116	$631,172	$634,288	0.308
2011	$8,024	$0	$650,107	$658,131	0.287
2012	$0	$0	$669,610	$669,610	0.266
2013	$0	$0	$689,698	$689,698	0.247
2014	$0	$0	$710,389	$710,389	0.230
2015	$0	$0	$731,701	$731,701	0.214
2016	$0	$0	$753,652	$753,652	0.198
2017	$0	$0	$776,261	$776,261	0.184
2018	$0	$0	$799,549	$799,549	0.171
2019	$0	$0	$823,536	$823,536	0.159
2020	$0	$4,188	$848,242	$852,430	0.148
2021	$10,783	$0	$873,689	$884,472	0.137
%NPV	7.90	3.22	88.88		
	$444,372	$181,186	$4,999,269		
DISCOUNTING CONVENTION	E-O-Y	E-O-Y	E-O-Y		

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ALTERNATIVE 5: Poth 14"

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1996	$179,606	$179,606	$451,239	-$271,633
1997	$440,592	$620,198	$414,555	$205,643
1998	$329,889	$950,087	$380,191	$569,896
1999	$315,698	$1,265,785	$348,017	$917,768
2000	$302,117	$1,567,902	$317,908	$1,249,994
2001	$289,121	$1,857,023	$289,745	$1,567,278
2002	$276,683	$2,133,706	$263,417	$1,870,289
2003	$264,781	$2,398,487	$238,818	$2,159,669
2004	$253,391	$2,651,878	$215,847	$2,436,031
2005	$242,490	$2,894,368	$194,411	$2,699,957
2006	$232,059	$3,126,427	$174,420	$2,952,007
2007	$222,076	$3,348,503	$155,789	$3,192,714
2008	$212,523	$3,561,026	$138,438	$3,422,588
2009	$203,381	$3,764,407	$122,292	$3,642,115
2010	$195,593	$3,960,000	$107,279	$3,852,721
2011	$188,558	$4,148,558	$93,331	$4,055,227
2012	$178,247	$4,326,805	$80,384	$4,246,421
2013	$170,579	$4,497,384	$68,379	$4,429,005
2014	$163,241	$4,660,625	$57,258	$4,603,367
2015	$156,219	$4,816,844	$46,967	$4,769,877
2016	$149,499	$4,966,343	$37,455	$4,928,888
2017	$143,068	$5,109,411	$28,675	$5,080,736
2018	$136,913	$5,246,324	$20,581	$5,225,743
2019	$131,023	$5,377,347	$13,131	$5,364,216
2020	$126,006	$5,503,353	$6,283	$5,497,070
2021	$121,474	$5,624,827	$0	$5,624,827
%NPV			0.00	
			$0	
DISCOUNTING CONVENTION			E-O-Y	

EQUIVALENT UNIFORM ANNUAL COST = $497,501 (7.63% DISCOUNT RATE, 26 YEARS)

EXPENSE ITEMS 1, 2 AND 3 USED INFLATION INDEX 1 - 94 General Inflation.

2.0 COST ELEMENTS

Investigations were made to determine the cost elements which should be addressed in the three alternatives investigated. All costs for these economic analyses were gathered and calculated by Thonhoff Consulting Engineers. Inc, and are displayed in Figures B-2 through B-5. The Thonhoff Report identified and evaluated the current and future needs and supply sources for seven participating municipalities in Atascosa, Frio, Karnes, and Wilson Counties. These municipalities included Falls City, Floresville, Karnes City, Kenedy, Pearsall, Pleasanton, and Runge. At the request of the Corps of Engineers, TCE, Inc. made a subsequent trip to additional municipalities in Karnes and Wilson Counties to maximize community participation.

Calculations were performed to estimate the present value of the stream of future expenditures required for the implementation of each alternative. Computer outputs were then generated which display the projected cost per year with estimated inflationary effects (1995 dollar analysis), present value per year, cumulative present value per year, and cumulative present value net of residual (terminal, or salvage value) for each year. Cost elements considered are displayed below.

Cost Element	Thonhoff Regional Plan	Thonhoff Autonomous Plan	Aquifer Optimization Plan
Construction Costs	X	X	X
Planning and Design Costs	X	X	X
Local O&M Costs	X	X	X
Regional O&M Costs	X		

2.1 Thonhoff Regional Plan

The estimated cost of the Thonhoff Regional Plan by municipality (shown in Tables 5-1a and b) is based on high population projections (Table 2.3-2) from the Thonhoff report. Cost data for the Thonhoff Regional Water Supply Plan were taken from the Thonhoff Report (Appendices C-3 through C-5)displayed below in Figures B-2 and B-3.

Factored into total costs for the Thonhoff regional plan is the assumption that all municipalities will continue to utilize, repair, replace, and expand their existing water systems until the regional system is in place. Consequently, a portion of total costs for the regional water system include the current autonomous system.

2.2 Thonhoff Autonomous Plan

The cost of remaining autonomous is based upon maintenance of the existing system, replacement of water supply and infrastructure as required to sustain current capacity, and construction of new supply and infrastructure to meet future demands. In the Thonhoff Autonomous Plan, we make the *a priori* assumption that cities will remain in their current aquifer.

Cost data for the Thonhoff Autonomous Plan were taken from the Thonhoff Report (Appendices C-1 and C-2)displayed below in Figures B-4 and B-5. For municipalities that did not participate in the Thonhoff study, TEC, Inc. gathered the cost data for this study.

2.3 Aquifer Optimization Plan

Table 5-2 above displays the depths of each aquifer from which municipalities can choose, i.e., optimize their aquifer resources.
Cost estimates are based on well drilling costs approximated by the Corps of Engineers. The components of the well drilling costs include well diameter, cost of drilling per foot, cost of gravel/concrete, well capacity (GPM), and the cost of a pump. Cost estimates for the Aquifer Optimization Plan assume that the cost of drilling a well into more shallow aquifer is the only cost that changes, holding all other costs in Figures B-4 and B-5 constant.

Similar to the Thonhoff Autonomous Plan, the cost of the Aquifer Optimization Plan is based upon maintenance of the existing system, replacement of water supply and infrastructure as required to sustain current capacity, and construction of new supply and infrastructure to meet future demands. However, this plan differs from the Thonhoff Autonomous Plan in that each municipality knows what aquifer systems lie beneath them.

Figure B-2: REGION A PRELIMINARY ESTIMATE OF TOTAL PROJECT COSTS (THONHOFF REPORT)

16" LINE	73,200 LF @ $16/LF	1,171,200
8" LINE	11,100 LF @ $8/LF	88,800
18" LINE	93,100 LF @ $18/LF	1,675,800
16" LINE	41,200 LF @ $16/LF	659,200
12" LINE	26,800 LF @ $12/LF	321,600
8" LINE	53,500 LF @ $8/LF	428,000
Stockdate Booster Station		
2-800 gpm pumps	2 @ 10,000/Ea	20,000
Floresville Booster Station		
2-3200 gpm pumps	2 @ 30,000/Ea	60,000
Poth Booster Station		
2-3200 gpm pumps	2 @ 30,000/Ea	60,000
Falls City Booster Station		
2-3200 gpm pumps	2 @ 30,000/Ea	60,000
	Subtotal Construction Cost	$ 4,544,600
Contingencies		682,000
Engineering		364,000
Surveying		299,000
Geotechnical		20,000
Inspection		100,000
Land Acquisition		100,000
Legal and Fiscal		153,000
	Subtotal	$ 1,718,000
	Total Project Costs	$ 6,262,600

OPERATION AND MAINTENANCE COSTS

Line Work	22,000
Tanks	-0-

Pump Stations	10,000
Power Cost	195,000
Labor	111,000
Chemicals	45,300
	$ 383,300/Year

Figure B-3 COST TO MAINTAIN CURRENT RATED CAPACITIES THROUGH YEAR 2020 (THONHOFF REPORT)

	UNIT	QUANT.	UNIT COST	TOTAL
FALLS CITY				
Water Well	EA	1	138,000	138,000
Ground Storage	EA	1	83,000	83,000
Treatment (Auction)	EA	1	20,000	20,000
High Service Pumping	EA	3	5,000	15,000
Pressure Maintenance	EA	0	-	-
Distribution Lines	EA	0	-	-
Subtotal				$ 256,000
Contingencies				102,000
Total Project Cost				$ 358,000
FLORESVILLE				
Water Well	EA	1	120,000	120,000
Ground Storage	EA	1	138,000	138,000
Treatment (Auction)	EA	0	-	-
High Service Pumping	EA	8	10,000	80,000
Pressure Maintenance	EA	0	-	-
Distribution Lines	LF	0	-	-
Subtotal				$ 328,000
Contingencies, Engineering, etc.				135,000
Total Project Cost				$ 473,000
KARNES CITY				
Water Well	EA	3	80,000	240,000
Ground Storage	EA	0	-	-
Treatment (Auction)	EA	0	-	-
High Service Pumping	EA	4	5,000	20,000
Pressure Maintenance	EA	0	-	-
Distribution Lines	LF	0	-	-
Subtotal				$ 260,000
Contingencies, Engineering, etc.				104,000
Total Project Cost				$ 364,000

KENEDY				
Water Well	EA	5	80,000	400,000
Ground Storage	EA	0	-	-
Treatment (Auction)	EA	26	10,000	260,000
High Service Pumping	EA	3	5,000	15,000
Pressure Maintenance	EA	0	-	-
Distribution Lines	LF	0	-	-
Subtotal				$ 675,000
Contingencies, Engineering, etc.				270,000
Total Project Cost				$ 945,000
RUNGE				
Water Well	EA	2	140,000	550,000
Ground Storage	EA	0	-	-
Treatment (Auction)	EA	0	-	-
High Service Pumping	EA	3	5,000	15,000
Pressure Maintenance	EA	0	-	-
Distribution Lines	LF	0	-	-
Subtotal				$ 155,000
Contingencies, Engineering, etc.				62,000
Total Project Cost				$ 217,000
STOCKDALE				
Water Well	EA	2	70,000	140,000
Ground Storage	EA	0	NA	-0-
Treatment	EA	1	20,000	20,000
High Service Pumping	EA	1	10,000	10,000
Pressure Maintenance	EA	0	NA	-0-
Distribution Lines	LF	0	NA	-0-
Subtotal				$ 170,000
Contingencies, Engineering, etc.				68,000
Total Project Cost				$ 238,000
POTH				
Water Well	EA	2	80,000	160,000
Ground Storage	EA	3	100,000	300,000
Treatment	EA	2	20,000	40,000

High Service Pumping	EA	0	NA	-0-
Pressure Maintenance	EA	0	NA	-0-
Distribution Lines	LF	0	NA	-0-
Subtotal				$ 500,000
Contingencies, Engineering, etc.				200,000
Total Project Cost				$ 700,000

Figure B-4: COST TO MEET FUTURE SUPPLY, TREATMENT, PUMPING AND STORAGE NEEDS THROUGH YEAR 2020 (THONHOFF REPORT)

FALLS CITY

* No additional Facilities Anticipated

FLORESVILLE

* 1800 gpm High Service Pump (1995)	20,000
* 200,000 Gal. Ground Storage Tank (2010)	100,000
* 250,000 Gal. Electrical Storage Tank (2010)	300,000
Subtotal	$ 420,000
Contingencies, Engineering, etc.	168,000
Total Cost	$ 588,000

KARNES CITY

* 400 gpm High Service Pump (2000)	5,000
Subtotal	$ 5,000
Contingencies, Engineering, etc.	2,000
Total Cost	$ 7,000

KENEDY

* Reverse Osmosis Ground Water Treatment (1995)	350,000
* 400 gpm High Service Pump (1995)	5,000
* 400 gpm High Service Pump (2020)	5,000
Subtotal	$ 360,000
Contingencies, Engineering, etc.	144,000
Total Cost	$ 504,000

RUNGE

* Improve Water Quality (1995)	80,000
* 100 gpm Well (2020)	80,000
Subtotal	$ 160,000
Contingencies, Engineering, etc.	64,000
Total Cost	$ 224,000

STOCKDALE

* No additional Facilities Anticipated

POTH

* 400 gpm High Service Pump (1996)	5,000
* 400 gpm High Service Pump (2010)	5,000

* 400 gpm High Service Pump (2020)	5,000
Subtotal	$ 15,000
Contingencies, Engineering, etc.	6,000
Total Cost	$ 21,000

APPENDIX C - Atascosa County Economic Development Corporation

MISSION STATEMENT
of the
ATASCOSA COUNTY ECONOMIC DEVELOPMENT CORPORATION

The Atascosa County Economic Development Corporation serves as a focal point organization within Atascosa County to promote economic development throughout the county. The ACEDC works to promote jobs and opportunity through county-wide economic growth and increased prosperity for all of the citizens of Atascosa County. The ACEDC exists as a non-profit organization supported by funding from both the public and private sectors. The ACEDC seeks to support and promote existing business and industry, as well as to attract new business and industry to broaden the base of the economy in Atascosa County. The ACEDC is committed to develop and protect the natural resources of Atascosa County through an environmentally sound economic development program.

ACEDC EXECUTIVE DIRECTOR

The ACEDC Executive Director will receive his direct supervision from the President and Executive Committee as directed by the Board of Directors.

Duties and Responsibilities:

1. Responsible for the enforcement of the bylaws and operating policies and procedures as established by the Board of Directors and the Executive Committee.

2. Must maintain a continuing evaluation of objectives, activities, and operations in order to analyze for and counsel with the officers and directors in regard to the soundness and effectiveness of policies and procedures.

3. Directs the basic planning and provides counsel in the making of decisions which shape our objectives and initiates measures for the continuing development of community leadership.

4. Must be available for consultation with officers, directors, committee chairmen, public officials, members and representatives of the public when the opinion or advice of the executive head of the organization is solicited. Act as local government liaison.

5. Maintains communication and working relationships with public officials, administrators and business organizations at all levels and counsels and advises them on developments affecting the Atascosa County business community.

6. Directs economic research as it pertains to community development and suggests, plans and initiates major projects resulting from this research.

7. Maintains a constant knowledge or record of the performance and productions of each committee. Locates and pinpoints breakdowns and offers suggested courses of positive action. Helps volunteer workers by injecting ideas for projects, practices, problems, solutions, etc. for their consideration.

8. Serves as staff representative on the following committees: Board of Directors; Executive Committee; By-Laws/Legal Committee; Finance and Funding Committee; Operations/Logistics Committee; and Marketing/Promotion/Public Relations Committee.

9. Works with the President in developing an agenda for the Executive Committee, Board of Directors' Meetings and membership meetings. Also coordinates the financial operations of the organization for maximum economy and sees that control of the budget is maintained. Serves as Chief fundraiser.

10. Works with, counsels with, does research for and otherwise assist the President in the performance of his duties. Also serves as an ideator, public relations man and consultant to the Officers, Directors, and Committee Chairmen.

11. Supervises the preparation, interpretation, and the execution of the program of work.

12. Sees that the best interest of the Atascosa County business community is represented to local, state and federal governments, including both elected officials and agencies.

13. Makes personal knowledge and self-training a continuing process.

14. Supplies the officers and directors with essential background information needed to act on recommendations submitted by committees and other organizations.

15. Sees that all contracts and agreements between our organization and any other entity for administrative and clerical services are fulfilled.