CITY OF ALVIN
216 W. Sealy • Alvin, Texas 77511 • (281) 388-4200 • FAX (281) 331-7215

October 26, 2001

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GRANTS MANAGEMENT

Mr. Craig D. Pederson
Executive Administrator
Texas Water Development Board
1700 N. Congress Avenue, Room 513
P.O. Box 13231, Capital Station
Austin, Texas 78701

Re: Regional Facility Planning Grant Contract between City of Alvin and the Texas Water Development Board, TWDB Contract No. 2001-483-367, FINAL REPORT Entitled "Regional Surface Water Plant Feasibility Study for Mid-Brazoria County Planning Group"

Dear Mr. Pederson:

Per the City of Alvin's contract with the Texas Water Development Board, enclosed is the FINAL REPORT of the Regional Surface Water Plant Feasibility Study for Mid-Brazoria County Planning Group. As required by the terms of the contract, the following are submitted:

- One (1) electronic copy,
- One (1) unbound single-sided camera-ready original, and
- Nine (9) bound double-sided copies

If you have any questions, please contact me at 281-388-4231.

Sincerely,

Paul A. Hofmann
City Manager

PAH:lh
Enclosures

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Table of Contents

Table of Contents

List of Tables

List of Tables

List of Tables

List of Figures

Faced with a growing potable water demand and concerns regarding the long term sustainability of the underlying groundwater aquifer water supply, eight water utilities in the Mid-Brazoria County region have formed a partnership with the State of Texas to evaluate the feasibility of constructing and operating a regional surface water treatment facility. This study reports on the findings of the constructability, feasibility, and preliminary cost of a proposed regional surface facility and associated raw and finished water delivery improvements. Raw surface water supply studies conducted and published by the Region H Water Planning Group of the State Water Plan identify the Brazos River as the raw water source for the study area. Negotiations with Brazos River water rights holders should be conducted by the Mid-Brazoria County Planning Group.

The primary water supply for residents of the Mid-Brazoria County region continues to be the Evangeline and Chicot aquifers. This primary source is more than adequate to meet current municipal, domestic, manufacturing, and agricultural uses throughout Brazoria County. However, studies conducted by the Region H Planning Group indicate the existing groundwater sources will not meet future demand without a decrease in water quality or subsidence.

According to Region H Water Plan, which studied water needs in the 15 counties surrounding Houston, including Brazoria County, additional raw water supplies will be necessary to meet water demands of several communities in the Mid-Brazoria County Region. Region H estimates the existing groundwater supply to be able to sustain community growth through 2030, but overproduction of the aquifer may lead to supply shortages thereafter.

Conversion of the existing potable water sources from a primary groundwater source to a combination of treated surface water and groundwater would not only expand the region's water production capability, but offer the following regional benefits:

- ***Increase water production capabilities***. As an additional water source is introduced into the area, the growth potential of the area is not limited by water production capacity. By converting to surface water, groundwater slated to be used for domestic purposes can be reallocated for industrial and agricultural uses, thereby allowing greater growth in these economic sectors.

- ***Reduce potential for subsidence***. As surface water is distributed into the system, groundwater production will decrease. As this production decreases, the potential to drawdown the water level in the underlying aquifer will diminish. If the water table remains high, subsidence will decrease and property damage and localized flooding conditions due to subsidence will be minimized.

- ***Reduce potential for water quality degradation***. Also, as the aquifer level drops, groundwater quality can progressively degrade, thus requiring additional treatment processes, increasing costs dramatically. A reduction in groundwater pumping will increase the level in the aquifer and increase groundwater quality.

As stated earlier, , Region H reports that the Brazos River will serve as the raw water source for the conversion of the region from groundwater to surface water. In lieu of each municipality in the Mid-Brazoria County Region designing and constructing individual water plants to serve their customers, a regional surface water plant may be a viable and an economically attractive alternative to supply surface water to this region. This study evaluates the feasibility of this alternative.

SCOPE

This study was authorized to investigate the feasibility of constructing a regional surface water plant, including an analysis of the surface water treatment alternatives and site locations. Through this study, the estimated cost to plan, design, construct, operate and maintain a regional surface water treatment plant, complete with raw water delivery and finished water transmission, was determined. This study started with the development of the projected water demand for eight Participating Utilities and culminates with a facility plan of the proposed facilities necessary to satisfy this water demand through the year 2050 through a mix of groundwater and treated surface water.

BACKGROUND

The planning area, shown on **Figure ES-1**, for this study encompasses the northern portion of Brazoria County. Water utilities located in the planning area were contacted regarding their interest in participating in a regional surface water plan and eight utilities elected to be part of this regional planning effort. These Participating Utilities are collectively known as the Mid-Brazoria County Planning Group (MBCPG). MBCPG members include:

- City of Alvin,
- City of Angleton,
- City of Brookside Village,
- City of Danbury,
- City of Hillcrest,
- City of Iowa Colony,
- City of Manvel, and
- City of Pearland

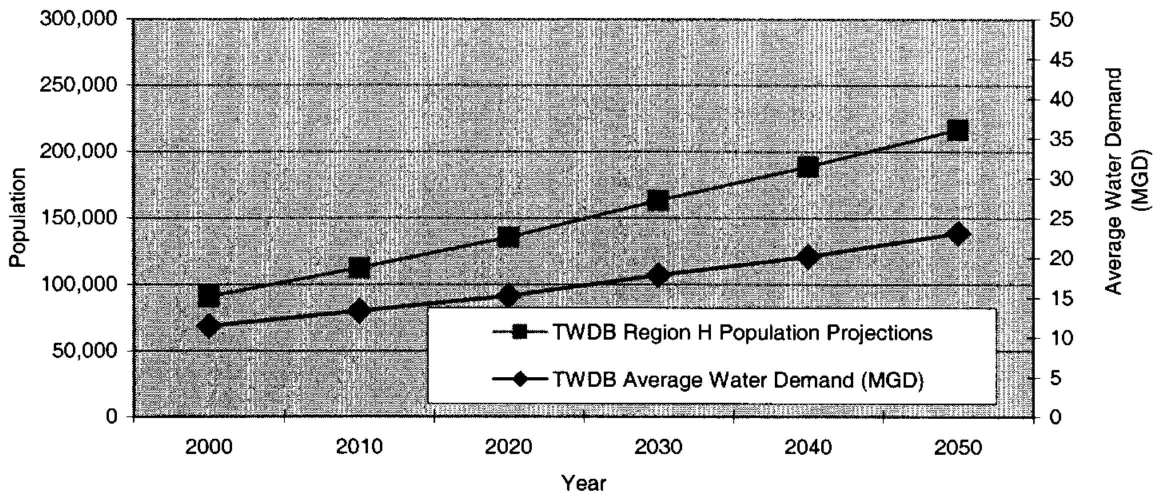
The major surface water feature in this area is the Brazos River. Region H has identified this surface water body as the future raw water source for the potable water needs of the Mid-Brazoria County Region. Water rights for this surface water source are managed through water permits allocated by Texas Natural Resources Conservation Commission (TNRCC). The TNRCC reports that all available water permits for sustainable water rights for Brazos River water have been allocated and that the State is completing the 2002 State Water Plan in which the quantity of available sustainable surface water will be revisited. Major holders of senior lower Brazos River water rights include Gulf Coast Water Authority (GCWA), Chocolate Bayou Water Company (CBWC), Reliant Energy, and the Brazos River Authority (BRA).

Currently, none of the Participating Utilities hold Brazos River water rights. As such, long term raw water contracts or water rights will need to be secured. Region H is in the process of planning water usage through the region and this report assumes that Region H will plan facilities necessary to provide the MBCPG with the required raw surface water.

WATER DEMAND

The Participating Utilities estimate that the portion of their utilities in the planning area have a current population of 100,000 and an average daily water demand of 11.5 MGD. Over the next 50 years, the population of the Participating Utilities in the planning area and water demand are projected to grow to 216,918 and 23.13 MGD. **Figure ES-2** shows the growth in population and water demand over the planning period. This represents a 101 percent increase in water demand and will require a significant expansion in water production capabilities to meet expected demand.

FIGURE ES-2
WATER DEMAND AND POPULATION PROJECTION FOR THE PLANNING AREA



FACILITY DEMAND

To meet this potable water demand, the Participating Utilities will need to expand their water production facilities. With conversion from groundwater to surface as part of this facility expansion, the effective split between groundwater and surface water usage is a determining factor on the size of the surface water treatment facilities. Local experience indicates that the utilization of groundwater sources is more cost effective than treating surface water. As such, it is the desire of the Participating Utilities to maximize the use of groundwater to the extent practicable by the availability and quality of groundwater.

The Harris-Galveston Subsidence District, which is a regulatory entity controlling groundwater pumping in the neighboring Harris, Galveston, and Fort Bend Counties, has completed a regional groundwater model which includes the northern portion of Brazoria County. This model indicates that groundwater production in the Mid-Brazoria County region at current withdrawal rate is not expected to negatively impact the availability or quality of the groundwater.

Given these expectations, it is the intention of the Participating Utilities to maintain average annual groundwater production at year 2000 levels through the planning horizon in this study thereby:

- maintaining the current water table level in the underlying aquifer,
- maintaining acceptable groundwater quality,
- mitigating the potential for subsidence, and
- maximizing use of their existing infrastructure.

Therefore, to serve the future average day potable water demand with an effective groundwater production at 11.5 MGD, the Participating Utilities will need to construct surface water treatment facilities with an average annual water capacity equal to the growth in average water demand from year 2000 to the end of the planning horizon.

The Participating Utilities agreed to develop this facility plan based on a plant that delivers a fairly constant supply of surface water and to augment this supply with groundwater from their wells during periods when supply from the surface water treatment plant was exceeded. The Participating Utilities will activate their wells during times when the water demand exceeds the capacity of the regional surface water plant. Each participating utility noted that they would expand their existing well and storage facilities to meet future peak day demands in lieu of drawing additional water from the surface water plant. Peak hour demands will be met through use of the Participating Utilities individual storage capacity.

Given these assumptions, the Planning Area surface water treatment demands are as follows:

TABLE ES-1
PLANNING AREA SURFACE WATER DEMAND

Year	Surface Water Demand (MGD)
2010	8
2020	13
2030	17
2040	21
2050	25

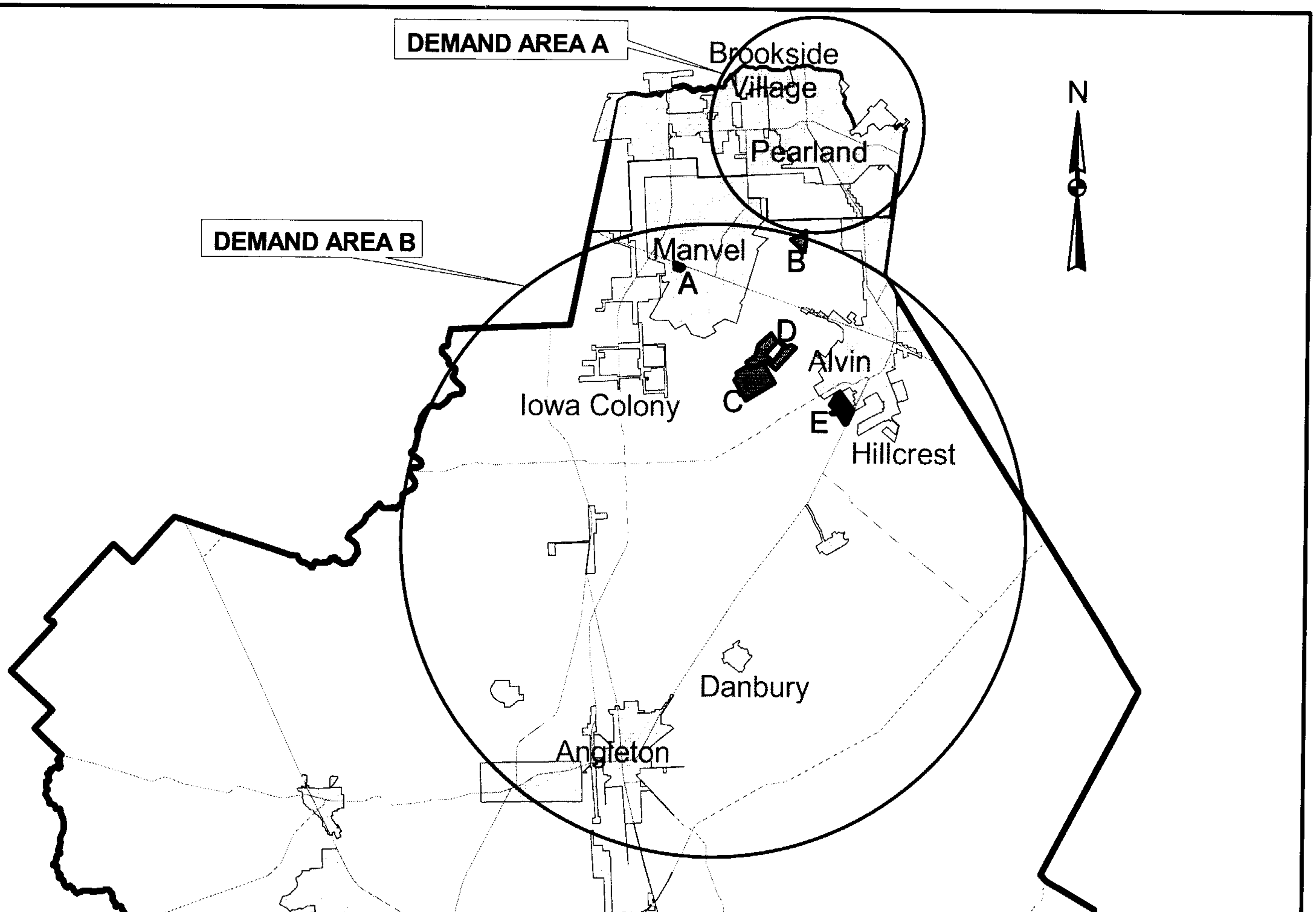
The planning area can be divided into two areas of potable water demand. This division is based on the population within each area. Over one half of the total Participating Utility water demand is allocated for the Cities of Pearland and Brookside Village. The remaining water demand is geographically located in the central and southern portion of the planning area within an ten mile radius of County Road 121 and Hwy 1462 just southeast of Iowa Colony. The two demand areas are located approximately 14 miles apart and are shown on **Figure ES-3**.

Strategic locations for regional surface water treatment facilities were investigated throughout each Demand Area. Due to the relative proximity of the demand to the planning area, the primary focus of a regional surface water plant was central to Demand Area A and B to minimize the overall length of finished water pipelines required to reach each Participating Utility.

TAKE POINTS

As a wholesale provider of raw and potable water, the MBCPG will contract with each participating utility to deliver water at specified "take points". Take points are defined as the end point at which the MBCPG will transport potable water to the Participating Utilities. At each of these take points, a flow meter will be installed to record and monitor the total flow delivered to each participating utility. From this point on, the participating utility will be responsible for operation and maintenance of the water distribution system.

Each participating utility requested water to be delivered at pressure either through system pressure from regional water treatment plant high service pump station or through an individual booster pump station located in the Participating Utility. The take points with flow demands are tabulated in **Table ES-2**. The City of Pearland, Brookside Village, and Alvin have noted that their take points may be shifted



MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

FINISHED WATER DEMAND AREAS

FIGURE ES-3

depending on the location of the water treatment plant relative to their city. The following table highlights the alternative take points for each Participating Utility.

TABLE ES-2
REQUESTED FLOW UTILITY TAKE POINTS

Utility	Take Point Number	Address	Average Day Water Demand (MGD)	Ground Elevation at Take Point (ft)
City of Manvel	1	Iowa Lane and Hwy 6, Manvel TX	3.77	55
City of Pearland	2a	SH 288 at 518, Pearland TX	13.66	60
	2b	SH 35 at 518, Pearland TX		40
City of Brookside Village	3a	Garden Road and Brookside Road	0.57	50
	3b	Mykawa Road and Knapp Road		50
City of Alvin	4a	SH 6, north of Mc Cormick Road	4.13	40
	4b	SH 35, at Johnson Road		40
City of Hillcrest Village	4a or 4b	Same as City of Alvin take point	0.07	40
City of Iowa Colony	5	At the intersection of County Road 64 and Iowa School Road	0.24	50
City of Danbury	6	5th Street at St. Spur 8	0.48	20
City of Angleton	7	At the intersection of Henderson Road and Krankawa Road in the North part of the City	2.45	20

ALTERNATIVE ANALYSIS

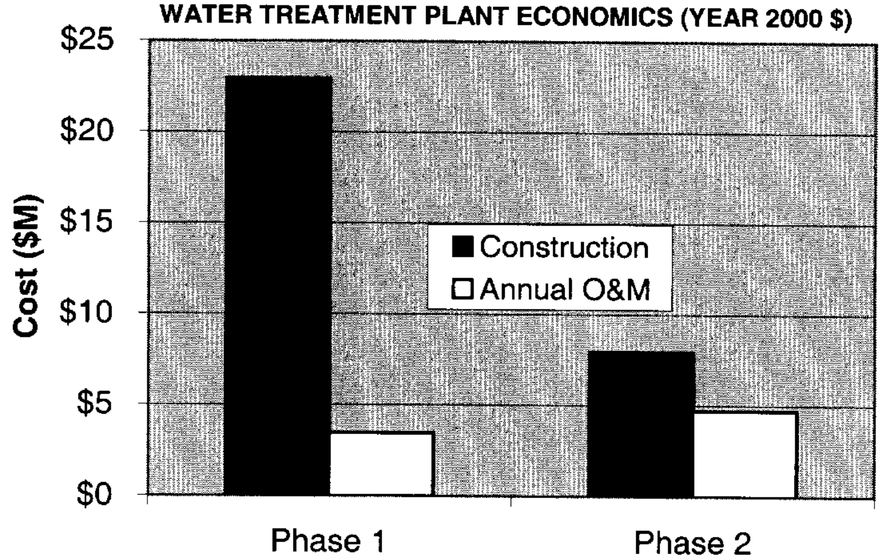
Since the planning area is currently served primarily from groundwater wells, conversion to surface water will require construction of a raw water delivery system, water treatment plant, and finished water transmission system. There are a number of alternative approaches to construct these facilities depending on the location of the water treatment plant. A selection approach was developed and used to ensure that several alternatives were considered and the benefits to each participating utility were taken into consideration in the selection of the final alternatives. The approach consisted of three distinct steps: alternative development, preliminary screening, and participating utility feedback. The entire process used group meetings and participating utility feedback to develop the best alternatives for more detailed evaluation. Final alternative evaluation was based on the economic cost to implement the alternative, including capital costs to construct the facilities and operating and maintenance (O & M) costs over the planning horizon of the project, and the non-economic impact of each alternative on the surrounding community and environment.

Water Treatment Plant Treatment Process

Recent Texas Water Development Board (TWDB) studies have compared the treatability of the Brazos River water through various treatment processes. These studies comparing conventional, high-rate conventional, and membrane treatment technologies show that each alternative treatment process will meet federal and state standards, but the high-rate conventional process has the lowest economic cost to construct and operate. As such, the proposed treatment facilities for this study will treat the raw Brazos River water through a high rate conventional water treatment process.

For the high rate conventional process, the capital cost required to construct a 25 MGD water treatment plant were estimated based on established design criteria. Construction costs were estimated based on providing a 15 MGD initial phase in 2010 and a 10 MGD expansion in the year 2030. O & M costs were estimated assuming full production equal to the capacity of the plant. A summary of the water treatment plant capital cost is shown in **Figure ES-4**.

FIGURE ES-4
WATER TREATMENT PLANT ECONOMICS (YEAR 2000 $)



Preliminary Water Plant Locations

The Participating Utility Team reviewed the planning area in search of alternative treatment plant locations that met established minimum acreage requirements. In sum, five preliminary sites were identified. After careful evaluation by the Participating Utility Team, several potential water plant sites were eliminated from consideration based on the following criteria: proximity of the proposed plant site to the demand, proximity of the proposed plant site to the raw water source, and acreage of the proposed plant parcel. The Participating Utility Team screened these five sites to two sites based on the relative location of the sites to the demand, raw water source, and access to the site.

After this screening, the following two potential water treatment sites remained:

- Manvel – Hwy 6 and Iowa Lane, and
- Alvin – Hwy 35 and Briscoe Canal.

The locations both the two screened sites and the three sites not selected for further review are shown on **Figure ES-5**.

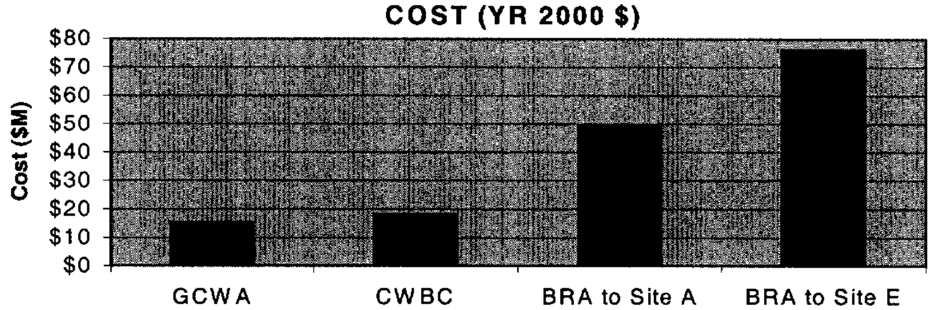
Raw Water

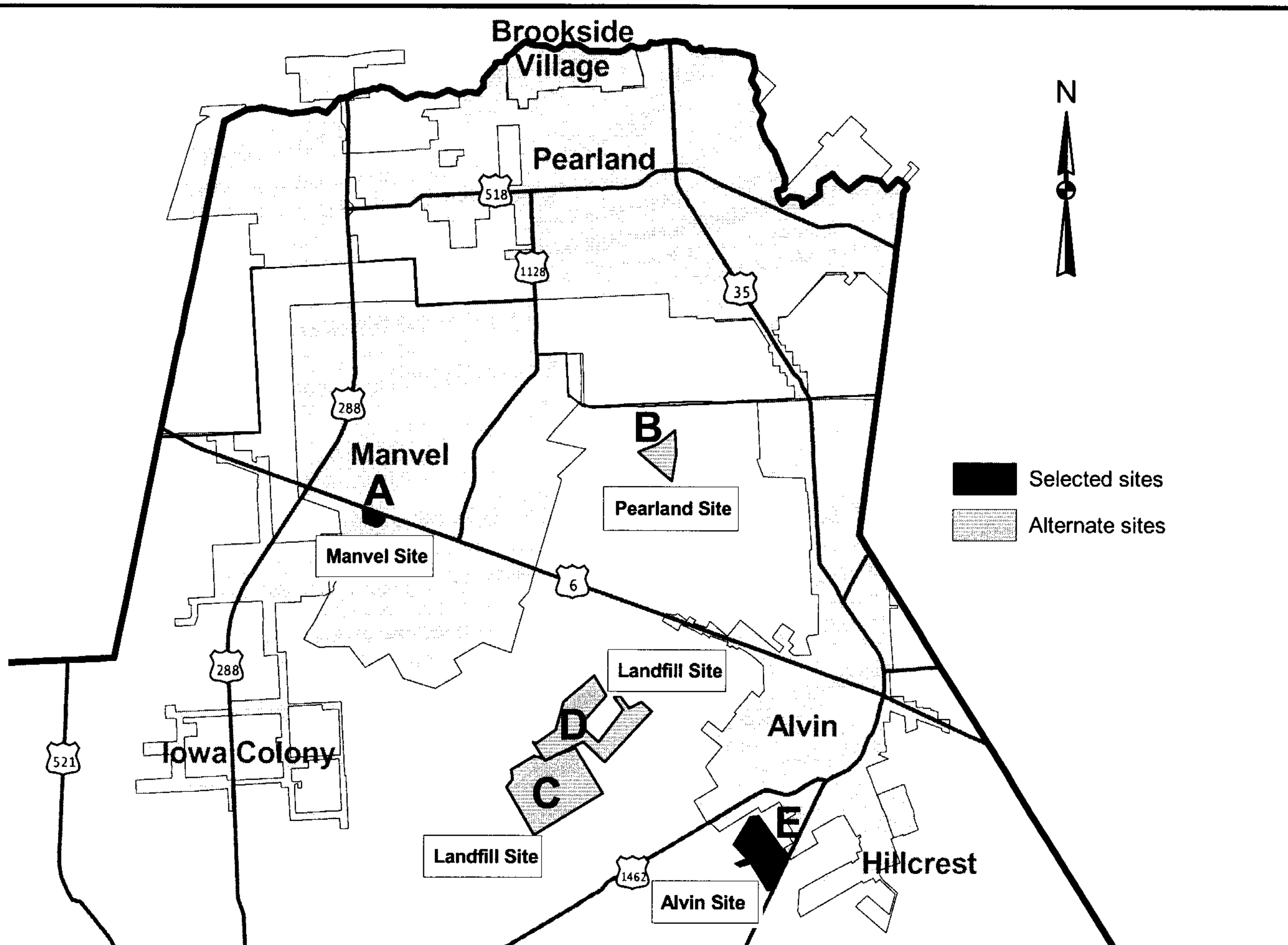
Raw water for the regional water plant must be taken from the Brazos River. In a letter report to the TWDB by Turner Collie and Braden dated February 27th 2001, three raw water conveyance mechanisms were identified, by which Brazos River water may be transported from the River to the water treatment plant site. The study reviewed each of these alternatives to determine the feasibility of carrying raw water for the MBCPG through each alternative. The reviewed alternatives were:

1) Gulf Coast Water Authority (GCWA). In this alternative, the MBCPG would purchase raw water on a per gallon contract basis. As existing GCWA canals carry Brazos River water from the river through Fort Bend, Brazos, and Galveston Counties and both screened alternative water treatment plant locations are adjacent to GCWA canals, no additional facilities are needed in order to transport Brazos River from the river to the either WTP locations.
2) Chocolate Bayou Water Company (CBWC). Turner Collie & Braden, through a letter report to the Texas Water Development Board dated February 27 2001 proposed that for this option, the MBCPG would initially purchase the water rights owned by CBWC. By owning water rights, the MBCPG would not have to purchase raw water on an annual basis from another agency, but would utilize their rights to meet the required raw water demand. In purchasing the rights, the MBCPG would construct a raw water pipeline and pump station to transport the water from the CBWC canal to the alternative raw WTP locations.
3) Brazos River Authority. In this alternative, the MBCPG would contract for raw water from the Brazos River Authority. To transport the raw water from the Brazos River to the alternative WTP locations, new large diameter raw water pipeline and pump stations will be required.

Figure ES-6 shows the alternative raw water conveyances options relative to the alternative WTP locations. In comparing the three alternatives based on the present worth cost to construct, operate, and maintain facilities necessary to transport the water to the alternative WTP sites. **Figure ES-7** shows the

FIGURE ES-7
RAW WATER ALTERNATIVE PRESENT WORTH COST (YR 2000 $)





MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

WATER TREATMENT PLANT SITES

FIGURE ES-5

overall present worth costs of the three alternatives.

This present worth analysis is based on assumptions regarding the relative availability and stated cost of raw water. Each aforementioned entity has conditions and requirements regarding sale or purchase of raw water which will impact the overall cost of the raw water for this project. Even with the expected variability in the raw water costs, the evaluation showed that the BRA option is significantly less cost effective than the GCWA or CBWC alternatives. The analysis also showed that with the stated assumptions, the overall economic cost of the CBWC and GCWA alternatives were within the variability of the cost estimates. It is recommended that the MBCPG negotiate with both CBWC and GCWA to develop either a raw water option contract or purchase water rights outright to bring Brazos River water for potable use in the Mid-Brazoria Region. This contract would enable the MBCPG to further solidify the costs associated with bring raw water to the area and would secure raw water availability when the MBCPG is ready to augment their current groundwater supply with treated surface water. Due to the high degree of variability associated with the cost of the CBWC raw water due to potential sale of their water rights to an outside entity, the study compiled total facility costs with GCWA alternative as the raw water transportation mechanism for the regional water plant. ***This does not in any way preclude the Planning Group members to negotiate for raw water from other entities.***

Finished Water Transmission

For each water treatment plant alternative, the finished water transmission system that presents the lowest overall capital and O & M costs was developed. The pipeline alignment was based on the preferred pipeline corridors identified in a pipeline corridor analysis. The analysis reviewed alternative pipeline corridors between the various treatment plant alternatives and the participating utility take points. The preferred pipeline corridors were identified based on the following criteria:

- Minimize overall length of finished water pipelines,
- Minimize construction in urban areas,
- Minimize construction in corridors with numerous existing utilities, wetlands, and private lands requiring easements.

To develop the cost effective sizing of the finished water transmission system components, a hydraulic model was utilized to size pipeline components based on the take point requirements and the preferred pipeline alignments. The goal of the model was determine the minimum sized pipelines and booster pump station pressure that could adequately meet the take point requirements. The results of the model runs for each of the alternatives are provided in **Section 6**.

For each water treatment plant alternative, two modeling scenarios were evaluated to determine the relative economic cost to deliver water to each Participating Utility Take Points at system pressure from the WTP high service pumps or through a through a distributed system in which finished water is delivered to each Ground Storage Tanks and repumped to system pressure for each Participating Utility.

Economic Evaluation

An economic evaluation was performed for the two different WTP sites alternatives. The following is a summary of the evaluation.

Capital Cost

The capital costs for each plant site alternative includes costs associated with the finished water pipeline, high service pump station, booster pump stations, easements, and treatment plant facilities. The capital costs also includes engineering construction administration and contingency.

Construction projects have certain unpredictable expenses. To cover the costs of these unpredictable expenses, an allowance for various contingencies is designed to reduce project risk. The contingency will vary according to the type of project, complexity of design, and geographical location. This allowance can be reduced as the design progresses from concept through final construction documents, but some contingency must remain throughout the life of the project as a reserve for events that experience shows will likely occur. Contingency is applied to total construction cost which includes the construction estimate with engineering and construction administration.

The capital costs associated with the identified raw water conveyance for the GCWA option, finished water transmission systems, and water treatment process for each of the identified plant site alternatives, inclusive of engineering and construct administration are shown in **Table ES-3.**

TABLE ES-3
CAPITAL EXPENDITURE (YR 2000 $)

Alternative	Phase I Year 2008	Expansion Year 2028
Manvel at Pressure	$77,979,000	$16,142,000
Manvel to GSTs	$79,275,000	$18,466,000
Alvin at Pressure	$87,929,000	$16,142,000
Alvin to GSTs	$86,565,000	$18,466,000

Operation and Maintenance Costs

O & M costs for the facility include the costs associated with producing and delivering the water demand to the Participating Utilities. O & M costs include the following items:

- Electricity,
- Maintenance,
- Chemicals,
- Labor,
- Sludge disposal, and
- Administration

The annual O&M costs for the alternative plant site scenarios are summarized in **Table ES-4**

TABLE ES-4
ANNUAL O&M (YR 2000 $)

Alternative	Phase 1 2010-2030	Phase 2 2030-2050
Manvel at Pressure	$4,355,000	$6,165,000
Manvel to GSTs	$4,445,000	$6,295,000
Alvin at Pressure	$4,395,000	$6,205,000
Alvin to GSTs	$4,475,000	$6,325,000

Present Worth Analysis

A present worth analysis was prepared for the purposes of evaluating the identified alternatives. The present worth of an alternative represents the investment required today to construct and operate the recommended raw water improvements, water treatment plant, and finished water transmission system. The present worth analysis of each of the alternatives evaluated is provided in **Table ES-5**.

TABLE ES-5
PLANT SITE ALTERNATIVES PRESENT WORTH SUMMARY (YR 2000$)

Alternative	Present Worth Cost ($M)
Manvel WTP Site Delivering Water At Pressure	$160
Manvel WTP Site Delivering Water To GSTs	$164
Alvin WTP Site Delivering Water At Pressure	$169
Alvin WTP Site Delivering Water To GSTs	$170

The analysis indicates that the scenario of constructing a new regional water treatment plant at the Manvel site and transmitting water to the Participating Utilities at pressure is less expensive than either delivering water to Ground Storage Tanks or constructing a new plant at the Alvin location.

GCWA Regional Water Treatment Plant Alternative

The study also looked at the relative economic cost of participating in a larger regional water treatment plant proposed by the Gulf Coast Water Authority to serve utilities in Fort Bend, Harris, and Brazoria Counties. This regional water treatment plant was studied as part of the TWDB / GCWA Facility Plan study completed in November, 2000. The plant was designed with an ultimate capacity of 150 MGD and would be located in Stafford, Texas. The advantage of combining forces and constructing a larger regional facility is documented cost savings associated with the "economy of scale" in constructing a larger facility. Offsetting this saving would be the cost of a trans-county pipeline. In addition, in this alternative, the MBCPG members would be a raw water customer instead of a wholesale supplier of treated surface water. This study evaluated the benefits and costs of this larger regional plant.

CONCLUSIONS

- The Mid-Brazoria County region will require surface water conversion to protect the groundwater quality and quantity throughout the planning horizon.
- A 25 MGD high-rate conventional plant at the Manvel site, with associated raw and finished water improvements provides the lowest present worth option for the local regional surface water facility plan
- A unit cost of participation with neighboring communities in Fort Bend and Harris County is less expensive than a local 25 MGD facility serving just the Mid-Brazoria County Region.
- The alternative analysis developed in this study provides a number of sites and plant configurations that are technically and economically feasible.
- Based on the assumptions governing raw water supply costs, the relative present worth cost for either the GCWA or CBWC are significantly less expensive than the alternative of buying contract raw water through the Brazos River Authority.

RECOMMENDATIONS

- MBCPG should form of join a regional authority with the power to construct and operate regional water supply facilities. The MBCPG members should negotiate raw water contract or purchase for use in this project.
- Investigate Federal and State grants and other available funding sources to help offset project development costs.
- Investigate the feasibility of joining with neighboring communities to benefit for the cost savings associated with a larger regional water treatment plant.
- If the Participating Utilities proceed with a local water treatment plant, a 25 MGD high-rate conventional plant at the Manvel site, with associated finished water improvements should serve as the basis for the development of regional surface water facilities in the planning area.

Construction projects have certain unpredictable expenses. To cover the costs of these unpredictable expenses, an allowance for various contingencies is designed to reduce project risk. The contingency will vary according to the type of project, complexity of design, and geographical location. This allowance can be reduced as the design progresses from concept through final construction documents, but some contingency must remain throughout the life of the project as a reserve for events that experience shows will likely occur. Contingency is applied to total construction cost which includes the construction estimate with engineering and construction administration.

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Based on the unit cost to construct and operate a two-phase 150 MGD plant as reported in the November 2000 TWDB report, the estimated present worth cost to buy treated water from the GCWA and bring the water to the Participating Utilities through a large diameter finished water pipeline is 154 million dollars. This represents a 6 million dollar savings of the low present worth alternative for a smaller Mid-Brazoria County regional water plant.

Non-Economic Evaluation

The Participating Utility Team met to discuss the non-economic factors involved in site selection and developed the following list of general criteria: Public Acceptance, Expandability, Reliability, Environmental Impacts, and Permitting. An analysis was completed to review this criteria.

The analysis compared the Manvel site against the Alvin site and showed that no significant difference existed between the two sites based on non-economic impacts to the community. Each site has drawbacks and benefits, but no one criteria outweighed another.

FACILITY PLAN

For the smaller regional water plant alternatives, a facility plan detailing a preliminary site layout, operational requirements, and estimated costs have been developed for the low present cost option. The Manvel site delivering water at pressure from the plant's high service pump station offers the lowest present worth cost and will serve as the basis for the recommended facility plan. However, there is less than a 6% cost difference between all of the siting alternatives.

The facility plan is based on the development of a single 25 MGD high-rate conventional surface water treatment plant at the Manvel site, as shown in **Figure ES-8**. The plant would be developed in two phases. The initial phase would provide 15 MGD to meet the regional surface water conversion requirements for the year 2010. A 10 MGD expansion would be accomplished in year 2030 to satisfy future growth requirements.

The facility plan also includes improvements to the raw water delivery system and the associated finished water transmission systems required to deliver water to the individual participants. A summary of the probable capital costs for the facility plan is presented in **Table ES-6**.

TABLE ES-6
FACILITY PLAN CAPITAL COSTS

ITEMS	COST (YR 2000 $)	
	15 MGD Initial Phase	10 MGD Expansion
Property and Site Improvements	$760,000	$-
Water Treatment Plant	$22,931,000	$7,930,000
Finished Water Transmission	$23,268,000	$1,792,000
Raw Water Improvements	$0	$0
Capital Subtotal	$46,959,000	$9,722,000
Contingency	$16,440,000	$3,400,000
Engineering and Administration	$14,580,000	$3,020,000
Total Capital	$77,979,000	$16,142,000

CONCLUSIONS

- The Mid-Brazoria County region will require surface water conversion to protect the groundwater quality and quantity throughout the planning horizon.
- A 25 MGD high-rate conventional plant at the Manvel site, with associated raw and finished water improvements provides the lowest present worth option for the local regional surface water facility plan
- A unit cost of participation with neighboring communities in Fort Bend and Harris County is less expensive than a local 25 MGD facility serving just the Mid-Brazoria County Region.
- The alternative analysis developed in this study provides a number of sites and plant configurations that are technically and economically feasible.
- Based on the assumptions governing raw water supply costs, the relative present worth cost for either the GCWA or CBWC are significantly less expensive than the alternative of buying contract raw water through the Brazos River Authority.

RECOMMENDATIONS

- MBCPG should form of join a regional authority with the power to construct and operate regional water supply facilities. The MBCPG members should negotiate raw water contract or purchase for use in this project.
- Investigate Federal and State grants and other available funding sources to help offset project development costs.
- Investigate the feasibility of joining with neighboring communities to benefit for the cost savings associated with a larger regional water treatment plant.
- If the Participating Utilities proceed with a local water treatment plant, a 25 MGD high-rate conventional plant at the Manvel site, with associated finished water improvements should serve as the basis for the development of regional surface water facilities in the planning area.

BACKGROUND

The primary current water supply for the residents of Brazoria County is groundwater drawn from the underlying Gulf Coast Aquifer. Although existing sources are more than adequate to meet current municipal, domestic, manufacturing, and agricultural uses throughout Brazoria County, the region is concerned about whether existing sources can meet future demand without a decrease in water quality or subsidence. A drop in the groundwater level would force many well owners to lower their wells or find alternative sources of water. In addition, the piezometric head or groundwater level in aquifers serves as a barrier to salt water intrusion from the Gulf of Mexico. A decline in the piezometric head can potentially lead to salt water intrusion, further compromising water quality of the aquifer.

The residents of Brazoria County are considering converting to surface water for domestic use to minimize required groundwater consumption. In Texas, the State controls the use of surface water by allocating water right permits to users. These rights are based on the availability of water and may be superseded by an entity with more senior water rights during drought conditions. The State of Texas through the Texas Water Development Board (TWDB) has established regional planning groups to assist in identifying regional water needs and proposed projects to assure that each region has an adequate supply of water. The Brazoria County Region is part of the State of Texas designated "Region H". Region H comprises 15 counties in and around Houston and is a political entity of the State of Texas charged with defining regional water needs and identifying potential sources of water.

The Region H has just completed their review of the water needs in the area and has compiled a list of proposed projects to supply the region with adequate water supply. For the Mid-Brazoria County Region, the TWDB reports that the Brazos River can serve as the raw water source for the conversion of the region from groundwater to surface water. In lieu of each municipality in the Mid-Brazoria County Region designing and constructing water plants to serve their customers, a regional surface water plant may be a viable and an economically attractive alternative to supply surface water to this region. This study evaluates the feasibility of this alternative.

SURFACE WATER ADVANTAGES

Although conversion from drinking water comprised primarily of groundwater sources to a blend of treated surface water and groundwater will require an extensive capital investment to the construction of new surface water treatment and transmission facilities, the benefits of such an expansion will enhance and protect the quality of life in the region. By expanding current potable water supplies to include treated surface water, the region will:

- ***Increase water production capabilities***. As an additional water source is introduced into the area, the growth potential of the area is not limited by water production capacity. By converting to surface water, groundwater slated to be used for domestic purposes can be reallocated for industrial and agricultural uses, thereby allowing greater growth in these economic sectors.

- ***Reduce potential for subsidence***. As surface water is distributed into the system, groundwater production will decrease. As this production decreases, the potential to drawdown the water level in the underlying aquifer will diminish. If the water table remains high, subsidence will decrease and property damage and localized flooding conditions due to subsidence will be minimized, and

- ***Reduce potential for water quality degradation***. Also, as the aquifer level drops, groundwater quality progressively degrades, thus requiring additional treatment processes, increasing costs dramatically. A reduction in groundwater pumping will increase the level in the aquifer and increase groundwater quality.

STUDY PURPOSE

The purpose of this **Regional Surface Water Plant Feasibility Study** is to evaluate alternatives for regional water treatment facilities and transmission piping system to serve Participating Utilities in Mid-Brazoria County Region. This feasibility study will estimate the capital cost to construct a regional water treatment facility inclusive of the cost of raw water pumping and treatment process facilities, potable water pump stations, and potable water pipelines. Operating and maintenance costs for the facility will also be estimated. The study provides a planning horizon through year 2050.

SCOPE OF FACILITY PLAN

Montgomery Watson has been hired by the City of Alvin to evaluate the feasibility of constructing a new regional surface water treatment plant to serve the Participating Utilities. This study includes the following tasks:

- A determination of the expected water demand for each planning group member,
- An evaluation of alternative water treatment plant site locations,
- A pipeline corridor study,
- A water conservation study,
- Overall capital and operating costs, and
- A facility plan for recommended alternative.

In addition, a cultural resources survey and public information program were included in this study. References used in the preparation of this report are included in **Appendix A**.

PLANNING AREA

The planning area is located in the Texas Water Development Board Regional Water Planning Area H in southeast Texas. The planning group covers the northern half of Brazoria County and includes many major cities and population centers. Participating Utilities electing to be included in this study are:

- City of Alvin
- City of Angleton
- City of Brookside Village
- City of Danbury
- City of Hillcrest
- City of Iowa Colony
- City of Manvel
- City of Pearland

A map of the planning area is shown in **Figure 1-1**. The Participating Utilities estimate that the portion of their utilities in the planning area have a current population of 97,694 and an average daily water demand of 10.4 MGD.

River basins within the planning are: the lower portion of the Brazos River Basin, the northeast portion of the San Jacinto-Brazos Coastal Basin and the southwest portion of the San Jacinto Coastal Basin.

AVAILABLE SURFACE WATER

The major surface water feature in this area is the Brazos River. The Brazos River flows diagonally through Fort Bend County from the northwest to the southeast and then serves as the border between

Brazoria and Fort Bend Counties until the Brazos turns southward and flows through Brazoria County before discharging into the Gulf of Mexico. The State of Texas, through the Texas Natural Resources Conservation Commission (TNRCC), currently allocates water from the Brazos River for agricultural, industrial, and municipal needs through water permits.

The Participating Utilities in the Mid Brazoria County Region do not currently hold any water rights on the Brazos and will need to secure water rights or long term contracts for raw water. The State of Texas through Region H is in the process of planning water usage through the region and this report assumes that Region H will plan facilities necessary to provide the region with the required surface water.

Section 2
Planning Area Existing Infrastructure

The Participating Utilities plan to minimize the cost of improvements for surface water conversion by maximizing the use of their existing infrastructure. This section reviews the planning area and identifies the existing envirostructure in the planning area and highlights the capacity of the surface water availability and conveyance in the planning area.

WATER SOURCE AND SUPPLY

Currently, the Mid-Brazoria County Area relies predominantly on groundwater for their potable water needs, with the exception of the City of Angleton, which satisfies part of its water demand by surface water. As the reliability of groundwater supply is reduced in the next five decades, the Brazos River Authority (BRA) and the Gulf Coast Water Authority (GCWA) will continue to be an increasingly viable treated surface water source to the major cities of the Planning Area.

Surface water

The Brazos River is the main source of surface water for members of the Planning Area. The Gulf Coast Water Authority currently draws surface water from the Brazos River. Water quality for the Brazos River is presented in **Section 4** of this report.

Groundwater

The Region H area has two major aquifers supplying groundwater, the Gulf Coast aquifer, and the Carrizo-Wilcox aquifer. The members of the Planning Group are supplied groundwater from the Gulf Coast aquifer. This aquifer is composed of the Evangeline, Chicot, and Jasper formations, and extends from near the shoreline to approximately 100 to 120 miles inland, to Walker and Trinity counties. The groundwater availability for Brazoria County is 50,315 acre-feet per year.

Surface Water Rights

The right to take water from the Brazos is based on the permit allocation from the State of Texas and the date of the permit. Holders of the oldest water permits have first right to take available water from the Brazos River. Junior water rights must wait until all holders of senior water rights have had the chance to receive their allocated water rights. Gulf Coast Water Authority currently holds 3 water permits for diversion of water from the run of the Brazos, the Chocolate Bayou Water Company holds 2 permits, and the Brazos River Authority holds 1 permit. A summary of permits and allocations held by various entities are shown in **Table 2-1**.

TABLE 2-1
EXISTING WATER PERMITS ON LOWER BRAZOS RIVER

Permit #	Date	Priority No.	Total Withdrawal ac-ft / yr.	Total Withdrawal MGD	Maximum Withdrawal Rate Cfs (cubic feet per second)	Maximum Withdrawal Rate MGD
1040 - GCWA	1/15/1926	1	99,932	89	685	443
1041 – Reliant Energy	10/23/1926	2	28,000	25	385	249
1145- CBWC	2/8/1929	3	40,000	36	400	259
1145 - DOW	2/28/1929	4	20,000	18	132	85
1262 - BRA	5/9/1938	5	230,750	206		
1299 - GCWA	2/2/1939	6	125,000	112	600	388
1345/1631 - DOW	2/14/1924	7	150,000	134	630	407
1299 - GCWA	12/12/1950	8	50,000	45	600	388
1145 - CBWC	3/3/1955	9	40,000	36	268	173
1964 - DOW	4/4/1960	10	65,000	58	630	407
1145 - CBWC	7/25/1983	21	75,000	67	900	582
Total		Total	923,682	824	5230	3380

DOW – DOW Chemical Company

The City of Pearland currently has a water contract, which expires after the year 2010, with the GCWA for 5,559 acre-feet per year. The City of Angleton has a water contract with the Brazosport Water Authority (BWA) for 1,815 acre-feet per year of treated surface water expiring after the year 2040. The City of Angleton is currently using this contract to serve their municipal needs.

MID-BRAZORIA COUNTY PLANNING GROUP EXISTING FACILITIES DESCRIPTION

The planning area contains municipally owned water systems that deliver potable water to customers. These entities have constructed the infrastructure to withdraw, store, and treat water for delivery and consumption by their customers. Participating Utility water customers in the planning area are served either via water pumped from the Gulf Coast Aquifer, treated surface water from the City of Houston, or contracts with the GCWA and the BWA.

The cities of Pearland and Angleton use treated surface water for a portion, or all of their potable water supplies and supplement water from groundwater wells to meet demand. The other Participating Utilities serve their customers entirely with groundwater. A summary of the Participating Utilities in this study and their water infrastructure are provided below.

City of Manvel

The City of Manvel is located in Brazoria County and serves an area bordered by Lewis Lane to the North, SH 288 to the west, Taylor Lane to the south, and Lewis Lane to the east. The City of Manvel ETJ is approximately 23.3 square miles. The city has approximately 4,686 residents with extensive expansion expected in the future. Currently the water needs for the City are met by water wells. The city currently operates a water treatment facility with a rated well production capacity of 175 GPM and a back up well rated at 50 GPM. The primary well was drilled to a depth of approximately 550 feet and has 30 feet of screening. This enables the City to service a maximum of 375 service connections. The ground storage tank is designed to hold 125,000 gallons with the capability of being expanded to approximately 165,000 gallons. The existing water treatment facility has two 10 HP booster pumps rated to keep pace with the well. The plant also has a 10,000 gallon pressure tank designed to maintain a system pressure near the plant of 57 psi. The current average demand is 0.63 MGD. The service area of the existing plant, located near the intersection of Lewis Lane and School Road, stretches along SH-6 as far west as SH-288. In addition, the City serves customers along FM-1128 as far south as Taylor Lane and north as far as Lewis Lane

The development of Manvel both residentially and commercially will be centralized radially around the intersection of SH-288 and SH-6. The City plans on building a water treatment facility to service this area. The current facility will be used to service the downtown business/residential areas, and any development east of FM 1128, along SH-6.

It is anticipated that the City will experience rapid growth over the next 15 years, with some estimates expecting 10,000 homes to be constructed. Therefore, the City would require a water supply ultimately capable of meeting a demand of approximately 3.15 MGD for residential customers alone within the next twenty years.

City of Brookside Village

The City of Brookside Village currently has approximately 1,800 residents. The current average water demand is 0.18 MGD, estimated on a 100 gallon per person per day basis. The water demands are met by private water wells. The City currently does not have a community system to meet its water demand.

City of Pearland

The City of Pearland, located in Harris and Brazoria County, has an existing population of 31,893 residents and an ETJ of approximately 58.4 square miles in the planning area. The City serves its customers through groundwater wells, and a contract with the City of Houston. The City currently has seven water wells having a total capacity of 6,412 GPM. The water distribution system is comprised of eight ground storage tanks having a total capacity of 2,824,000 gallons, and three elevated storage tanks having a total capacity of 1,500,000 gallons. The City also has seven pump stations. **Table 2-2** presents detailed pump station information.

TABLE 2-2
CITY OF PEARLAND PUMP STATION INFORMATION

Pump Station No.	Location	Estimated Range of Capacity (GPM)
1	McLean Road	520-560
2	Garden Road	780-840
3	Magnolia	720-840
4	Liberty	980-1190
5	Alice	640-1120
6	SH 518	500
7	Old City	340-385

City of Alvin

The City of Alvin, located in Brazoria County, serves a geographic area of 14.8 square miles with a current population of approximately 24,075 residents. The water supply sources for the City currently include water from ground water wells. There is no surface water currently purchased by the City, nor is there any surface water treated and supplied to the system. The City of Alvin water distribution system consists of one pressure plane that includes: five water wells, three booster pump stations, six ground storage tanks, and two elevated storage tanks. **Table 2-3** presents a listing of the water wells. Well number 8 was the most recent well to be constructed, being completed and on-line during the summer of 1999.

TABLE 2-3
CITY OF ALVIN WATER WELLS

Well No.	Diameter (inches)	Estimated Capacity (GPM)	Depth (feet)
3	10 ¾	1,200	700
4	14	800	700
6	16	900	700
7	18	1,500	700
8	16	1,200	700
Total Capacity 5,600 GPM			

The three pump booster stations are referred to as Water Plant No. 3, No. 4, and No. 6. Water Plant No. 3, located on Snyder Street, includes three service pumps and one ground storage tank that is supplied by one water well. The pumping capacity of each of the pumps and storage capacity of the tanks is presented in **Table 2-4**.

TABLE 2-4
CITY OF ALVIN WATER PLANT NO. 3

Service Pumps				
No.Pump	Estimated GPM	Rated Head	HP	RPM
1	500	183	30	1,750
2	500	183	30	1,750
3	500	183	30	1,750
Ground Storage Tanks				
Tank No.	Fed by Well No.	Diameter (feet)	Height (feet)	Volume (MG)
1	3	300	24	1

Water Plant No. 4, located on Robinson Street, includes three service pumps and two ground storage tanks that are supplied by two water wells. The pumping capacity of each of the pumps and storage capacity of the tanks is presented in **Table 2-5**.

TABLE 2-5
CITY OF ALVIN WATER PLANT NO. 4

Service Pumps				
Pump No.	Estimated GPM	Rated Head	HP	RPM
1	450	180	25	1,750
2	450	180	25	1,750
3	450	180	25	1,750
Ground Storage Tanks				
Tank No.	Fed by Well No.	Diameter (feet)	Height (feet)	Volume (MG)
1	4 and 8	148	24	0.25
2	4 and 8	104	24	0.125

Water Plant No. 6, located on Brazos Street, includes four service pumps and three storage tanks that are supplied by two water wells. The pumping capacities of each of the pumps and storage capacity of the tanks are presented in **Table 2-6**.

TABLE 2-6
CITY OF ALVIN WATER PLANT NO. 6

Service Pumps				
Pump No.	Estimated GPM	Rated Head	HP	RPM
1	600	170	40	1,750
2	600	170	40	1,750
3	600	170	40	1,750
4	600	170	40	1,750
Ground Storage Tanks				
Tank No.	Fed by Well No.	Diameter (feet)	Height (feet)	Volume (MG)
1	6 and 7	148	24	0.25
2	6 and 7	148	24	0.25
3	6 and 7	148	24	0.25

Total theoretical output from all service pumps is 7.6 MGD. The firm capacity is 5.32 MGD with the largest pump out of service.

The City of Alvin water system contains two elevated storage tanks located in the southern area of the City, and they are identified as Verhalen and Dyche Lane.

City of Hillcrest Village

The City of Hillcrest Village has an approximate area of 25 square miles and a population of approximately 891 residents. The city serves its residents through a total of 2 wells with capacity of 185 and 284 GPM. The City has one storage structure with a capacity of 0.10 MG. The current average demand is 0.11 MG.

City of Danbury

The residents of Danbury meet their water demand through private wells. The City does not have a community system to meet their water demands.

City of Angleton

The City of Angleton currently has approximately 20,000 residents. The City has a water contract with the Brazosport Water Authority (BWA) for 1,815 acre-feet per year of treated surface water. In addition to this contract, the City serves its residents through a total of 6 wells with capacity of 450 to 850 GPM per well. It has two storage structures, one ground and one elevated storage tank. The ground storage tank has a capacity of 2.65 MG, and the elevated tank has a capacity of 1 MG. The current average demand is 2.64 MGD. The city has reported experiencing taste and odor problems. It is projected that the city will need a new water plant in the next 5 years.

City of Iowa Colony

The residents of Iowa Colony meet their water demand through private wells. The City does not have a community system to meet their water demands.

Summary of Existing Infrastructure

Table 2-7 reviews the existing infrastructure details for cities in the Planning Area.

TABLE 2-7
EXISTING INFRASTRUCTURE REVIEW

Participating Utilities	Water Wells		Storage Capacity				Pump Stations		
			GSTs		ESTs		Number	Actual Capacity (MGD)	Firm Capacity (MGD)
	Number	Capacity (GPM)	Number	Capacity (MG)	Number	Capacity (MG)			
Manvel	1	175	1	1.25	-	-	NA	NA	NA
Pearland	7	6,412	8	2.82	3	1.15	7	7.8	6.1
Alvin	5	5,600	6	2.12	2	-	3	7.6	5.3
Hillcrest Village	2	469	1	0.10	-	-	NA	NA	NA
Angleton	6	5,100	1	2.65	1	1	NA	NA	NA

NA – Not Available

PROJECTED POTABLE WATER DEMAND

The size of the regional water plant depends on the potable water requirements of the Participating Utilities to the year 2050. Water and population projections for the Participating Utilities were evaluated and summarized to obtain the projected ultimate capacity for the water plant in the year 2050. The size of the water plant will be governed by the service area of the plant, the projected average and peak potable water demand for the planning area, and percentage of demand that each utility desires to obtain from the plant.

Current Population and Water Usage

Data for current population and water usage were taken from the Texas Water Development Board Population & Water Demand Projections: Board Approved Regional Projections to be used in the 2002 State Water Plan. For the Participating Utilities in this study, **Table 3-1** provides the year 2000 population and water use as reported by TWDB through the Region H Board.

TABLE 3-1
YEAR 2000 POPULATION AND AVERAGE WATER DEMAND

Participating Utility	Year 2000 Planning Area Population	Year 2000 Average Day Water Demand (MGD)
Alvin	24,075	2.94
Angleton	23,870	2.89
Brookside Village	2,059	0.25
Danbury	1,870	0.22
Hillcrest	891	0.11
Iowa Colony	851	0.11
Manvel	5,152	0.63
Pearland	31,983	4.32
Total for Study Area	90,751	11.47

Projected Population and Water Usage

Data regarding projected population and water use for the planning area was collected from the TWDB Region H Plan.

The TWDB population and water use projections will serve as a basis for the State's Year 2002 Water Plan. Detailed breakdowns of the TWDB population and water use projections can be found in **Appendix C** – TWDB Population and Water Use Projections.

For this study, the TWDB Region H data will be used as the official projected population and water use for the planning area.

Participating Utility Projected Population

The population projections for the Participating Utilities are reported in the **Table 3-2**. The data lists projected water use and population in 10-year increments to the year 2050.

TABLE 3-2
PROJECTED POPULATION FOR PARTICIPATING UTILITIES IN PLANNING AREA

Participating Utility	2000	2010	2020	2030	2040	2050
Alvin	24,075	28,723	33,822	40,240	45,715	51,935
Angleton	23,870	28,737	34,037	40,661	46,773	52,884
Brookside Vill.	2,059	2,282	2,551	2,934	3,337	3,696
Danbury	1,870	2,174	2,442	2,802	3,079	3,381
Hillcrest	891	995	1,245	1,479	1,592	1,696
Iowa Colony	851	922	1,086	1,272	1,375	1,477
Manvel	5,152	6,084	7,080	8,352	9,412	10,606
Pearland	31,983	42,347	53,105	65,569	77,338	91,243
Total for Planning Area	90,751	112,264	135,368	163,309	188,621	216,918

Water Demand Projection

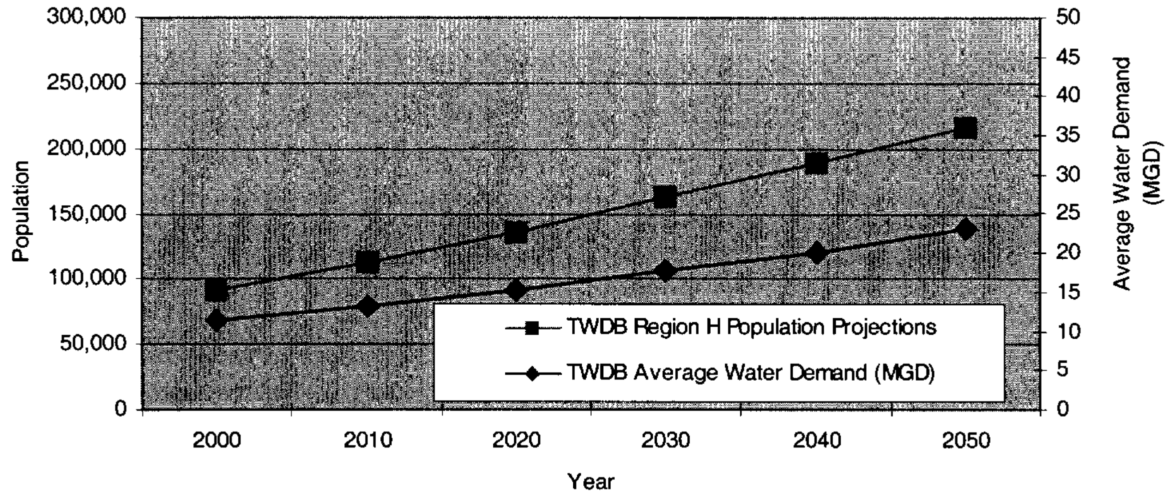
Given the Participating Utility population projections, the corresponding TWDB water use projections are shown in **Table 3-3**. These water use projections represent the expected annual water use reported as average daily demand in MGD.

TABLE 3-3
PROJECTED AVERAGE WATER DEMAND (MGD)
FOR PARTICIPATING UTILITIES IN PLANNING AREA

Participating Utility	2000	2010	2020	2030	2040	2050
Alvin	2.94	3.27	3.65	4.23	4.71	5.30
Angleton	2.89	3.28	3.68	4.23	4.73	5.34
Brookside Vill.	0.25	0.27	0.28	0.31	0.34	0.38
Danbury	0.22	0.24	0.25	0.27	0.30	0.32
Hillcrest	0.11	0.12	0.14	0.16	0.17	0.18
Iowa Colony	0.11	0.11	0.13	0.14	0.15	0.16
Manvel	0.63	0.70	0.76	0.88	0.96	1.08
Pearland	4.32	5.34	6.32	7.61	8.79	10.37
Total for Planning Area	11.47	13.32	15.21	17.83	20.15	23.13

By the year 2050, the daily water use for the eight utilities is approximately 23 MGD, which represents an increase of approximately 12 MGD over the water demand in the year 2000. The planning area expected population and water demand growth are show in **Figure 3-1.**

FIGURE 3-1
WATER DEMAND AND POPULATION PROJECTION FOR THE PLANNING AREA



The per capita water use figures for each participating utility will vary as several utilities have diverse commercial and industrial centers with differing water use projections and can be seen in the **Figure 3-3.**

Based on the current ETJs, and planned development, some of the Participating Utilities anticipate a faster growth rate than Region H projections. Several Participating Utilities therefore felt the need for safety factors to size the facilities to meet this higher growth rate. These safety factors were incorporated in determining the size of facilities necessary to meet the Participating Utility water demand. are shown in **Table 3-4**. The corresponding water use projections with safety factors to be used in sizing facilities are shown in **Table 3-5**.

FIGURE 3-2
REGION H PER CAPITA WATER DEMANDS

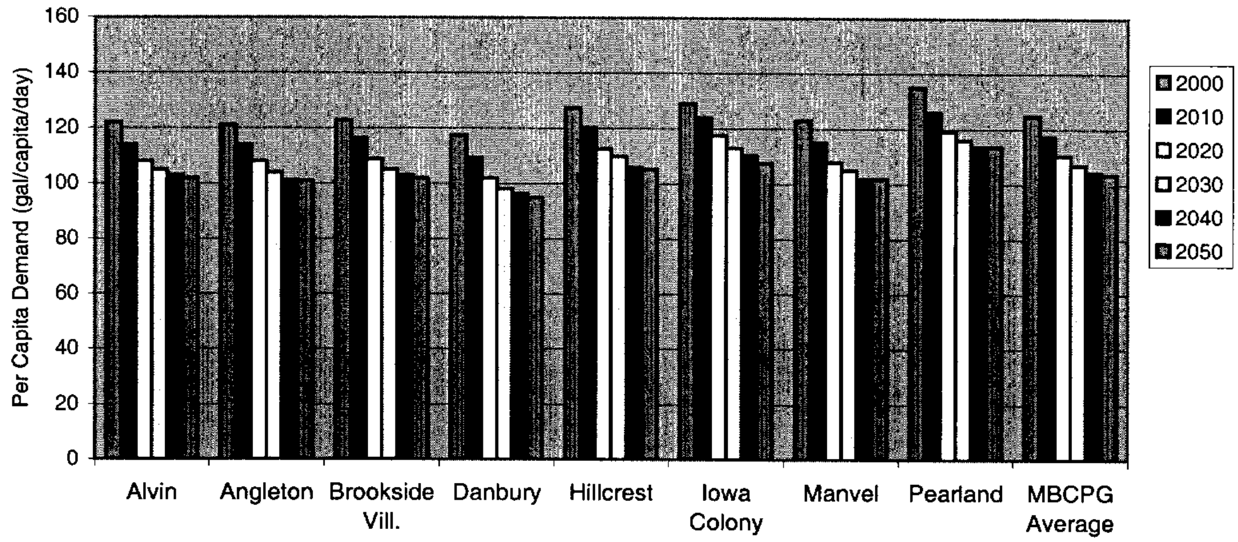


TABLE 3-4
SAFETY FACTORS USED FOR PARTICIPATING UTILITIES

Participating Utilities	Safety Factor
Alvin	1.33
Manvel	4.07
Pearland	1.73

TABLE 3-5
PROJECTED MODIFIED AVERAGE WATER DEMAND (MGD)
FOR PARTICIPATING UTILITIES IN PLANNING AREA

Participating Utility	2000	2010	2020	2030	2040	2050
Alvin	2.94	3.27	4.86	5.62	6.26	7.05
Angleton	2.89	3.28	3.68	4.23	4.73	5.34
Brookside Vill.	0.25	0.27	0.28	0.31	0.34	0.38
Danbury	0.22	0.24	0.25	0.27	0.30	0.32
Hillcrest	0.11	0.12	0.14	0.16	0.17	0.18
Iowa Colony	0.11	0.11	0.13	0.46	0.15	0.16
Manvel	0.63	2.23	3.11	3.57	3.91	4.40
Pearland	4.32	8.66	10.93	13.16	15.21	17.94
Total for Planning Area	11.47	18.18	23.37	27.78	31.07	35.77

AVERAGE AND PEAK DAY DEMAND

The water use projections reported in **Table 3-5** are for average daily demand. In addition to the average daily water demand, each utility also reported their expected peak day water demand to average day water demand ratio. The peaking factors for each utility are shown in **Table 3-6**. The peaking factor is influenced by the distribution of residential, commercial, and industrial customers throughout the utility.

TABLE 3-6
PEAK DAILY TO AVERAGE DAILY FLOW PEAKING FACTORS AND PEAK DEMANDS

Participating Utility	Peaking Factor	Peak Daily Flow in the Year 2050 (MGD)
Alvin	1.64	11.55
Angleton	1.50	8.01
Brookside Vill.	1.50	0.57
Danbury	1.50	0.48
Hillcrest	2.61	0.47
Iowa Colony	1.50	0.24
Manvel	1.50	6.61
Pearland	2.00	35.88
Total for Planning Area		63.81

For the overall planning area, the peak daily flow to average daily flow ratio is 1.78. If the water treatment plant were to be sized to meet 100 percent of the water demand at each of the utilities, the plant would be required to deliver at least 64 MGD to meet the peak daily demand for the planning area.

Water Plant Capacity

The water plant capacity is defined as the amount of water that each Participating Utility reserves as its allotted "take" from the water plant. One option is to supply the entire water demand (average and peak flow) with water from the surface water plant. Another option is to supply the water demand with a combination of water produced from the new regional water treatment plant and the existing groundwater infrastructure. The Participating Utilities have selected to use their existing infrastructure to minimize the required plant capacity and the associated cost of water production. The following is a discussion on this selection and the ramifications of this choice.

Selecting the Appropriate Level of Groundwater Usage in the Planning Area

If the piezometric level in the underlying aquifer remains at or near the current level, experience indicates that groundwater usage remains the most economical method to meet potable water demand. If the groundwater level or quality decreases as expected under an increased groundwater pumping scenario, the cost of providing potable water from groundwater sources will increase. As this scenario unfolds, treated surface water will become a more viable and economic solution to supplement groundwater supplies to meet regional demand and maintain the aquifer and groundwater quality at the current acceptable levels.

The Harris-Galveston Subsidence District has conducted groundwater modeling of the Harris – Galveston-Fort Bend County region to evaluate the effects of proposed groundwater pumping on the availability of water and subsidence of the overlying ground. This modeling effort also covered the northern Brazoria County area. Through this modeling effort, the Harris-Galveston Subsidence District expects groundwater pumping at existing production levels in the Mid-Brazoria County area not to impact the aquifer level and quality at today's standards. Given this expectation, it is the intention of the Participating Utilities to maintain average day groundwater production at current levels through the planning horizon in this study thereby:

- maintaining the current water table level in the underlying aquifer,
- maintaining acceptable groundwater quality,
- mitigating the potential for subsidence, and
- maximizing use of their existing infrastructure.

Groundwater production will be increased to meet peak daily demands. The existing groundwater capacity of each participating utility in the study and how that relates to their year 2000 water demand are shown in **Table 3-7.** The MBCPG has 3.63 MGD in reserve or excess capacity beyond the projected year 2000 peak demand, but is about 4 MGD short of TNRCC requirements of 0.6 GPM per connection. The relation of the Participating Utility existing production capability and the expected 2050 demand is presented in **Table 3-8**. The region needs to construct production capability of 45.48 MGD to meet the 2050 projected demand. Based on TNRCC requirements of 0.6 GPM per connection, a total additional capacity of 47.5 MGD. The actual capacity that will need to be added may be slightly higher since this does not account for firm capacity pumping with the largest unit out of service.

TABLE 3-7
PARTICIPATING UTILITY EXISTING GROUNDWATER PRODUCTION CAPACITY VERSUS EXISTING DEMAND

Participating Utility	2000 Water Production Capacity (MGD)	2000 Average Water Demand (MGD)	2000 Peak Water Demand (MGD)	2000 TNRCC Requirement (MGD)***
Alvin	4.50	2.94	4.82	7.32
Angleton	5.60 *	2.89	4.34	7.26
Brookside Vill.	0.00	0.25	0.38	0.63
Danbury	0.00	0.22	0.33	0.57
Hillcrest	0.68	0.11	0.29	0.27
Iowa Colony	0.00	0.11	0.17	0.26
Manvel	0.25	0.63	0.95	1.57
Pearland	12.5**	4.32	8.64	9.73
Total for Planning Area	23.53	11.47	19.90	27.61

**Includes 1.8 MGD contract for surface water from Brazosport Water Authority*

*** Includes 5 MGD from a contract of 10 MGD for surface water from City of Houston*

**** Based on 0.6 GPM per connection, Year 2000 population, and 2.84 persons per connection*

TABLE 3-8
PARTICIPATING UTILITY WATER CAPACITY NEEDS

Participating Utility	2000 Water Production Capacity (MGD)	2050 Peak Water Demand (MGD)	Additional Capacity needed to meet 2050 Peak Demand (MGD)
Alvin	4.50	11.55	7.05
Angleton	5.60 *	8.01	2.41
Brookside Vill.	0.00	0.57	0.57
Danbury	0.00	0.48	0.48
Hillcrest	0.68	0.47	0.00
Iowa Colony	0.00	0.24	0.24
Manvel	0.25	6.61	6.36
Pearland	7.50	35.88	28.38
Total for Planning Area	18.53	63.81	45.48

* *Includes 1.8 MGD contract for surface water from Brazosport Water Authority*

Assumptions

In meeting the Participating Utilities desire to keep the groundwater production at the current rate, the capacity of the water treatment plant can be calculated as the difference between expected demand and current production. In doing such, the following bullets summarize the recommended assumptions for consideration in determining this water plant capacity:

- Use of Region H Population and Water Demand Projections, with application of safety factors as determined from each participating utility data.
- The City of Angleton's contract with Brazosport Water Authority for 1.8 MGD of treated surface water will continue through the year 2040. Region H has suggested an extension of the contract.
- For communities with no public water system (all private wells), meet water demand (average and peak day) from the regional surface water facility. The required "take" capacity from the water treatment plant will be equal to the peak day demand of each community.
- For communities, with an existing public water distribution system, average day groundwater production will be maintained at rate equal to current average water demand (11.5 MGD). These Participating Utilities "take" capacity from the water plant will be defined as the projected growth in average water demand over the next 50 years. It is these communities desire to receive a fairly constant supply of surface water and to augment this supply with groundwater from their wells. These communities will activate their wells during times when the daily water demand exceeds their take from the water plant. During winter months, when water demand is typically lower, the

Participating Utilities may not need to operate their wells as the constant flow of the surface water may meet the daily demand in and of itself. During the non-winter months, the Participating Utilities will be required to utilize their groundwater wells to meet the daily water demand.

- The Participating Utilities will meet peak hour demand through water stored in their individual water distribution system infrastructure. The Participating Utilities can draw on their elevated and ground storage tanks to provide water over and above their maximum regional surface water treatment and groundwater production capability to meet hourly fluctuations in demand. Each participating utility noted that they plan on expanding their water distribution facilities to meet future peak flow demands.

Water Treatment Plant Reserve Capacity

Given these assumptions, the projected water demand for the participating utilities along with the ultimate reserve water plant capacity are shown in **Table 3-9**.

TABLE 3-9
RESERVE SURFACE WATER TREATMENT PLANT CAPACITY (MGD)

Participating Utility	2000 Average Water Demand from Public System (MGD)	2050 Water Demand (MGD)	Reserve Water Plant Capacity in Year 2050 (Water Demand Growth 2000-2050 (MGD))
Communities with Existing Central Water Distribution Systems			
Alvin	2.94	7.05 (1)	3.95
Angleton	2.89	5.34 (1)	2.45
Hillcrest	0.11	0.18 (1)	0.07
Manvel	0.63	4.40 (1)	2.83
Pearland	4.32	17.94 (1)	13.31
Communities without Existing Central Water Distribution Systems			
Brookside Village	0.0 (3)	0.57 (2)	0.57
Danbury	0.0 (3)	0.48 (2)	0.48
Iowa Colony	0.0 (3)	0.24 (2)	0.24
Total for Planning Area	10.89	36.20	25.31

1) Average Water Demand

2) Peak Water Demand, due to the absence of existing wells

3) Demand met through Private Wells, No Existing Public Distribution System

Water Treatment Plant Capacity Phasing

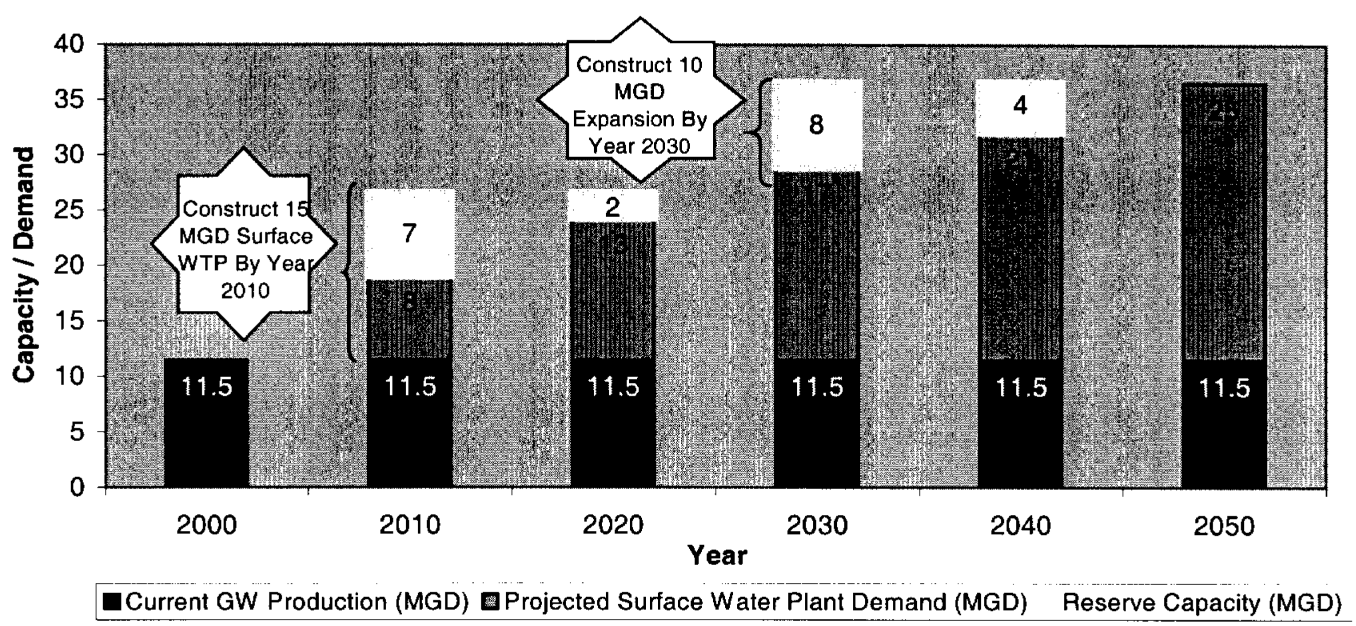
Assuming that the water treatment is operational by the year 2010, the required capacity of the water treatment plant to meet the demand under the aforementioned assumptions is shown in **Table 3-10**. Assuming groundwater production for the participating utilities remains at the current level (11.5 MGD), the average day surface water demand (water required from a regional surface water plant to meet average day demands over the expected groundwater production) will increase from 8 MGD in 2010 to 25 MGD in 2050. The difference between the planned plant capacity in 2050 of 25 MGD and the additional capacity required by TNRCC of 47.5 MGD will be added to the individual systems as required by the addition of groundwater production.

TABLE 3-10
SURFACE WATER TREATMENT PLANT DEMAND

Year	Water Treatment Plant Reserve Capacity (MGD)
2010	8
2020	13
2030	17
2040	21
2050	25

The water plant can be constructed in one or two phases. For a one phase construction, a 25 MGD surface water plant could be built by the year 2010 and would serve the area through the planning period. For a two phase construction plan, a 15 MGD surface water plant could be built by 2010 and serve the area until the year 2030. At this time, a 10 MGD expansion would be constructed to supply the area through year 2050.

Figure 3-3
Two Phase 25 MGD Regional Water Treatment Plant



The two phased construction also minimizes the required initial capital outlay by only constructing the size facility to meet current and near term needs. A one phased construction approach would require expenditure of all capital funds in the first phase to build a facility with enough capacity to meet the water demand for all years in the planning horizon. This one phased approach will result in a higher initial water rate to retire the initial capital debt. Through a two phased construction approach, the capital debt payments can be spread over the entire planning period, thereby lowering the annual cost of the debt repayment and minimizing the annual cost of the water. The two phase construction approach meeting the surface water demand of the Participating Utilities over the planning horizon in shown in **Figure 3-4**.

Water Treatment Plant Capacity and Construction Recommendation

To offer the lowest apparent rates to the residents, it is recommended that the feasibility study proceed on the basis of constructing a 25 MGD water treatment plant under a two phase construction approach. A 15 MGD facility will be built by 2010 with a 10 MGD expansion in the year 2030.

RAW WATER SOURCE

The raw water source for the Mid-Brazoria surface water plant is as of yet unsecured. This section identified several options that may be pursued by the Regional Planning Group for securing surface water for use in the Mid-Brazoria County Regional WTP.

Brazos River

In the Turner Collie and Braden letter report to the Chairman of Region H, dated February 27, 2001, the adopted strategy was to use the Brazos River as the raw water source for the new surface water plant. This report, attached as **Appendix E**, is dated February 27, 2001 and evaluated the following Brazos River conveyance alternatives:

- Purchase contact raw water from the Brazos River Authority and transport this water to the WTP site via a dedicated pipeline from the Brazos River.
- Purchase contract raw water from the Gulf Coast Water Authority and transport this water to the WTP site via the existing GCWA raw water canals that run from the Brazos River through the Mid-Brazoria Region to Galveston County.
- Purchase water rights or contract water from the Chocolate Bayou Water Company and construct a raw water pipeline to transport water from Chocolate Bayou to the WTP site.

The Region H report evaluated each of these options on overall cost necessary to purchase the water, construct conveyance facilities, and maintain the facilities through the year 2050. Based on their evaluation, the option of drawing water through the Gulf Coast Water Authority was the most economical alternative for using Brazos River Water as the surface water source for the Mid-Brazoria Regional Water Plant.

Other Sources

In addition to the Brazos River, water from other sources could serve as the raw or treated water source for the MBCPG participants. The following is a brief synopsis of several identified alternatives to Brazos River water.

Trinity River Basin

The Trinity River is located along the eastern edge of the City of Houston. The City has constructed storage capacity in Lake Livingston and owns a significant allotment of water rights on this river. The City, through Coastal Water Authority, also has in place a system of canals to transport the water from the river to the City of Houston water treatment plant. The City has indicated they can sell treated water. Current indications place the costs of treated wholesale water from the City of Houston for between $1.10 and $1.15 per 1,000 gallons. To utilize this source, the MBCPG would need to

- Contract with the City of Houston for treated water
- Finance and construct a new finished water pipeline from the Cities network near Beltway 8 and Hwy 35 to the participating utilities take points.

Brackish Groundwater

Groundwater sources near the coast of Brazoria County contain higher levels of TDS than allowed by regulations for use as potable water. Treatment of this brackish water is technologically feasible and this water could serve as an alternate water source for the MBCPG. Historically, treatment of brackish water by reverse osmosis has been cost prohibitive.

Dow Chemical, located in Freeport, Texas, has indicated that they would like to propose on constructing a reverse osmosis brackish groundwater treatment plant in Freeport and provide water transmission pipelines to serve the MBCPG. Dow Chemical would then contract with the MBCPG to sell potable water to the participating utilities.

Raw Water Demand

The raw water demand placed on the GCWA canal by the new surface water plant will be equal to the finished water flow plus the water losses in the treatment process. It is expected that process will lose about 7 percent of the raw water flow in producing the finished water. Therefore, to meet a finished water demand of 25 MGD, the raw water flow entering the plant should be 26.75 MGD, or 7 percent over the desired finished water capacity.

Section 4
Development of Treatment Process

This section provides discussion of the raw water quality in the Planning Area, along with descriptions of current and potential federal drinking water regulations that have applicability to treatment of this water. The raw water quality data presented below is a summary of the information presented in the Turner Collie and Braden letter report submitted to the Chairman of Region H, dated February 2001 and the ***GCWA Regional Surface Water Plant Facility Feasibility Study for Brazoria, Fort Bend, and West Harris Counties*** report dated November, 2000.

WATER QUALITY

Regional Raw Water Quality for Brazos River

The GCWA report evaluated the raw water quality of the Brazos River, and listed a summary of the historical raw water data. The water quality data was obtained from two sources: United States Geological Society (USGS) data for the Brazos River at the Richmond – Rosenberg Monitoring Station, and data from the GCWA for the river intake and for the raw water at the existing water treatment plant in Texas City. A summary of the available data provided in the report is shown in **Table 4-1**.

The raw water quality evaluation showed that the Brazos River contained elevated levels of total dissolved solids, aluminum, manganese, bromide, and total organic carbon, but the observed contaminant levels in the raw water is easily treatable through conventional processes.

Federal and State Standards

Federal standards for drinking water are summarized in **Table 4-2**. Standards for the State of Texas are set by the Texas Natural Resources Conservation Commission. In most cases, Texas standards match federal standards. Some secondary standards are different; Texas has a maximum contaminant level (MCL) of 1,000 mg/l for Total Dissolved Solids, and a chloride MCL of 300 mg/l.

Pending federal regulations must be considered in the evaluation of treatment processes for the proposed plant. The Stage 2 Disinfectants/Disinfection By-Products (D/DBP) Rule is expected to maintain current MCLs for total trihalomethanes (TTHMs) and total haloacetic acids (THAAs) at 80 and 60 ug/l. The rule will become more stringent in that individual monitoring sites will be used to determine compliance, rather than on a system-wide basis. This change will probably have the effect of requiring lower levels of TTHMs and THAAs leaving a treatment plant. The recently promulgated Interim Enhanced Surface Water Treatment Rule (ESWTR) set a goal for disinfection/removal of *Cryptosporidium* of zero, with an MCL of 2-log disinfection/removal. The rule grants 2-logs of disinfection/removal credit to facilities using conventional treatment processes that meet other requirements of the rule. A second Enhanced Surface Water Treatment Rule is expected in the future. This rule is expected to focus on more stringent disinfection/removal requirements for microbiological contaminants, such as *Cryptosporidium*. The Backwash Treatment Rule is in development, and is expected to require all plants to recycle waste washwater from backwashing of filters to the head of the treatment process after equalization. The Backwash Treatment Rule is not expected, at least initially, to set treatment limits.

The Stage 1 D/DBPR and the Interim ESWTR were promulgated in December, 1998. Data related to future changes in these two rules has been collected by utilities, and is now under evaluation by EPA and other agencies and groups. The EPA has formed advisory committees to begin a negotiated process for future regulations. Based on the time required for the negotiations for the most recent two regulations, it is anticipated that the Stage 2 D/DBPR and a future ESWTR may be proposed in the next five to ten years. If proposed in this time frame, it is likely that compliance would be required within an additional three to five years after the rules are actually promulgated.

TABLE 4-1
SUMMARY OF RAW WATER QUALITY

Quality Analysis	Unit	BRAZOS RIVER[1] Average [a]	BRAZOS RIVER[1] Range [b]	River Intake [c]	Raw Water at WTP[d]
Algae count	(cells/ml)			14214	
Alkalinity(as CaCO3)	Mg/l	136	75 - 234	156.6	141
Aluminium, dissolved	Ug/l	51	10 - 390		
Ammonia Nitrogen (as N)	Mg/l	0.06	0 - 0.23	0.068	
Apparent Color	ACU				
Arsenic	Ug/l	3.0	1 - 7		
Beryllium	Ug/l	0.6	0.5 - 2		
Boron, dissolved	Ug/l	119	60 - 170		
Bromate	Mg/l			0.26	0.07
Bromide	Mg/l			0.26	
Cobalt (as Co)	Ug/l	2.9	0 - 60		
Cadmium (as Cd)	Ug/l	1.4	0 - 3		
Calcium	Mg/l	60	28 - 100		53
Chloride	Mg/l	114	12 - 370	118	67
Chromium (as Cr)	Ug/l	10	0 - 20		
Copper (as Cu)	Ug/l	16.8	5 - 47		
Dissolved oxygen	Mg/l	8.6	5.4 - 12	6.8	
DOC	Mg/l	11	4.2 - 25	4.09	
Fecal coliform, 7um-mf	colonies/100 ml	730	12 - 7,300		
Flouride	Mg/L	0.3	0.1 - 0.5		
Glyphosate	Ug/l				
H_2S	Mg/L				
Iron, Total (as Fe)	Ug/l	5500	390 - 22,000	2650	24
Kjeldahl Nitrogen	Mg/l	0.9	0.01 - 7.3		
Lead (as Pb), Total	Ug/l	24.5	2 - 65		
Lithium (dissolved as Li)	Ug/l	14.3	6 - 30		
Magnesium	Mg/l	13	3.5 - 71		20
Manganese, Total (as Mn)	Ug/l	205	5 - 740		
Mercury (as Hg), Total	Ug/l	0.2	0.1 - 0.4		
Molybdenum (dissolved as Mo)	Ug/l	10.2	10 - 20		
Nickel (as Ni), Total	Ug/l	8.9	2 - 30		
Nitrate	Mg/l	0.4	0.01 - 1.5	1.47	1.40
Nitrite	Mg/l	0.04	0 - 0.29	0	0.05
Odor					
Organic Nitrogen	Mg/l	0.9	0.15 - 4.3	0.86	
Ortho-Phosphate Phosphorus (as	Mg/l	0.1	0.01 - 0.13		0.18
PH	Units	7.9-8.0	7.4 - 8.5	8.4	8.2
Potassium	Mg/l	4.7	1.8 - 7.5		
Selenium (as Se), Total	Ug/l	0.5	0 - 1		
Silica	Mg/l	8.7	0.3 - 40	8.4	
Silver (as Ag), Total	Ug/l	0.6	0 - 1		
Sodium	Mg/l	80	9.5 - 240		
Specific Conductance	Umho/cm	770	220 - 1,900	700	
Streptococci fecal, membrane	colonies/100 ml	860	20 - 9,100		
Strontium (dissolved as Sr)	Ug/l	570	70 - 1,000		
Sulfate (as SO4)	Mg/l	76	16 - 200		57
TDS	Mg/L	430	50 - 980	440	140
Temperature	OC	20	3.5 - 33.5		
Total Hardness, Non Carbonate	Mg/L	70	0 - 190		
Total Hardness, as CaCO3	Mg/l	200	90 - 470		189
Total Nitrogen N	Mg/l			0.90	
Total Organic Carbon (as C)	Mg/l	10	2.7 - 44	4.80	4.8
Total Organic Halogen	Ug/l				
Total Phosphorus P	Mg/l	0.2	0.04 - 0.95	0.07	
TSS	Mg/L	1150	12 - 7,360	280	19.8
Turbidity	NTU	150	0.4 - 890	160	50
UV-254	1/cm			0.10	
Vanadium (dissolved as V)	Ug/l	6.1	6 - 8		
Zinc (as Zn), Total	Ug/l	60	20 - 120		

1 : Richmond-Rosenberg Monitoring Station
a : Average of samples taken from 1970 to 1995.
b : Range of samples taken from 1970 to 1995.
c : Shannon Lift Station, Year 1990
d : Dr. Thomas Mackey Water Treatment Plant

TABLE 4-2
SUMMARY OF FEDERAL AND STATE STANDARDS

Volatile Organic Chemicals	Max Contaminant Level (mg/l)
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.005
1,2-Dichloroethane	0.005
1,2-Dichloropropane	0.005
1,2,4-Trichlorobenzene	0.07
Benzene	0.005
Carbon tetrachloride	0.005
Cis-1,2-Dichloroethylene	0.07
Dichloromethane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
o-Dichlorobenzene	0.6
para-Dichlorobenzene	0.075
Styrene	0.1
Tetrachloroethylene	0.005
Toluene	1
trans-1,2-Dichloroethylene	0.1
Trichloroethylene	0.005
Vinyl chloride	0.002
Xylenes (total)	10
Synthetic Organic Chemicals	**Max Contaminant Level (mg/l)**
2,3,7,8-TCDD (Dioxin)[a]	3×10^{-8}
2,4-D	0.07
2,4,5-TP (Silvex)	0.05
Alachlor	0.002
Atrazine	0.003
Benzo(a)pyrene	0.0002
Carbofuran	0.04
Chlordane	0.002
Dalapon	0.2
Di(2-ethylhexyl)adipate	0.4
Di(2-ethylhexyl)phthalate	0.006
Dibromochloro-propane (DBCP)	0.0002
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Ethylene dibromide	0.00005
Glyphosate	0.7
Heptachlor	0.0004
Heptachlor epoxide	0.0002
Hexachlorobenzene	0.001
Hexachlorocyclo-pentadiene	0.05
Lindane	0.0002
Methoxychlor	0.04
Oxamyl (vydate)	0.2
Pentachlorophenol	0.001
Picloram	0.5
Polychlorinated biphenyl (PCB)	0.0005
Simazine	0.004
Toxaphene	0.003
Acrylamide	TT
Epichlorohydrin	TT

TABLE 4-2 (CONTINUED)
SUMMARY OF FEDERAL AND STATE STANDARDS

Disinfection	Max Contaminant Level (mg/l)
Total Trihalomethanes (TTHMs)	0.080
Haloacetic Acids (HAAs)	0.060
Bromate	0.010
Chlorite	1.0
	Maximum Residual Disinfectant
Chlorine	4.0
Chloramines	4.0 as Total Chlorine
Chlorine Dioxide	0.8
Enhanced Coagulation	Treatment Technique
Giardia Lamblia	3-log inactivation/removal
Viruses	4-log inactivation/removal
Cryptosporidium	2-log inactivation/removal
Inorganics	**Max Contaminant Level (mg/l)**
Antimony	0.006
Arsenic	0.05
Asbestos	7 MFL > 10microns
Barium	2
Beryllium	0.004
Cadmium	0.005
Chromium	0.1
Copper	1.3 action level
Cyanide	0.2
Fluoride	4.0
Lead	0.015 action level
Mercury	0.002
Nickel	0.1
Nitrate	10 (as N)
Nitrite	1 (as N)
Total Nitrate and Nitrite	10 (as N)
Selenium	0.05
Thallium	0.002
Secondary Standards	**Max Contaminant Level (mg/l)**
Aluminum	0.05 to 0.2
Chloride	250
Color	15 color units
Copper	1
Corrosivity, Sat. Index	Non-corrosive
Fluoride	2.0
Foaming Agents	0.5
Iron	0.3
Manganese	0.05
Odor-TON[b]	3
PH	6.5-8.5
Silver	0.1
Sulfate	250
Total Dissolved Solids	500
Zinc	5
Solids	**Max Contaminant Level**
Turbidity	0.3 ntu
Microbiological	
Total Coliform	Presence/Absence
Radionuclides	**Max Contaminant Level (pCi/l)**
Combined Radium-226 and 228	5
Gross Alpha (incl. Radium-228,	15
Tritium	20,000
Strontium-90	8
Uranium	30 ug/L

A future ESWTR has not been proposed, nor has EPA suggested what contaminants, nor what levels of treatment may be regulated. It is recommended that the process treatment selection NOT be selected to meet the undefined requirements of the future EWSTR additional disinfection/removal requirements at this time. The federal advisory committee is currently discussing a period of monthly monitoring for *Cryptosporidium*. Based on the monitoring results, action levels would trigger additional inactivation/removal requirements. For example 1.0 to 3.0 oocysts/l of *Cryptosporidium* would trigger an additional 2.0 log inactivation/removal requirement. Multiple approaches for achieving inactivation/removal credit may be allowed, including watershed protection, enhanced turbidity removal, in addition to a mandatory partial disinfection process that is broadly defined as Ultraviolet light, ozone, or membranes.

It is recommended, however, that the treatment process evaluation consider the adaptability of the process to possible changes by this rule. It is recommended that an allocation (both site area and hydraulic head) be set aside for future processes that may be required by this rule.

FINISHED WATER QUALITY GOALS

The key water quality goals for the proposed WTP are listed in **Table 4-3**. The goals are based on federal Primary and Secondary Standards, and TNRCC standards from its draft proposal for Chapter 290, Subchapter F, Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems. The new TNRCC standards are for turbidity, TTHMs, THAAs, bromate, chlorite, and enhanced coagulation.

TABLE 4-3
SUMMARY OF TREATMENT GOALS

Parameter	Units	Treatment Goal	Remarks
Giardia Lamblia	-	0.5-log chemical disinfection	2.5-log removal provided by conventional process
Cryptosporidium	-	No additional treatment	2-log removal provided by conventional process
Viruses	-	2.0-log chemical disinfection	2-log removal provided by conventional process
Turbidity	Ntu	< 0.1	
TOC	mg/l	Up to 25 percent removal	
Total coliform	-	Not detectable	
Alkalinity, Total	mg/l	No additional treatment	
Langlier Index	mg/l	Between 0.1 and 0.4	
Total Hardness	mg/l	No additional treatment	
pH	-	Between 7.5 and 8.0	
Chlorite	mg/l	< 1.0	
Total Haloacetic Acids	ug/l	< 30	Quarterly running average in distribution system
Total Trihalomethanes	ug/l	< 40	Quarterly running average in distribution system

TREATMENT PROCESS

The recently completed GCWA report preformed a detailed evaluation of several alternative treatment processes to determine the most cost effective method of treating Brazos River water. In their report, the GCWA evaluated the following three treatment alternatives.

- Conventional process - The conventional process is similar to the existing Dr. Thomas Mackey WTP in Texas City.
- A high-rate conventional process - The high-rate conventional process assumes that a high-rate pretreatment process is used to reduce the space and cost of pretreatment before filtration.
- A membrane filtration process - The membrane filtration process is experiencing more widespread use in the United States as the cost of membranes and the cost of pumping associated with the membrane treatment is lowered.

The GCWA evaluated the three alternatives in terms of finished water quality, capital costs required to construct the water treatment plant, and the operating and maintenance costs to operate each alternative process facilities. With regards to a 35 MGD water treatment plant, the GCWA report concluded the following:

- The high-rate conventional process had the lowest overall project cost including capital expenditures and operating and maintenance costs over the lifespan of the project,
- The high-rate conventional process met required finished water goals, and
- The high-rate conventional process was easily adaptable to changes in finished water regulations.

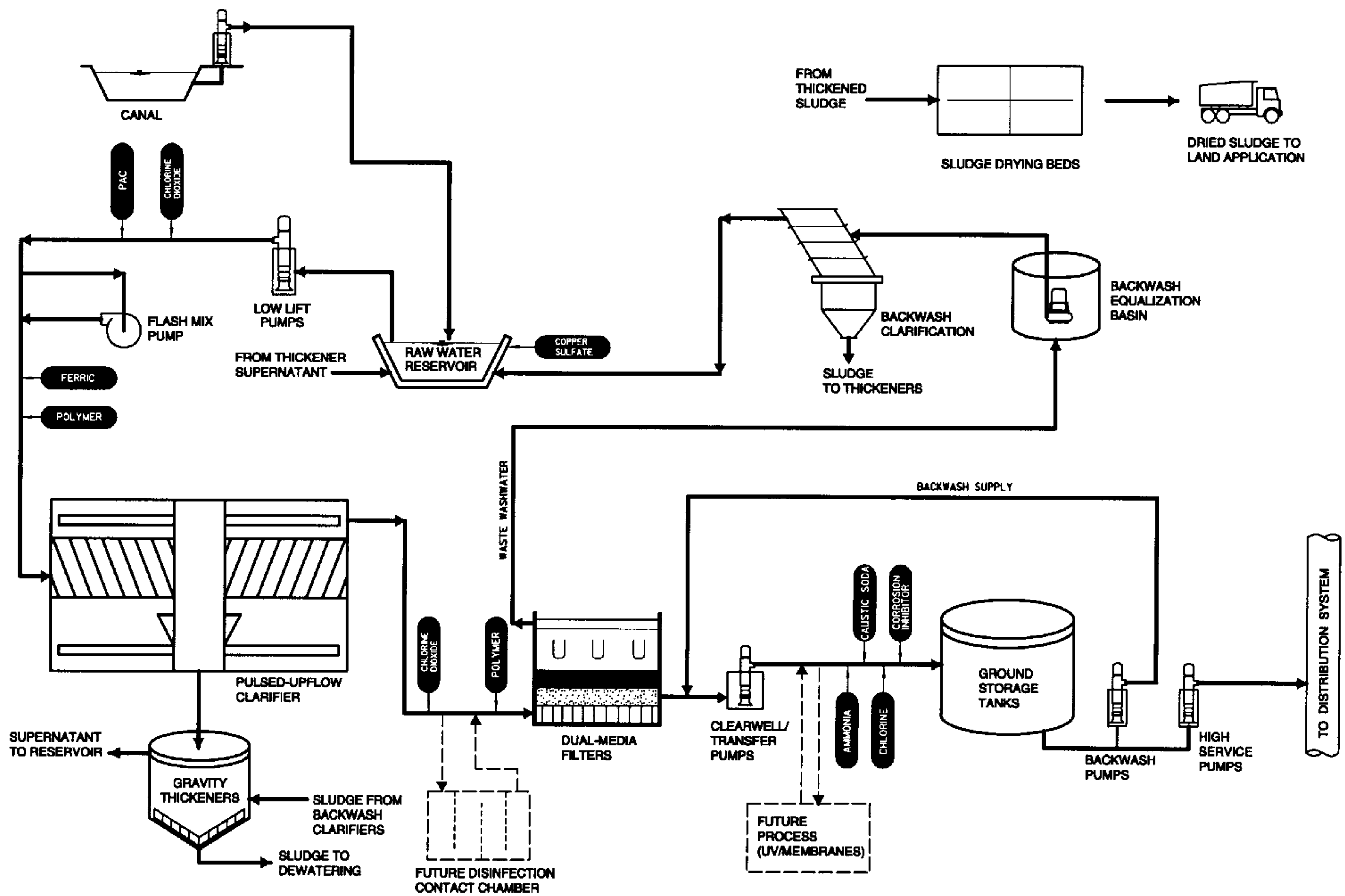
As the regional water treatment plant for the Mid-Brazoria County Planning Group will have the same water source and be of a capacity similar to the GCWA 35 MGD plant alternative, a high-rate conventional process plant is also expected to be the most cost-effective treatment process for the proposed 25 MGD MCBPG WTP.

High Rate Conventional Process

The High-rate conventional process has the following unit operations:

Oxidation	*Chlorine dioxide*
Pretreatment	*High Rate Solids contact (Pulsed Upflow)*
Filtration	*Media filters*
Adsorption	*Powdered and Granular Activated Carbon*
Primary disinfectant	*Chlorine dioxide*
Residual disinfectant	*Chloramine*

A process schematic for the conventional process with High-Rate Pretreatment is shown in **Figure 4-1**. Pre-oxidation is accomplished with chlorine dioxide. Taste and odor control is accomplished with chlorine dioxide or PAC addition. This treatment process is similar to the conventional process, except that the pretreatment process is solids-contact type utilizing pulsed upflow clarifiers. These proprietary units can be operated at higher rates than is normally allowed for conventional processes. The high-rate process combines two processes into a single unit. The high rate process results in space savings because w:\proj\alvin\report\figure4-1.dgn 10 SEP 2001 15:25:45



MONTGOMERY WATSON

MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

HIGH-RATE CONVENTIONAL PROCESS SCHEMATIC

FIGURE 4-1

of the smaller basin volume which in-turn results in reduced construction costs. This process is proven with source waters similar to those for this facility. In addition, the clarifiers maintain a sludge blanket, which when used in conjunction with powdered activated carbon, is an efficient process for removing organic material. Filters are assumed to be deep-bed, constant-level, constant loading filters. Media is assumed to be granular activated carbon (for taste and odor control) with an underlayer of sand. Additional processes that may be required by future regulations include post-sedimentation ozone or chlorine dioxide for inactivation of *Cryptosporidium*, and / or post-filtration membrane filtration or UV disinfection. Circular concrete, aboveground tanks are provided for storage of finished water. Sludge from the pretreatment process is sent to a gravity thickener for preliminary separation of solids and water. Thickened sludge is dewatered on-site with centrifuges. Ultimate disposal is to a permitted disposal site. Dirty filter backwash water is equalized and clarified, and then recycled to the head of the treatment process.

PROCESS CRITERIA

Criteria for unit processes are listed in Table 4-4. Where applicable, criteria is based in TNRCC criteria contained in Subchapter D: Rules and Regulations for Public Water Systems, 290.42, Water Treatment. Criteria for proprietary process equipment, such as the pulsed upflow clarifiers and membranes are based on manufacturer's recommendations. Criteria for other unit processes are based on criteria from "Integrated Design of Water Treatment Facilities" by Kawamura.

TABLE 4-4
CRITERIA FOR SIZING WATER TREATMENT PROCESSES

Sizing Criteria	Units	Value
Mixing		
Type		Pumped Diffusion
Velocity Gradient	sec^{-1}	2000
Flocculation Basins		
No. Stages	Each	4
Velocity Gradient	sec^{-1}	75,60,40,25
Type		Vertical Turbine
Detention Time	Minutes	30
Conventional Sedimentation Basins		
Type		Rectangular, Plug Flow
L:W Ratio		> 4:1
Depth	Ft	12
Surface Loading Rate	gpm/ft^2	0.6
Media Filters		
Type		Deep Bed, Dual Media (GAC/Sand)
L/d Ratio		1500
L:W Ratio		2
Loading Rate (one filter off-line)	gpm/ft^2	5
Backwash Rate	gpm/ft^2	22
Average Filter Runtime	Hours	72
Auxiliary Wash Type		Air Scour
Auxiliary Wash Rate	scfm/sq ft	3.0
Gravity Thickener		
Solids loading rate	lb/ft^2	9
Hydraulic Loading Rate	gpm/ft^2	0.12
Sludge Lagoon Process		
Loading Rate	lb/ft^2	14
Minimum length	Ft	100
Storage Capacity per Unit	Months	3
Minimum Number of Units	Each	4
Waste Washwater Equalization		
Type		Rectangular, Sloped Bottom
L:W Ratio		4
SWD	Ft	16
Storage Volume	# of backwashes	3
Waste Washwater Clarification		
Clarifier Type		Lamella
Clarifier Loading Rate	gpm/ft^2	0.2
Sludge Removal	%	85

TABLE 4-4 (CON'T)
CRITERIA FOR SIZING WATER TREATMENT PROCESSES FEED CRITERIA

Sizing Criteria	Units	Value
Dewatering		
Holding Tank Capacity	days	4
Holding Tank Depth	ft	30
Centrifuge Type		Solid Bowl
Hydraulic Loading Rate	Gpm/unit	200
Finished Water Storage		
Operational Volume	Hours	4
Type		Above Ground, Pre-stressed Concrete
High-Rate Clarification		
Type		Pulsed-Upflow
Unit Design Application Rate	Gpm/ft^2	2.1
Membrane Filtration		
Design Flux	gfd	70
Average Recovery	%	90
Temperature	Degrees C	10
Maximum TMP	psi	13
Cleaning Cycle	Per year	4 (max)

Expected chemical feed criteria based on other regional water treatment plants treating lower Brazos River water are shown in **Table 4-5**. It should be noted that these chemical doses are preliminary and represent likely chemical doses at the water plant. It would be advantageous to establish a pilot plant to test and optimize chemical doses.

TABLE 4-5
CHEMICAL FEED CRITERIA

Chemical	Purpose	Avg. Dose (mg/l)	Application Point
Ferric sulfate	Coagulant	30	Flash Mix Pump
Cationic Polymer	Coagulant Aid	5	Flash Mix Pump
Anionic Polymer	Flocculant / Filter Aid	1	After Flash Mix Pump and Settled Water Channel
Sodium Chlorite	Form Chlorine Dioxide for Disinfection	0.8	Chlorine Dioxide Generator
Chlorine	Form Chlorine Dioxide for Disinfection	0.8	Following Low Lift Pumps and Clarifier
Chlorine – BW	Disinfection	5	Backwash Supply Pipe
Chlorine	Residual Disinfection	3	Following Transfer Pumps
Ammonia	Disinfection	1	Following Transfer Pumps
PAC	Taste and Odor	10	Following Low Lift Pumps
Caustic Soda	pH Adjustments	10	Following Transfer Pumps
Fluoride	Aesthetics	0.6	Following Transfer Pumps
Poly – or orthophosphate	Corrosion Inhibitor	0.5	Following Transfer Pumps
Copper Sulfate	Algae Control		Raw Water Reservoir

Water Treatment Process Costs

For a high-rate conventional water treatment plant, estimated construction costs were developed based on the preliminary process sizing using the aforementioned design criteria. Estimates of the O&M costs were calculated based on the labor, maintenance, and electrical demands of the plant process based on a capacity of 25 MGD. **Table 4-6** summarizes the construction cost for a two phased construction effort as described in **Section 3**. Details of the construction estimate can be found in **Appendix F**.

TABLE 4-6
ALTERNATIVE PROCESS CONSTRUCTION COST ESTIMATE (YR 2000$)

Unit	High Rate Conventional Water Treatment Process
Sitework	$3,500,000
Yard Piping	$2,125,000
Low Lift Pumping	$792,000
Mixing/Flocculation/Sedimentation	$1,170,000
Filters	$5,467,000
Transfer Pumping	$780,000
PAC System	$250,000
Backwash Equalization Tank	$232,000
Backwash Clarification	$106,000
Gravity thickeners/holding tanks	$16,000
Chemical Systems, Building, Tanks	$5,335,000
Sludge Lagoons	$888,000
Ground Storage Tanks	$2,800,000
Subtotal	**$23,461,000**
Electrical, Instrumentation, and Controls	$3,050,000
Subtotal	**$26,511,000**
Mobilization	$795,000
Subtotal	**$27,306,000**
Construction Management, Insurance, Bonds, Profit	$3,550,000
Total	$30,856,000

The high rate conventional plant has an estimated construction cost at $30.9 M, which equates to $1.23 cents per gallon of capacity. Construction contingency and engineering fees are not included in these calculations as they are percentages of construction and are independent of the process selection.

The O&M costs to operate the plant include the following items:

- Electricity,
- Maintenance,
- Chemicals,
- Labor,
- Sludge disposal, and
- Administration

The costs for the operating and maintenance were based on recent quotes from vendors and current operations at the GCWA Dr. Thomas Mackey Water Treatment Plant, which treats the same water as expected for this regional water treatment plant. A summary of the O&M costs for a high-rate conventional process appear in **Table 4-7.**

TABLE 4-7
HIGH RATE CONVENTIONAL PROCESS O&M COST ESTIMATE (YR 2000$)

O&M Component	Annual Usage	Units	Unit Cost	Annual Cost
Process Electrical				
Chemical				
Ferric	1256	tons	$450	$ 565,200
Cationic Polymer	209	tons	$1,000	$ 209,000
Anionic Polymer	21	tons	$1,500	$ 31,500
Sodium Chlorite	34	tons	$1,000	$ 34,000
Chlorine - ClO2	35	tons	$400	$ 14,000
Chlorine - BW	10	tons	$400	$ 4,000
Chlorine - Residual Disinfectant	114	tons	$400	$ 45,600
Ammonia	38	tons	$350	$ 13,300
PAC	419	tons	$1,100	$ 460,900
Caustic Soda	381	tons	$600	$ 228,600
Fluoride	23	tons	$1,500	$ 34,500
Corrosion Inhibitor, mg/L	19	tons	$5,200	$ 98,800
Total Chemical				$1,739,400
Sludge Disposal	8,200	Yd3	$15	$246,000
Maintenance	1.7	% of construction		$525,000
GAC Replacement	5832	Ft3	$100	$583,000
Labor	**Number at Plant**		**Burdened Hourly Rate**	
Process Operators	6		$25.50	$318,000
Electrician, Instrument Tech	2		$33.75	$140,000
Maintenance	3		$27.00	$168,000
Administration	1		$19.50	$41,000
Superintendent	1		$49.50	$103,000
Total	13		$28.50	$770,000
Administration	---		---	**$600,000**
Total Annual O&M for 25 MGD High Rate Conventional Plant				$4,702,000

The high rate conventional O&M costs for a 25 MGD plant is $4.7 M per annum. These O&M costs exclude high service pumping and raw water delivery costs which are a function of plant location and will be considered in the site location study.

These costs will be entered into part of the alternative selection process for the Regional Surface Water as described in **Section 7** of this report.

Section 5
Water Treatment Plant Site Development

One of the most important steps in this feasibility study is selecting the site for any treatment facility. The decision to select one site over another is complex and is influenced by many diverse criteria. This chapter will review these criteria with respect to several alternative sites throughout the planning area and summarize the benefits and costs associated with each alternative site.

APPROACH TO SITE SELECTION

One of the first tasks in this study was to identify possible sites of a water treatment facility. In order to evaluate the entire planning area, a selection approach was developed to ensure that all alternatives were considered and that the benefits to each Participating Utility were taken into consideration in the selection of the alternative WTP sites. The approach consisted of the following three steps:

- Establishment of Preliminary Siting Criteria
- Identify Candidate Sites
- Preliminary Screening
- Final Screening

This approach allowed the Participating Utilities to have control over the selection of the water treatment plant site and to offer input at each stage in the process. The following is a detailed description of the site selection process.

Establishment of Preliminary Siting Criteria

The first step was to identify potential sites for the water treatment plant. The Planning Group reviewed 5 alternative land parcels as potential sites based on the following criteria: estimated required acreage for the water plant, proximity of the plant to the Participating Utilities and the raw water source, proximity to greatest demand areas, surface features, and proximity to major highway and utilities. Each of these criteria is discussed below:

Estimated Minimum Acreage Required For A Water Plant

A key siting criterion is the minimum site area required to accommodate the necessary plant facilities. The layout of the facilities on the site has a large impact on the total required area. Water treatment plants with high-rate process units and compact, common-wall construction require less space than conservatively sized stand-alone process basins. According to Kawamura in "Integrated Water Treatment Plant Design", the required plant area for the basic process facilities of a conventional treatment plant is $Q^{0.6}$, where Q is the ultimate capacity of the plant in MGD. For a design flow of 25 MGD, the minimum plant area would then be 8 acres.

Ideally, the site should also contain ample land for a raw water forebay, sludge disposal, pipeline easements, finished water storage, and future expansion. Based on the data from local water treatment plants, an additional 35 to 80 acres would be required to support these ancillary facilities.

For this preliminary selection of potential water treatment plants, acceptable sites were limited to those with enough acreage to accommodate the basic processes of the water treatment plant. Preference was also given to sites with enough acreage to accommodate the ancillary facilities as well as the basic processes. Therefore the minimum acceptable parcel of land is 7 acres, with a preference for sites with a minimum of 43 acres.

Proximity to the Water Source and Distribution System

Another criterion for selecting the location of water plant facilities is the proximity of the plant to the raw water source and the customer. It is desirable to keep the raw water piping as short as practicable to simplify the maintenance and reduce the cost of the raw water pipeline. The new water plant can withdraw water indirectly from the Brazos River through the existing GCWA American and Briscoe Canals, and/or the Chocolate Bayou Water Company, depending on the site location. Sites adjacent to or in very close proximity to the Canals will be given preference, as no raw water pipeline will be required, and less energy will be expended in pumping water consumed by in-plant needs (backwash, sludge, etc.).

Similarly, the water treatment plant site should be located in close proximity to the distribution system. This will minimize the size of the finished water transmission pipelines and the cost of pumping the water to the Participating Utilities. Duplication of the raw water and finished water pipelines should also be avoided.

Site Surface Features

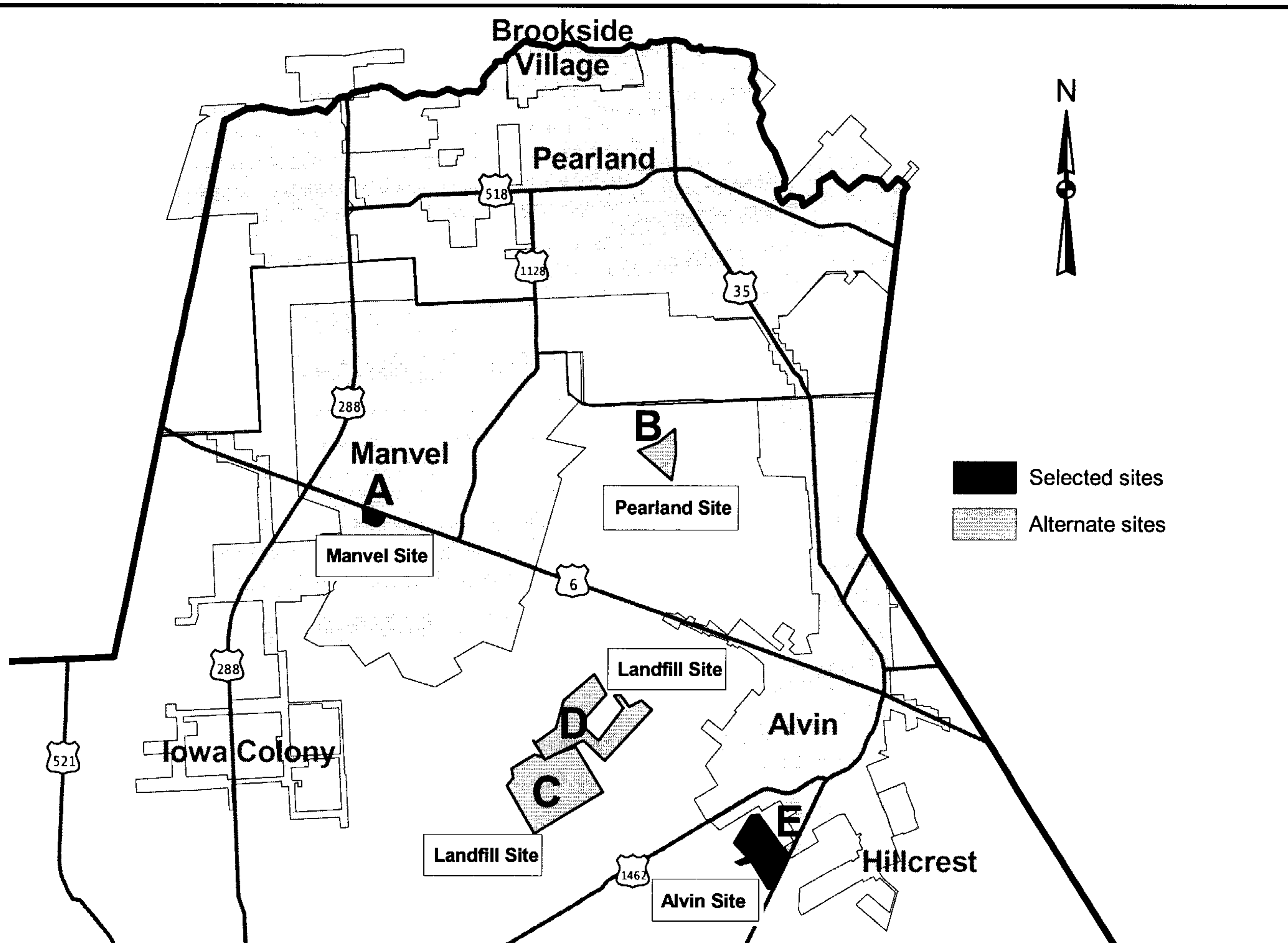
A potential site should be relatively flat without any major obstacles, such as fault zones, wetlands, areas prone to flooding, or encumbrances. This cursory review of the planning area for potential sites looked for sites in areas without large areas of known wetlands, utility encumbrances, or flood plains. Although wetlands and utilities can be relocated and levees can be built to protect the facility from flooding, these attributes of a site are not desirable and result in additional site work that increases cost and complicates permitting from regulating bodies. Sites without these surface features were given a higher rating in this preliminary site selection.

Proximity to major highway and utilities

The site should be as close as practicable to major roads and highways to minimize any costs in providing acceptable access to the site for delivery and sludge vehicles. The site should be as close as practicable to existing power lines, sanitary sewer, gas, and storm discharge facilities to minimize costs associated with providing these necessary utilities to the water plant site.

Identify Candidate Sites

Based on these criteria, the Participating Utilities team assessed the planning area and developed a list of alternative water treatment sites. The location of the sites that were selected by the Participating Utility team are shown in **Figure 5-1.** The listing of these sites with a brief description appears in **Table 5-1**.



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WATER TREATMENT PLANT SITES

FIGURE 5-1

TABLE 5-1
POTENTIAL WATER TREATMENT PLANT SITES

Plant Site	Location				Approx. Usable Acreage (AC)
	Current Owner	Nearest City	Closest Raw Water Source	Description	
A – Manvel	Private	Manvel	GCWA A or B Canal	SH 6 at Briscoe Canal and Lateral 19 intersection in Manvel	50
B – Pearland/ Alvin	Private	Alvin	GCWA A Canal	Near CR 285 and CR 144 west of Friendswood in Alvin ETJ	100
C – Alvin	Alvin/ Briscoe Properties	Manvel	GCWA A or B Canal / Chocolate Bayou Water Company Canal (via Pipeline)	West of Alvin adjacent to Saladino Road. Adjacent to Site D and City of Alvin Landfill Property	643
D – Alvin	Briscoe Properties	Manvel	GCWA A or B Canal	Near Parker Davis and West Road, west of Alvin adjacent to Site C	919
E – Alvin	Briscoe Properties	Alvin	GCWA A or B Canal or Chocolate Bayou Water Company Canal (via Pipeline)	Hwy 35 and Briscoe Canal south of Alvin	278

Preliminary Screening

The next step in the site selection process was to evaluate these five sites with respect to their preliminary siting criteria. The five sites contained in the preliminary review represent a geographically diverse selection across the planning area, each with a minimum usable acreage of 50 acres, meeting the minimum criteria established above. The following is a general comparison of the five sites in relation to the screening criteria.

Evaluation of Minimum Acreage Requirements

All five sites have the required minimum acreage with several sites having large open expanses of land available for use. The additional acreage is a valuable attribute of the sites providing land for future expansions, sludge disposal, buffer zone, or a raw water reservoir. The Manvel site is the smallest of the five sites and will yield a constrained site layout.

On the basis of available acreage, Sites B and E in Alvin, and Sites C and D in Manvel, were the most desirable as the large amount of usable land at each of these sites offers the following advantages:

- Operational flexibility. Layout of plant not scripted by limited site configuration,
- Future Expansion Possibilities, and
- Inclusion of Ancillary WTP options. Sludge Disposal, Raw Water Reservoir, Additional Finished Water Storage

Evaluation of Proximity of Site to Raw Water Source and Finished Water Demand

Proximity of Site to Raw Water Source

All the five selected sites are located close to a GCWA raw water canal. By locating the water plant as close to the raw water source as possible, the raw water transport costs are minimized or in some cases eliminated. The following compares proximity tp primary and alternative raw water sources for each site:

Site A, in Manvel, has a distinct advantage in this regard, as it can be served from either the American Canal (through lateral 10) or the Briscoe Canal. This site is also located approximately 5 miles from the existing Chocolate Bayou Water Company raw water pump station.

Of the remaining four sites, Site E in Alvin is the closest to the Chocolate Bayou, which can be the alternative raw water source, the primary being the Gulf Coast Water Authority Briscoe Canal.

Site B, in Pearland/Alvin is adjacent to the Gulf Coast Water Authority American Canal, but does not have any alternate raw water source. Transportation of raw water from the Chocolate Bayou will be expensive, as a major raw water transmission line of approximately 10 miles will be needed.

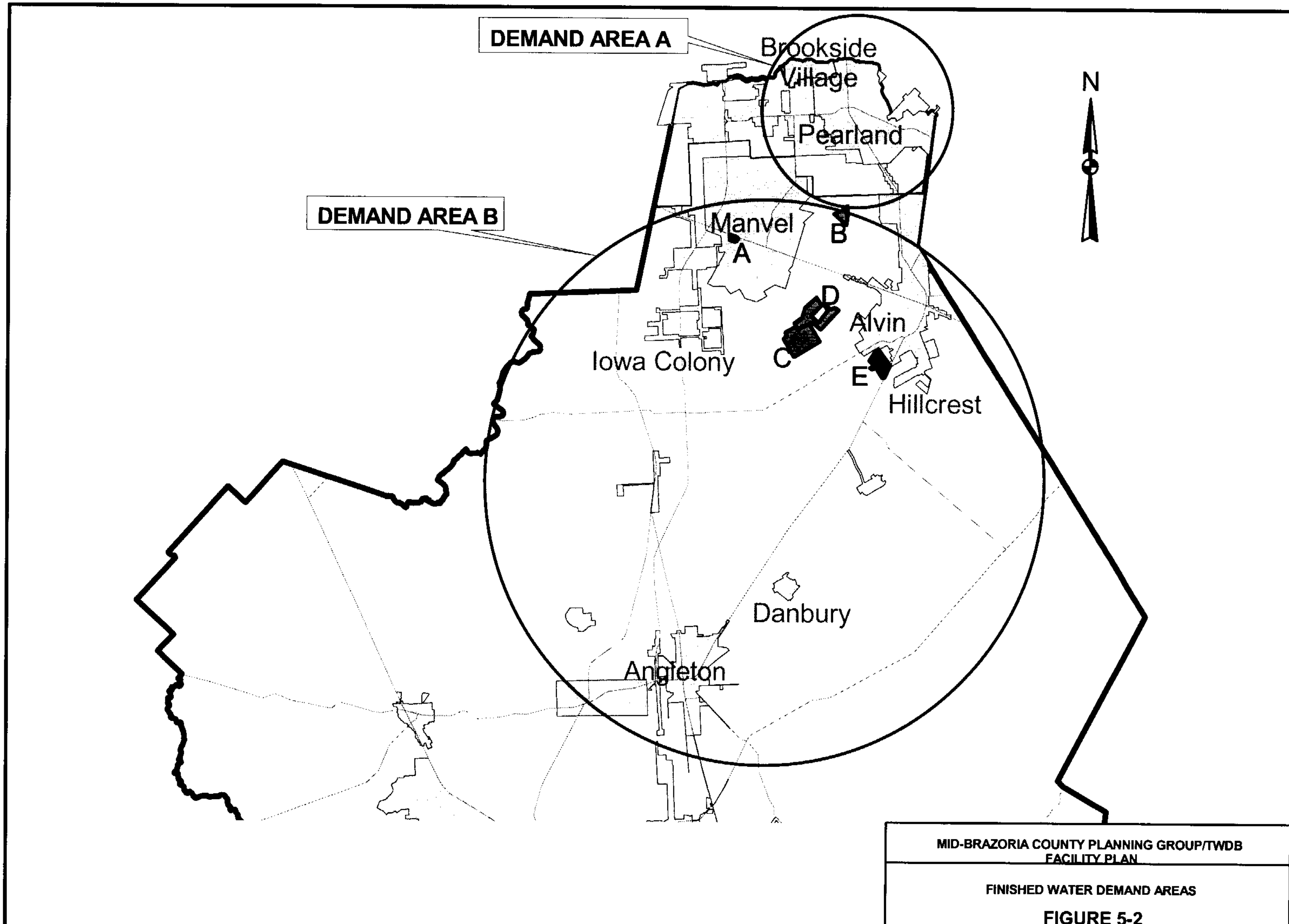
Sites C and D in Alvin have the Gulf Coast Water Authority Briscoe Canal as the primary water source. Chocolate Bayou can be the alternative source, but a raw water transmission line of over 2 miles will have to be constructed.

Proximity of Site to Finished Water Demand

The planning area can be divided into two areas of potable water demand. This division is based on the population within each area. For the purpose of this evaluation, the City of Pearland, and the City of Brookside Village constitute "Demand Area A", and comprises of approximately 50% of the total population of the Planning Area. The cities of Manvel, Alvin, Angleton, Danbury, Hillcrest, and Iowa Colony form the "Demand Area B". These two demand areas are shown in **Figure 5-2**. The proximity of the proposed plant location to the water demand is shown in **Table 5-2**. Since it is desirable to locate the plant close to the demand area to minimize the finished water pumping expense, the distance between the demand area centers creates several issues. If a plant is located near one of the demand center, an extensive piping network will be required to transport the finished water across the planning area to the other demand center, resulting in an increased expenditure for pipelines and pumping costs.

Site B is located in Demand Area A. If the water plant is located at this site, 50% of the demand, i.e. City of Pearland and City of Brookside Village, is located within 8 miles. A large finished water main will be required to convey the remaining 50% of the planning area average water demand, or 7.5 MGD, 30 miles to the City of Angleton, 5 miles to the City of Alvin, 7 miles to the City of Manvel, and 3 miles to the City of Pearland. Not only would this require a large transmission main, but the pumping cost to transport 7.5 MGD over the distances mentioned would be substantial.

The plant can be located at three possible sites located in Demand Area B. If the plant is located at Site A, in the City of Manvel, the distribution cost will be reduced, as the plant itself will be located within the city. There will still be the need for a transmission main, over a distance of 6 miles to service Demand Area A, and a transmission main of 20 miles to service the City of Angleton, and 2 miles to serve the City of Alvin. If the plant is located at either Site B or Sites C or D, there will be the need for transmission lines from this site to all the major take points in Distribution Areas A and B. The length of these transmission lines are shown in **Table 5-2**. Conversely, if the plant is located at Site E, transmission lines will have to be constructed for the cities of Angleton, and Manvel, of 16 and 11 miles respectively in



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FINISHED WATER DEMAND AREAS

FIGURE 5-2

Distribution Area B. Transmission lines of length 12 miles will have to be constructed to service the cities of Pearland and Brookside Village in Distribution Area A.

The scenario of having the water plant in Demand Area B over a water plant in Demand Area A will result in reduced finished water pipeline capital costs. In addition, the cost of pumping water from one side of the planning area to the other will be less expensive for a water plant in Demand Area B versus a water plant in Demand Area A.

TABLE 5-2
PROXIMITY OF SITE TO FINISHED WATER DEMAND

Plant Site	Finished Water Take Points (miles)			
	Pearland	Manvel	Alvin	Angleton
A – Manvel	6	0	2	20
B – Pearland/ Alvin	3	7	5	30
C – Alvin	8	6	4	20
D – Alvin	8	6	4	20
E – Alvin	12	11	0	16

Evaluation of Site Surface Features

Cursory reviews of each of the five sites revealed the following surface features that impact the sites use as a water treatment plant. The following is a list of these potential impacts:

- Site A is not expected to contain any environmentally sensitive areas. A portion of Site A is within 100-year flood plain, but it is not expected to impact construction of the main facilities.
- Site B contains several drainage facilities that may impact construction of any solids handling facilities or raw water reservoir. Site B contains portions that are inside the 100-year flood plain.
- Sites C and D contain the old City of Alvin municipal landfill, which is now capped. The remaining majority of the site is currently rice farms, and has enough land area to situate a water treatment plant. The site meets regulations governing municipal landfills.
- Site E is not expected to contain any environmentally sensitive areas, but does contain several drainage facilities that may impact construction of any solids handling facilities or raw water reservoir. Site E contains portions that are in the 100-year flood plain.

Proximity to Major Highway and Utilities

Site A is adjacent to State Highway 6 and is located within ½ mile of State Highway 288. The site is adjacent to an existing Reliant Energy power line. Site E is adjacent to State Highway 35. Power, sewer, and gas service are readily available along the Highway 35 corridor. Site B is 2 miles from the nearest major road, Highway 35. It is adjacent to a proposed residential community where sewer and power facilities would be accessible. Sites C and D is not adjacent to any major highways. The sites contain available power, but would require sewer and gas service.

Land Ownership

Sites C, D, and E are privately owned. Briscoe Properties, who own these tracts of land, have indicated that they are willing to donate these sites with special stipulations to the City of Alvin. The private landowner would secure water from the Gulf Coast Water Authority and then in turn sell it to the City of Alvin.

Sites Selected for Further Review

After preliminary review based on the above criteria, the Participating Utility team narrowed the field of alternative sites to two sites, sites A and E. These sites were chosen primarily due to their proximity to both raw water source, and the demand areas, and also due to alternate sources of raw water available to them. These alternatives were then subject to final screening criteria based on the economic and non-economic factors associated with each alternative. Ariel photos of 2 screened sites appear as **Figures 5-3** and **Figure 5-4**. The discussion of these costs and factors each site are described in **Section 7**.

Surface water must be transported from the raw water source to the selected plant site and finished water must be transmitted from the plant site to the Participating Utilities Take Points. This section develops facility plans for transporting the raw water from the Brazos River to the regional water treatment plant site and distributing treated water from the regional water treatment facilities to the Participating Utility Take Points.

FINISHED WATER PIPELINE

From the high service pumps at the regional water treatment facilities, treated water must be transported through a finished water transmission system to the Participating Utilities.

This development of this finished water transmission system plan depends on the following criteria:

- Plant site location
- Participating utilities water demand
- Participating utilities desired water pressure
- The finished water pipelines be installed

The finished water transmission system can be developed based on these criteria. The goal of the finished water transmission system is to deliver water at the specified flow and pressure to the Participating Utilities at the lowest overall project cost. To assist in this analysis, a hydraulic model was utilized to optimize the size of the finished water pipelines and pump stations in order to minimize project costs.

The first step in creating and analyzing the finished water transmission system was to locate the finished water source.

Finished Water Source

The location of the finished water depends on the location of the regional surface water plant. In **Section 5**, the Participating Utilities Team reviewed five alternative sites and screened out three. The following two sites were selected for further evaluation:

- Site A: Manvel
- Site E: Alvin

Pipeline Corridor Analysis

The corridor analysis focuses on the route the finished water pipelines will take from the water plant to the Participating Utility Take Points. Given the fixed location of the Take Points and the two alternate water treatment site locations, alternate pipeline corridors were identified to connect the Take Points with the alternate water plant sites. These alternative corridors were then evaluated to determine a preferred routing of the finished water pipelines. Factors considered in the selection of routes include the following:

- Length of corridor
- Known environmental impacts along route
- Land ownership
- Constructability

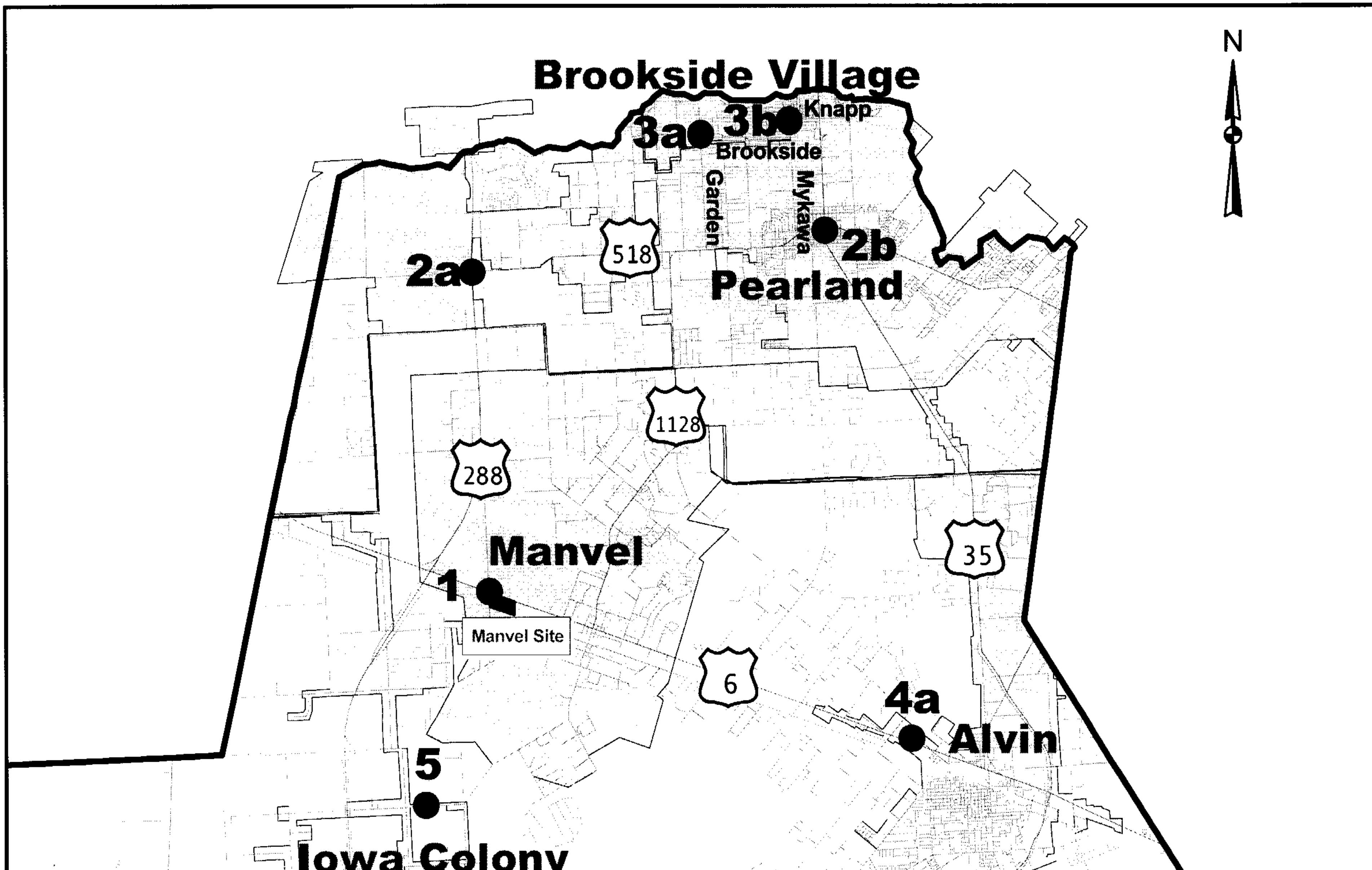
Each corridor has a general economic costs associated with the construction of a pipeline through the corridor. As the length of the corridor increases, so does the length of the pipeline and the construction costs. Construction cost also increase if the pipeline passes through an environmentally sensitive area.

Wetlands for example would require some form of mitigation. If the corridor is owned by a public agency, it is likely that right-of-way for the finished water pipeline can be obtained without expensive surveying and easement agreements. If a corridor traverses private land, pipeline easements will be required. These easements will increase the overall project costs. If the proposed corridor passes through developed areas, the corridor will likely contain existing utilities that will impact the alignment of the pipeline. Construction around these utilities will increase the cost of construction and impact utility services to the surrounding area.

Take Points

With the selection of alternative water treatment plant sites, the next step towards development of pipeline corridors is to identify finished water Take Points for each Participating Utility. Take Points are defined as the transfer point at which the Mid Brazoria Regional Water Plant will transport potable water to the Participating Utilities. At each of these Take Points, a flow meter will be installed to record and monitor the total flow delivered to each participating utility. From this point on, the participating utility will be responsible for operation and maintenance of the water system.

Each participating utility provided the physical address, desired water pressure, and expected water demand at each preferred "Take Point". As the alternative water treatment plant sites are scattered across the county, several Participating Utilities have provided alternative Take Points for consideration in the pipeline corridor and finished water pipeline evaluation. These Participating Utilities indicated that they will receive water at whichever Take Point makes better economic sense to lowering the capital and operational cost of the finished water pipeline system. The Take Points can be viewed on **Figure 6-1** and **Figure 6-2** and are summarized on **Table 6-1** by Participating Utility.



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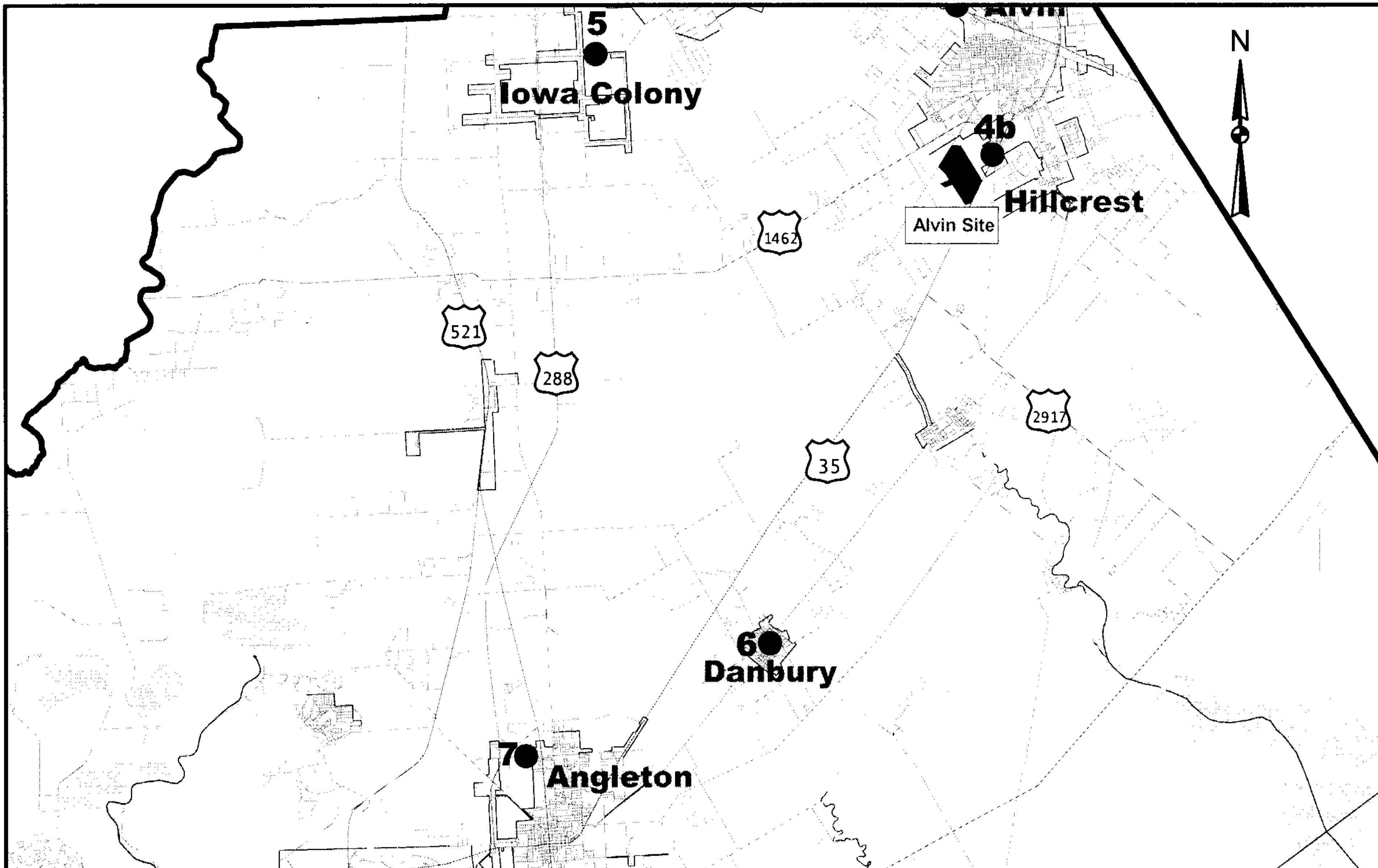
TAKE POINTS - NORTH BRAZORIA COUNTY

FIGURE 6-1



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TAKE POINTS - NORTH BRAZORIA COUNTY

FIGURE 6-2

TABLE 6-1
PARTICIPATING UTILITY TAKE POINT INFORMATION

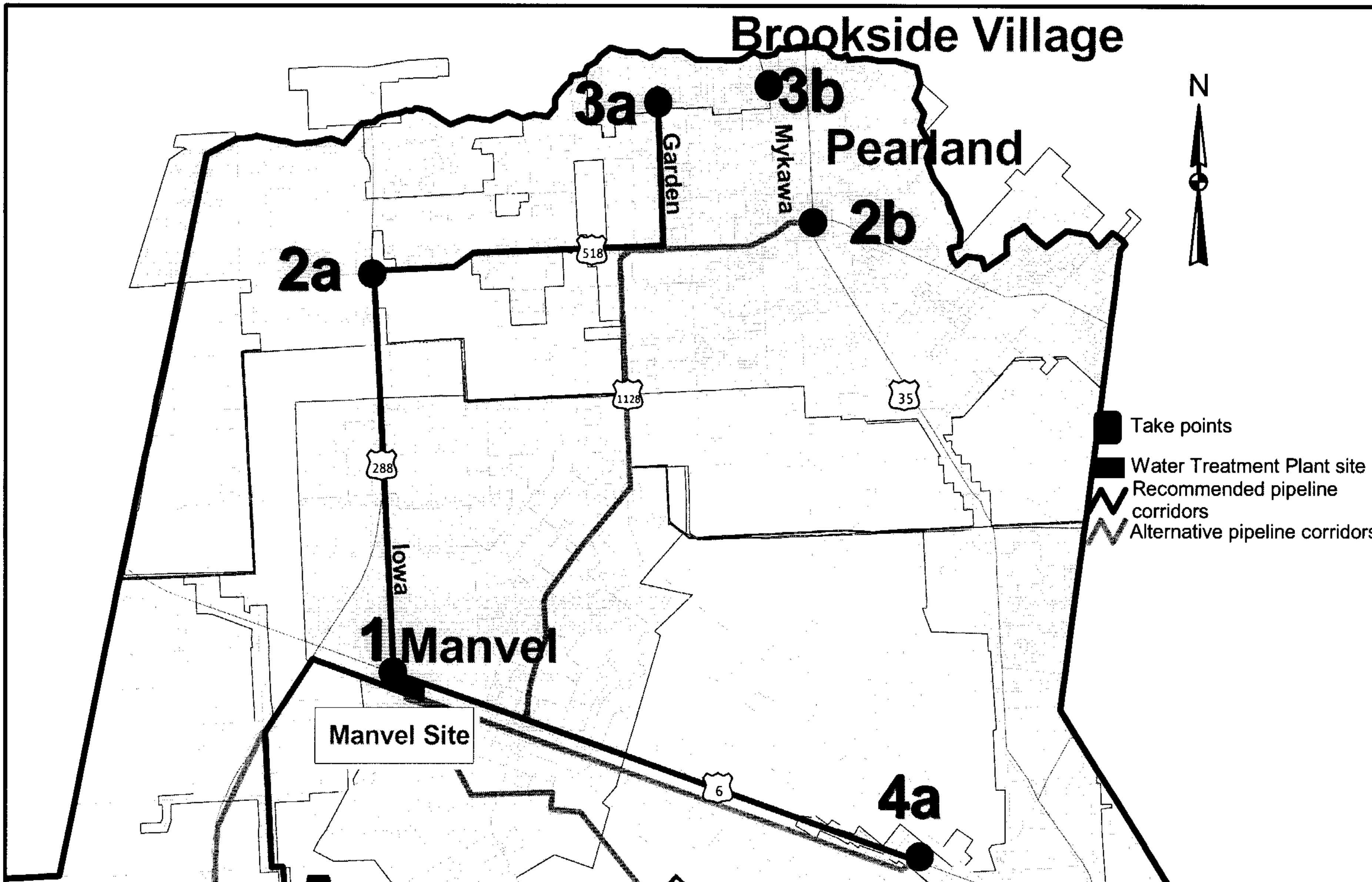
Utility	Take Point Number	Address	Average Water Demand (MGD)	Ground Elevation at Take Point (ft)
City of Manvel	1	Iowa Lane and Hwy 6, Manvel TX	3.77	55
City of Pearland	2a	SH 288 at 518, Pearland TX	13.66	60
	2b	SH 35 at 518, Pearland TX		40
City of Brookside Village	3a	Garden Road and Brookside Road	0.57	50
	3b	Mykawa Road and Knapp Road		50
City of Alvin	4a	SH 6, north of Mc Cormick Road	4.13	40
	4b	SH 35, at Johnson Road		40
City of Hillcrest Village	4a or 4b	Same as City of Alvin take point	0.07	40
City of Iowa Colony	5	At the intersection of County Road 64 and Iowa School Road	0.24	50
City of Danbury	6	5th Street at St. Spur 8	0.48	20
City of Angleton	7	At the intersection of Henderson Road and Krankawa Road in the North part of the City	2.45	20

Manvel WTP Site Pipeline Corridor Analysis

This section presents evaluations of prospective pipeline corridors from a regional water treatment plant located at Site A in Manvel to the Participating Utilities. The Manvel Site is located in the central western portion of the service area with Participating Utilities located to the north, east, and south. Based on the relative location of the Participating Utilities, their Take Points, and demand allocations, the most cost effective manner to serve the Participating Utilities is with three trunk lines feeding to the north, south, and east, respectively. The north line will serve the Cities of Manvel, Pearland, and Brookside Village. The south line will serve the communities of Iowa Colony, Angleton, and Danbury and the east line will serve the Cities of Alvin and Hillcrest Village. The corridor analysis evaluates alternative pipeline corridors to serve these three areas.

North Line

The north line will serve the City of Pearland and City of Brookside Village. Both the City of Brookside Village and the City of Pearland have noted alternative Take Points for use in the finished water pipeline evaluation. Two identified alternatives are the State Highway 288 corridor and the FM 1128 corridor. **Figure 6-3** shows the two alternative corridors to route water from the proposed Manvel WTP to the City of Pearland and City of Brookside Village.



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FACILITY PLAN

PIPELINE CORRIDORS FROM MANVEL SITE
TO SOUTH BRAZORIA COUNTY

FIGURE 6-3

The SH 288 corridor runs north from the Manvel WTP adjacent to Iowa Lane, then turns north in the Texas Department of Transportation (DOT) State Highway 288 right-of-way to the City of Pearland Take Point 2A. After the City of Pearland Take Point, the corridor turns west of FM 518 until Garden Road, where the corridor turns north to the City of Brookside Village Take Point 3A. The total length of this corridor is 5.5 miles to the City of Pearland Take Point and 11.5 miles to the Brookside Village Take Point.

The FM 1128 corridor runs east from proposed WTP site along Highway 6 until FM 1128. The corridor then turns north and runs approximately 5 miles to FM 518 in Pearland and turns east. The corridor splits at the intersection of Garden Road and FM 518 to go north along Garden to the City of Brookside Village Take Point and west along FM 518 to the City of Pearland Take Point 2B. The corridor is approximately 10.5 miles from the Manvel plant to the City of Brookside Village Take Point and 11.5 miles to the City of Pearland Take Point. A common pipe would be utilized between the WTP and the Brookside Village and Pearland Split.

The advantages and disadvantages of the alternative pipeline corridors are shown in **Table 6-2**. Since the City of Pearland is the largest demand in the MCBPG, the pipeline to the City of Pearland will be the largest diameter installed. By selecting the shortest possible route to the City of Pearland Take Point, the overall cost for installing the finished water network will be minimized. As the SH 288 corridor alternative has the shortest route to the City of Pearland Take Point and has no expected adverse environmental impacts, it is anticipated that the SH 288 corridor will result in the lowest cost alternative for North Line.

TABLE 6-2
MANVEL NORTH PIPELINE CORRIDOR ANALYSIS

Alternative	Advantages	Disadvantages
SH 288	• Minimizes pipeline length between WTP and City of Pearland Take Point. • A portion of this route is along public right-of-way. • No adverse environmental impact expected.	• Work Along long portion of FM 518. • Work in State right-of-way alongside of existing utilities
FM 1128	• No adverse environmental impact expected. • Construction along rural roads	• Significantly increased length of large diameter water main to the City of Pearland

East Corridor

The east line will serve the City of Alvin. The City of Alvin also indicated several Take Points for consideration. As the City of Alvin west Take Point, No. 4A is the closer to the Manvel WTP site than TP 4B, this Take Point will be used for this alternative. To transport finished water to the City of Alvin, the following two possible corridors exist:

- State Highway 6
- Burlington Northern Santa Fe Railroad (BNSFRR)

Both these corridors are a direct path from the Manvel WTP to the City of Alvin TP 4A. The SH 6 corridor utilizes public right of way along TXDOT State Highway 6 between Manvel and Alvin to route the single water line to Alvin. The BNSFRR corridor is parallel to the SH 6 corridor and utilizes the private right of way adjacent to the railroad approximately 1000 feet south of Highway 6. Both of these corridors are 8.5 miles in length.

Construction along this East corridor will require crossings of the Chocolate Bayou and the GCWA Lateral 10 in addition to several other bayous and creeks. As these crossings are common to each corridor, the costs associated with installing a pipeline through these environmentally sensitive areas will be common to both alternatives. The largest difference is that construction in the BNSFRR corridor will require purchase of 8.5 miles of easement from the BNSFRR. This private easement will greatly increase the cost of using this corridor. The SH 6 corridor utilizes public right-of-way and should have available room to install a small (less than 20 inch) water main. **Figure 6-4** highlights the alternative Manvel-East pipeline corridors

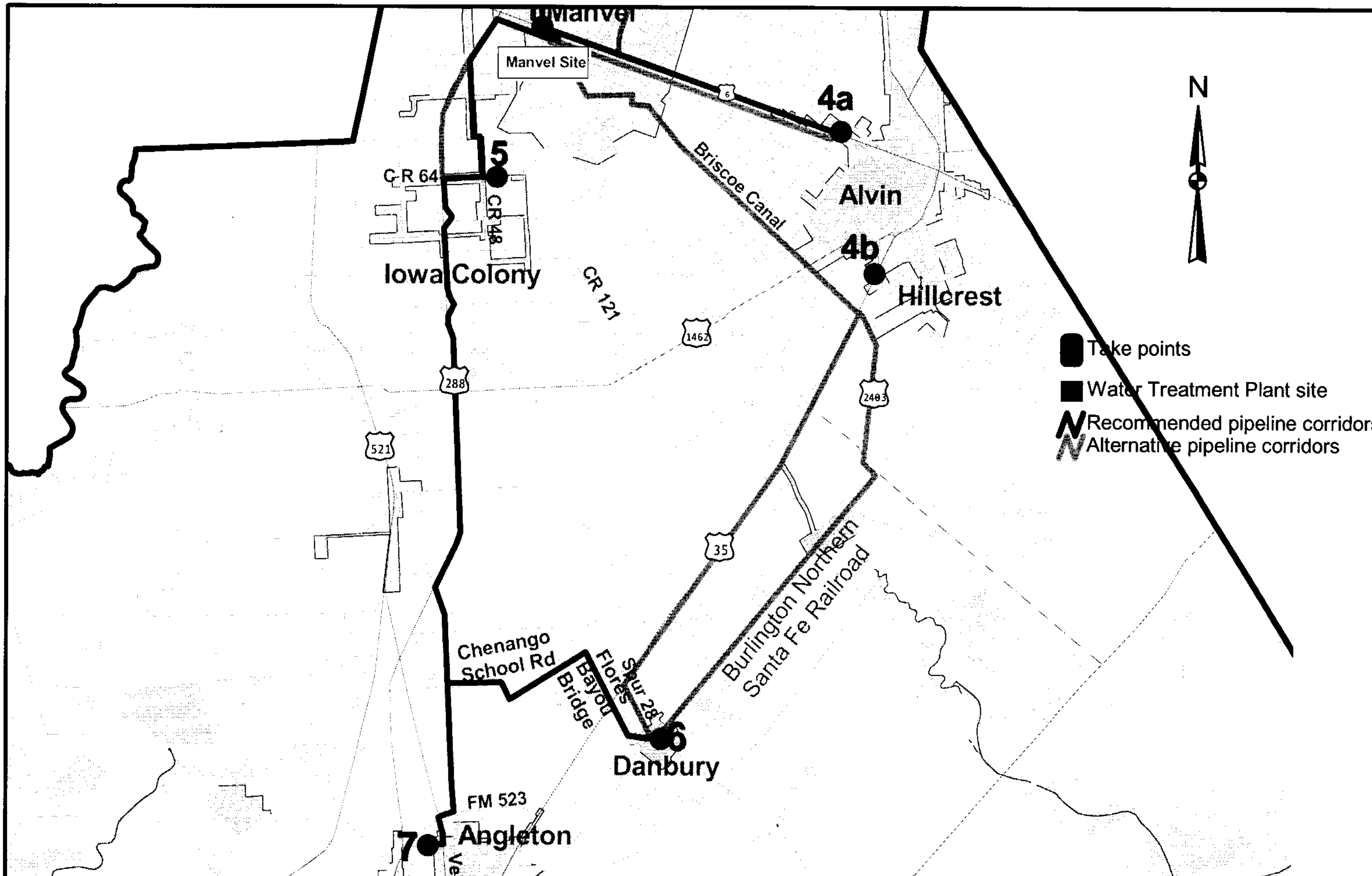
As the SH6 corridor should not require private easements, the relative cost of this corridor will be significantly less than construction within the BNSFRR corridor. As a result of this major cost saving and the ease of access to the SH6 corridor, this corridor is recommended as the preferred corridor to the City of Alvin from the Manvel WTP site.

South Corridor

The south corridor will serve the communities of Iowa Colony, Angleton, and Danbury. In reviewing the geography of the area, alternative corridors within public right-of-way were available to individually feed each community with a dedicated line, but the cost of such a network would be cost prohibitive. As Iowa Colony, the City of Angleton, and Danbury generally lie within a straight line from the Manvel WTP site, it would be cost effective to identify a corridor within this straight line to maximize pipeline capacity to meet the needs of all three south Participating Utilities. Fortunately, SH 288 runs between Manvel and Angleton and, according to the Brazoria County TXDOT office, there is available public land with the SH288 right-of-way which could be used as the pipeline corridor. As no major known environmentally sensitive areas or other known construction obstacles are located with the SH 288 south corridor and this corridor is the most direct route between the WTP site and Participating Utilities Take Point, the corridor analysis will focus on the State Highway 288 corridor. **Figure 6-4** shows the alternative feeds along State Highway 288 for Iowa Colony, Angleton, and Danbury.

Connection to Iowa Colony

Iowa Colony's Take Point is located just east of State Highway 288 near the intersection of County Road 64 and Iowa School Road. Routing to this location from State Highway 288 can be achieved in public right of way from County Road 64 to the west or from County Road 48 from the north. Connection via County Road 64 would require a separate small diameter line from State Highway 6. Connection from the north on County Road 48 could be a small tap on a large diameter line that could continue to south towards Angleton. As both corridors have no known concerns, either corridor would be feasible. In terms of cost, the alternative where a common line feeds Iowa Colony and then progresses to the south would maximize use of the carrying capacity in the line and would eliminate construction of a long small diameter line.



MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

PIPELINE CORRIDORS FROM MANVEL SITE
TO SOUTH BRAZORIA COUNTY

FIGURE 6-4

Connection to Angleton and Danbury

From Iowa Colony, the pipeline corridor will route south along the State Highway 288 right-of-way to the Cities of Angleton and Danbury. There are several alternatives for the pipeline corridor to serve both of these Take Points. These include:

- Continuation of the South Line to the Angleton Take Point along SH 288 and then turning northeast along SH 35 and Spur 28 to the City of Danbury
- Splitting the line near the intersection of SH 288 and North Velasco Street and serving the two Take Points with separate lines.

Figure 6-4 shows the two alternative pipeline routings.

The advantage of the second alternative, splitting the line, is in the reduced amount of pipeline that would need to be installed. From the flow split near SH 288, the Angleton branch is 7 miles and the Danbury Branch is 7.5 miles long. The combined system pipeline length is 13.8 miles and would consist a great diameter pipeline to handle the increased flow from both Danbury and Angleton in a common line.

More specifically, the flow-split alternative would likely use the following public right-of-ways from the intersection of SH 288 and North Velasco Street:

- Angleton: From North Velasco Street, the corridor will continue south until East Highway 35, where the corridor will the turn west until Business 288. On Business 288, the corridor will continue south until reaching the existing water booster pump station on West Henderson Road.
- Danbury: From North Velasco Street, the pipeline will turn east along Chenango School Road for 3.5 miles, and upon reaching Novak road, turn southeast for 2 miles until the Danbury Take Point.

As there are no apparent obstacles to construction in this corridor, this corridor will result in the most cost-effective route to serve the City of Angleton and Danbury.

Alvin WTP Site Pipeline Corridor Analysis

This section evaluates pipeline corridors from a regional water treatment plant located at site E in Alvin to the Participating Utilities. The analysis follows a similar methodology used in the previous section. The Alvin site is located in the central eastern portion of the service area with Participating Utilities located to the north, west, and south. Given the location of the demand centers and their Take Points, the most cost effective manner to serve the Participating Utilities is with three trunk lines feeding to the north, south, and west, respectively. The north line will serve the Cities of Pearland and Brookside Village. The south line will serve the communities of Danbury and Angleton. The west line will serve the Cities of Manvel and Iowa Colony. The corridor analysis evaluates alternative pipeline corridors to serve these three areas.

North Line

The north corridor will serve the Cities of Pearland and Brookside Village. Both the City of Pearland and Brookside Village have provided alternate Take Points. There are several alternatives for the pipeline corridors to serve these two cities. These include:

- State Highway 35
- Burlington Northern Santa Fe Railroad (BNSFRR)

These corridors represent a direct path to the Take Points. The first option utilizes public right-of-way along the TXDOT SH 35. The pipeline along this corridor runs north from the Alvin WTP along SH 35, looping around the City along SH 35. It runs further northwest to the City of Pearland Take Point 2b at the intersection of FM 518 and SH 35. After serving the City of Pearland Take Point, the corridor runs north along SH 35 turning west on Knapp Road to the City of Brookside Village Take Point 3b on Mykawa Road. The length of this pipeline corridor is approximately 14 miles. The second option will place the pipeline along SH 35 for approximately 4 miles, and then along the BNSFRR for another 9 miles. Though the total length of this railroad corridor is less than the SH 35 corridor, construction along the BNSFRR will require purchase of easements along 9 miles of the railroad tract. The SH 35 corridor utilizes public right-of-way and should have available room to install a 36 inch water main.

As a result of this major cost savings, the SH 35 corridor is the preferred corridor to the Cities of Pearland and Brookside Village from the Alvin WTP site. **Figure 6-5** presents the Alvin-North pipeline corridors. The advantages and disadvantages of the alternative corridors are shown in **Table 6-3**.

TABLE 6-3
ALVIN NORTH PIPELINE CORRIDOR ANALYSIS

Alternative	Advantages	Disadvantages
SH 35	• It is expected that public right-of-way will be sufficient to install the pipeline. • No adverse environmental impact expected.	• Work in State Right-of-way alongside of existing utilities
BNSFRR	• No adverse environmental impact expected. • Ease of construction along railroad	• Purchase of private easements

West Corridor

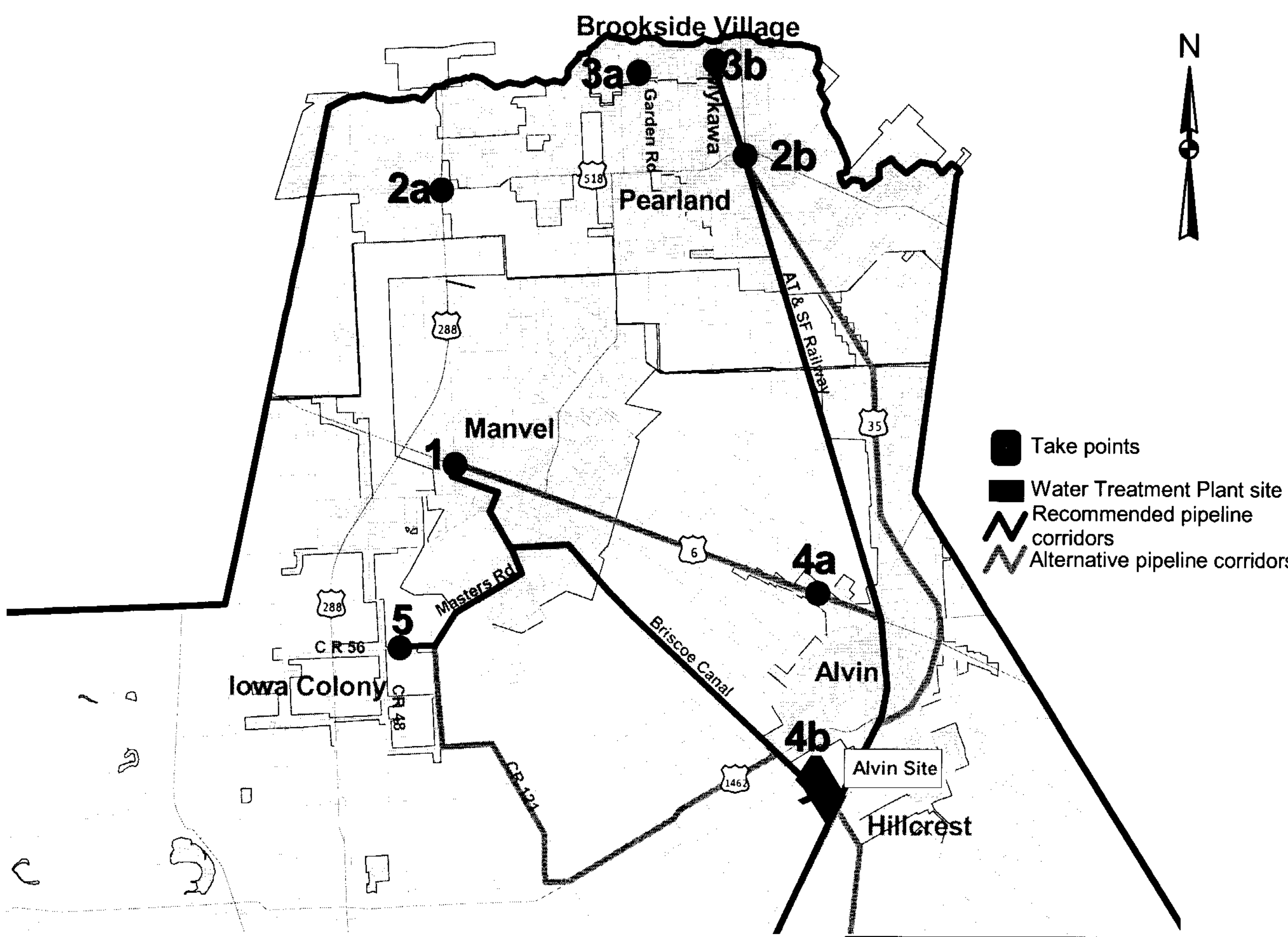
The west corridor will serve the cities of Manvel and Iowa Colony. Both these cities can be served by a common 20 inch water main along the Briscoe Canal, and then splitting flow to serve Manvel to the north and Iowa Colony to the south. Alternate pipeline corridors, running along SH 6 to Manvel and along FM 1462 to Iowa Colony can also serve these cities.

Connection to Manvel

Two alternate pipeline corridors can serve Manvel:

- State Highway 6
- Briscoe Canal

Pipeline along the SH 6 corridor will run north along Business 35, and then west along SH 6 to the Manvel Take Point 1. Pipeline along this corridor will traverse through a congested area of the City of



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FACILITY PLAN

PIPELINE CORRIDORS FROM ALVIN SITE
TO SOUTH BRAZORIA COUNTY

FIGURE 6-5

Alvin, and it will have to share the public right-of-way with other utilities. The length of this corridor will be 14 miles.

The second alternative would be to install a pipeline along the Briscoe Canal. The pipeline along this corridor will run northwest along the canal all the way to Take Point 1 for the City. The length of this corridor will be 11 miles. Construction along this corridor is expected to be higher, and private easements will need to be purchased.

Connection to Iowa Colony

Two alternate pipeline corridors can serve Iowa Colony:

- Briscoe Canal
- FM 1462

The first option will share the 20 inch pipeline with the City of Manvel along the Briscoe Canal. A smaller 8 inch pipeline can then be branched out from this 20 inch water main to run south along Masters road. It will then run west along CR 64 to the Iowa Colony Take Point 5. The total length of this corridor will be 11.5 miles.

The second option is to build a pipeline running north along Briscoe Canal from the Alvin WTP site, and then southwest along FM 1462. It then turns northwest along CR 121, and then north along CR 67 to the Take Point. The length of this corridor will be 13 miles.

Table 6-4 summarizes the advantages and disadvantages of the alternative pipeline corridors in the western trunk line from the Alvin WTP site. Though the requirement for easement along the Briscoe Canal will increase the cost associated with pipeline corridors, the Canal has an existing easement for raw water conveyance, and so it will be easier to obtain a finished water easement near the current raw water easement. The increase in cost due to construction along the Briscoe Canal will be offset by the increased construction cost due to longer lengths along the SH 6 corridor and the FM 1462 corridors. As a result of relative cost savings, the Briscoe Canal corridor is the preferred corridor to the cities of Manvel and Iowa Colony. **Figure 6-5** presents the Alvin-West pipeline corridors serving Manvel and Iowa Colony.

TABLE 6-4
ALVIN WEST PIPELINE CORRIDOR ANALYSIS

Alternative	Advantages	Disadvantages
SH 6	• It is expected that public right-of-way will be sufficient to install the pipeline. • No adverse environmental impact expected.	• Work in SH 6 Right-of-way alongside of existing utilities • Increased length compared to Briscoe Canal alternative
Briscoe Canal	• No adverse environmental impact expected. • Ease of construction along canal • Reduced cost due to reduced length	• Purchase of private easements • Need for easements along canal
FM 1462	• No adverse environmental impact expected. • Construction along public right-of-way	• Construction along rural roads • Increased length compared to Briscoe Canal alternative

South Corridor

The south corridor will serve the communities of Danbury and Angleton. An analysis of the regional geography shows that two parallel corridors can be used, which can feed both the communities.

Connection to Danbury and Angleton

A common water main can be constructed for these cities thus reducing construction costs. The two alternatives are

- State Highway 35
- Burlington Northern Santa Fe Railroad (BNSFRR)

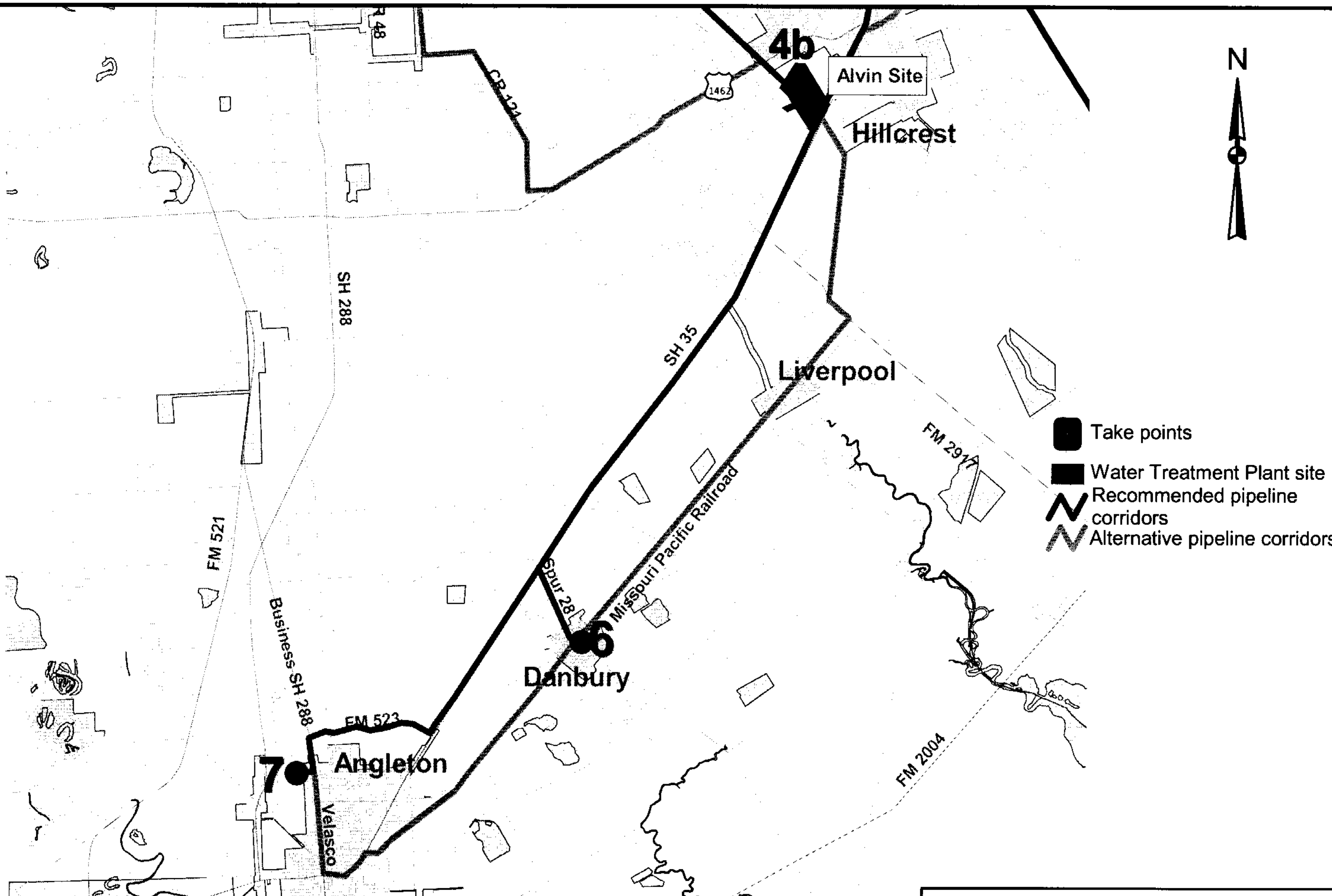
The SH 35 corridor will use the available TXDOT public right-of-way, which is sufficient for a 20 inch pipeline. The pipeline will run south along SH 35, with an 8 inch pipeline line tapped off at Spur 8 to feed Take Point 6 in Danbury. After meeting the City of Danbury water demand, the water main will run further south along SH 35, turning west on FM 523, south along business 288, and finally west on Henderson Road to Take Point 7 in Angleton. The length of the pipeline to the Danbury Take Point will be 12 miles. The length of the corridor from the Alvin WTP site to the Angleton Take Point will be 18 miles.

The alternative BNSFRR option will construct a water main along the railroad. This corridor will also be common for both the cities. The pipeline will run south along FM 2403, and then southwest along BNSFRR to Take Point 6 in Danbury. The pipeline will further run south along BNSFRR after feeding the Danbury Take Point. It will turn east on SH 35, and then north along Velasco Street. Finally it will turn east on Henderson Road to the Angleton Take Point. The length of this corridor to the City of Danbury Take Point will be 12 miles. The length of the corridor from the WTP in Alvin to the Angleton Take Point will be 22 miles.

Table 6-5 summarizes these alternative pipeline corridors in the south trunk of the distribution network. The major differences between the two options are the length and the construction cost associated with the BNSFRR corridor. The BNSFRR corridor is 4 miles longer than the SH 35 corridor to the Angleton Take Point. Construction in the BNSFRR corridor will require purchase of easement from the BNSFRR. This private easement will greatly increase the cost of using this corridor. Compared to this, the SH 35 corridor has a TXDOT public right-of-way. This will significantly reduce construction cost in SH 35 corridor. **Figure 6-6** highlights the alternative Manvel-South pipeline corridors.

TABLE 6-5
ALVIN SOUTH PIPELINE CORRIDOR ANALYSIS

Alternative	Advantages	Disadvantages
SH 35	• It is expected that public right-of-way will be sufficient to install the pipeline. • No adverse environmental impact expected.	• Work in SH 6 Right-of-way alongside of existing utilities
BNSFRR	• No adverse environmental impact expected. • Ease of construction along railroad	• Purchase of private easements • Increased length



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PIPELINE CORRIDORS FROM ALVIN SITE
TO SOUTH BRAZORIA COUNTY

FIGURE 6-6

MODELING AND PIPELINE LAYOUT DESCRIPTIONS

To develop the cost effective sizing of the finished water transmission system components, a hydraulic model was utilized to size pipeline components based on the Take Point requirements and the preferred pipeline alignments. The goal of the model was determine the minimum sized pipelines and booster pump station pressure that could adequately meet the Take Point requirements. Hydraulic models of the transmission pipeline system were constructed for each of the two alternative water treatment plant scenarios developed in **Section 5**.

The study looked at the relative economic cost of participating in a larger regional water treatment plant proposed by the Gulf Coast Water Authority to serve utilities in Fort Bend, Harris, and Brazoria Counties. This regional water treatment plant was studied as part of the TWDB / GCWA Facility Plan study completed in November, 2000. The plant was designed with an ultimate capacity of 150 MGD. The advantage of combining forces and constructing a larger regional facility is documented cost savings associated with the "economy of scale" in constructing a larger facility. Offsetting this saving would be the cost of a trans-county pipeline. A hydraulic model connecting the GCWA plant to the eight Mid-Brazoria County Participating Utilities was also constructed. The GCWA alternative is presented to offer the Participating Utilities a comparison with other regional water plans.

For each treatment plant site location, the following two modeling scenarios were evaluated.

- Delivery to each Participating Utility Take Point at a minimum system pressure to meet the Participating Utilities customer demand. The intent of this alternative is to deliver water at a set minimum pressure to the Participating Utilities and to directly feed customer demand from the regional water treatment plant
- Delivery to Participating Utilities Take Point at sufficient pressure to fill existing or proposed ground storage tanks. The intent of this alternative is serve as the Participating Utilities treated surface water supply, but the Participating Utilities would be responsible for repumping the water to meet the required system pressure to serve their customers.

Hydraulic Model

The program used for the hydraulic modeling was H_2ONET Utility Suite, which is a GIS based software. The software contains seven subprograms designed to optimize water distribution modeling. The subprogram used for this task was the H_2ONET Analyzer. H_2ONET Analyzer enables the modeler to track the flow and velocity of water in each pipe; the pressure, age of water, and fire flow capacity at each node; the height and volume of water in each tank; the discharge pressure/flow, efficiency and energy cost for each pump; the cost of physical improvements; and the movement and fate of water quality constituents as they travel through the distribution system. For this evaluation, only a portion of these modeling capabilities was utilized.

Model Assumptions and Layout

Several basic parameters and assumptions were used to design the hydraulic model. For this study, the following assumptions were defined:

- Pipeline size based on ultimate demand of Participating Utilities in year 2050
- Maximum velocity in any given pipeline - 8 ft/s
- Hazen and Williams pipe friction coefficient - 130
- Minimum system pressure – 50 psi

- Ground storage tank at Take Points are filled at top of tank
- Ground storage tank at water treatment plant or booster station is empty

Given these assumptions, results from all the hydraulic model scenarios depicting the layout of the demand points, plant location, pressure and pipeline sizes can be seen in **Figures 6-7** through **6-12.**

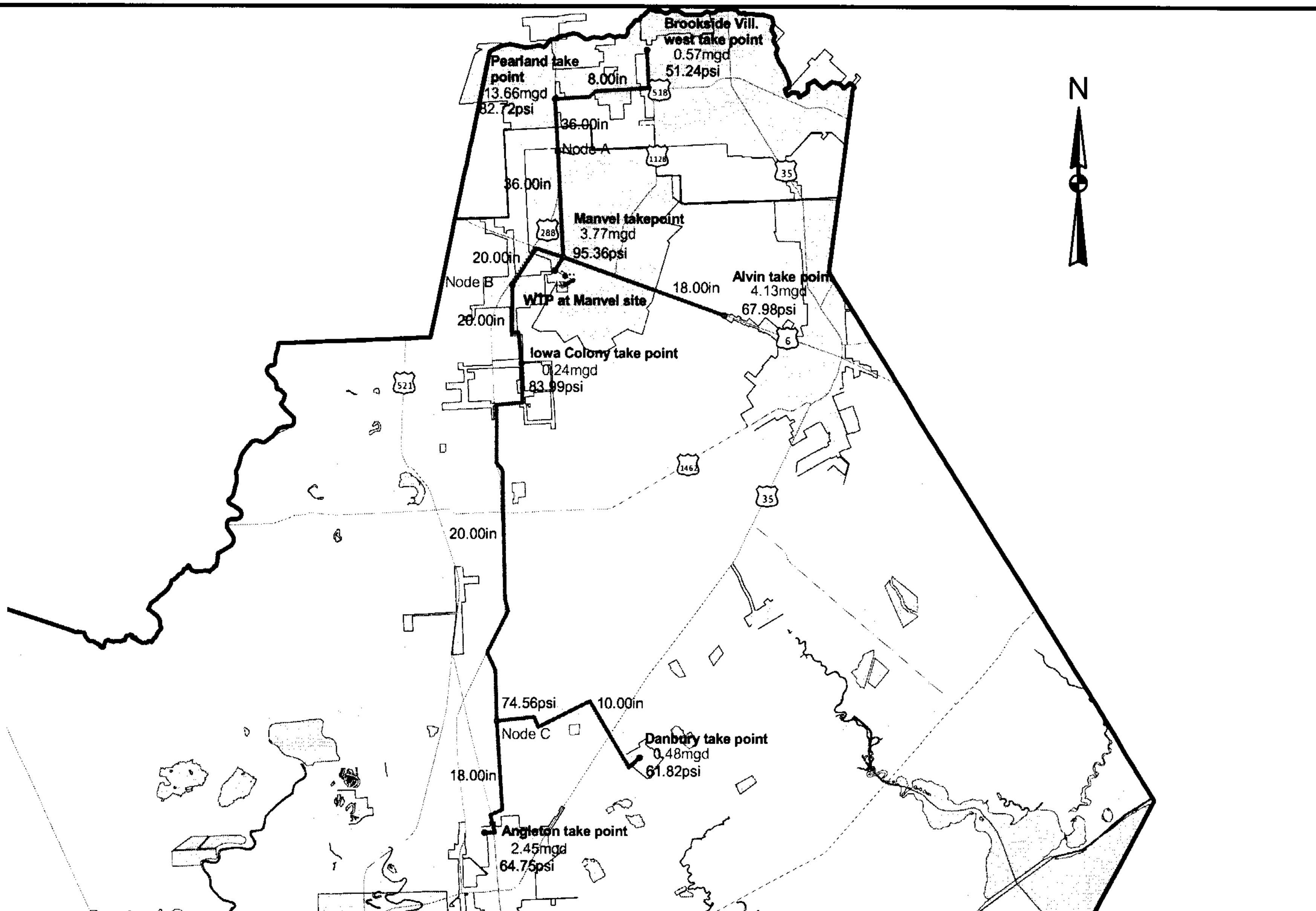
Model Results

For each alternative, finished water transmission system consists of the pipeline facilities and high service pump stations. The final quantities of finished water pipelines are shown in **Tables 6-6** and **6-7**. These tables report the finished water pipe lengths as either rural or urban, based on the existing site geography. Rural installations are italicized. Rural installations refer to pipelines that will be installed in open cut trenches with minimal utility crossings, pavement repair, and trenchless installations. Conversely, urban installations refer to pipelines installed in developed areas where frequent trenchless installations, pavement repair, utility conflicts, and traffic control will be required. The type of installation, either rural or urban, will affect the construction cost of the transmission alternatives. The tables also summarize the required length of private landowner easements.

TABLE 6-6
MODEL RESULTS FOR AT SYSTEM PRESSURE ALTERNATIVE

Pipeline Segment	Manvel Plant Site		Alvin Plant Site		GCWA Plant Site	
	Length (ft)	Diameter (in)	Length (ft)	Diameter (in)	Length (ft)	Diameter (in)
Manvel to Pearland	28,700	36	-	-	28,700	36
Pearland to Brookside from Site A	*24,800*	*8*	-	-	*24,800*	*8*
Manvel to Alvin	31,300	18	-	-	31,300	18
Manvel to Node B	13,100	20	-	-	13,100	20
Node B to Iowa Colony	15,500	20	-	-	15,500	20
Iowa Colony to Node C	70,400	20	-	-	70,400	20
Node C to Danbury	36,000	10	-	-	36,000	10
Node C to Angleton	23,800	18	-	-	23,800	18
Site E to Pearland	-	-	78,400	42	-	-
Pearland to Brookside Village From Site E	-	-	*12,300*	*8*	-	-
Site E to Node D	-	-	45,100	20	-	-
Node D to Manvel	-	-	14,300	20	-	-
Node D to Iowa Colony	-	-	19,900	8	-	-
Site E to Node E	-	-	56,100	20	-	-
Node E to Danbury	-	-	7,800	8	-	-
Node E to Angleton	-	-	37,900	18	-	-
Node A to Pearland	9,500	36	-	-	9,500	36
GCWA Plant to Node B	-	-	-	-	71,800	60
Total Pipe in Rural Areas (ft)	228,300		259,500		300,100	
Total Pipe in Urban Areas (ft)	24,800		12,300		24,800	
Total Pipeline Length (ft)	253,100		271,800		324,900	
Total In-Diameter Foot in Rural Areas(in-dia ft)		4,707,000		6,506,600		9,015,000
Total In-Diameter Foot in Urban Areas (in-dia ft)		198,400		98,400		198,400
Total In-Diameter Foot (in-dia ft)		4,905,400		6,605,000		9,213,400
Private Landowner Easements (ft)	55,530		59,400		127,330	

Note: Rural installations are designated in Italic Type (gray)



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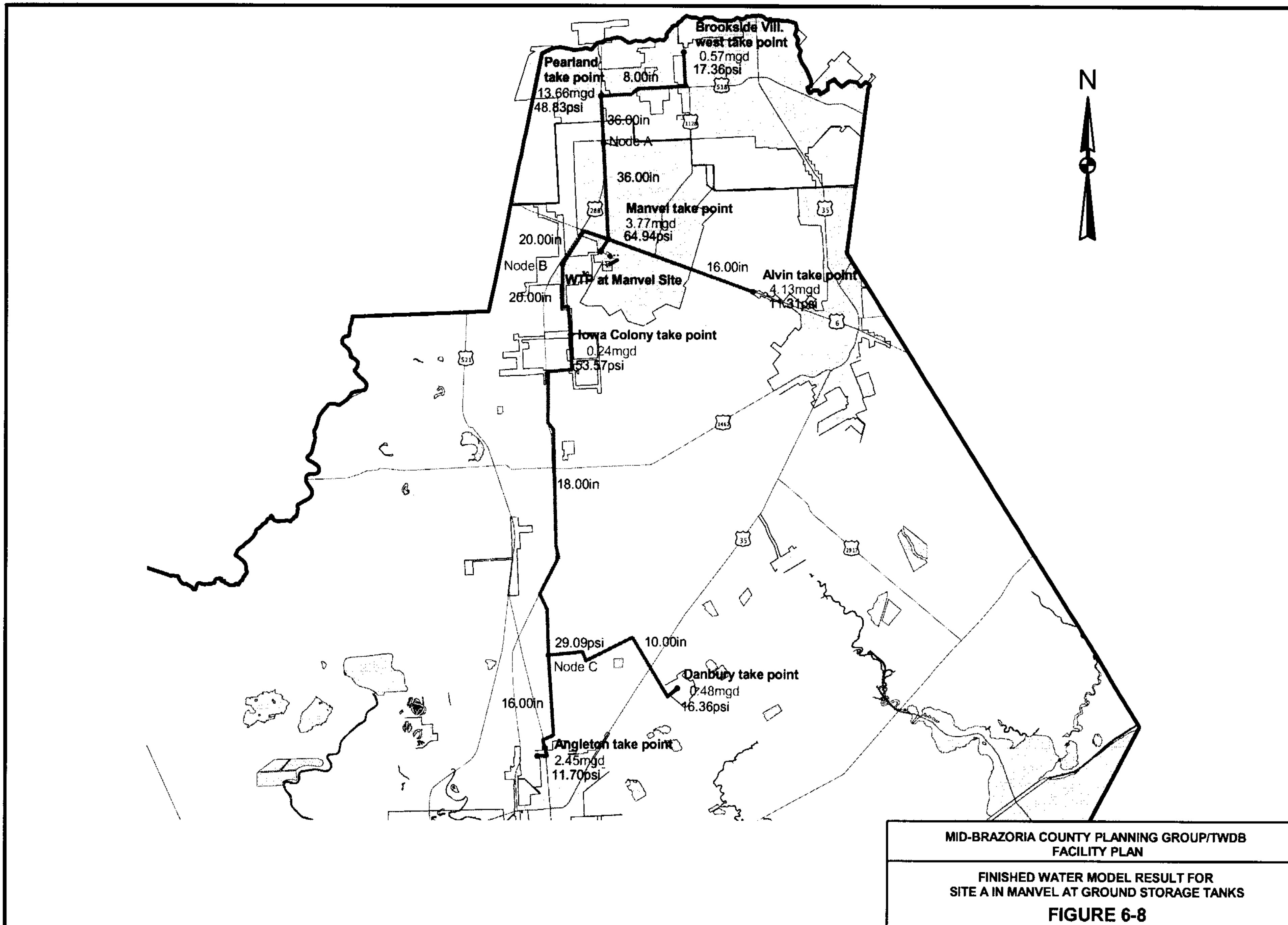
FINISHED WATER MODEL RESULT FOR
SITE A IN MANVEL AT PRESSURE

FIGURE 6-7



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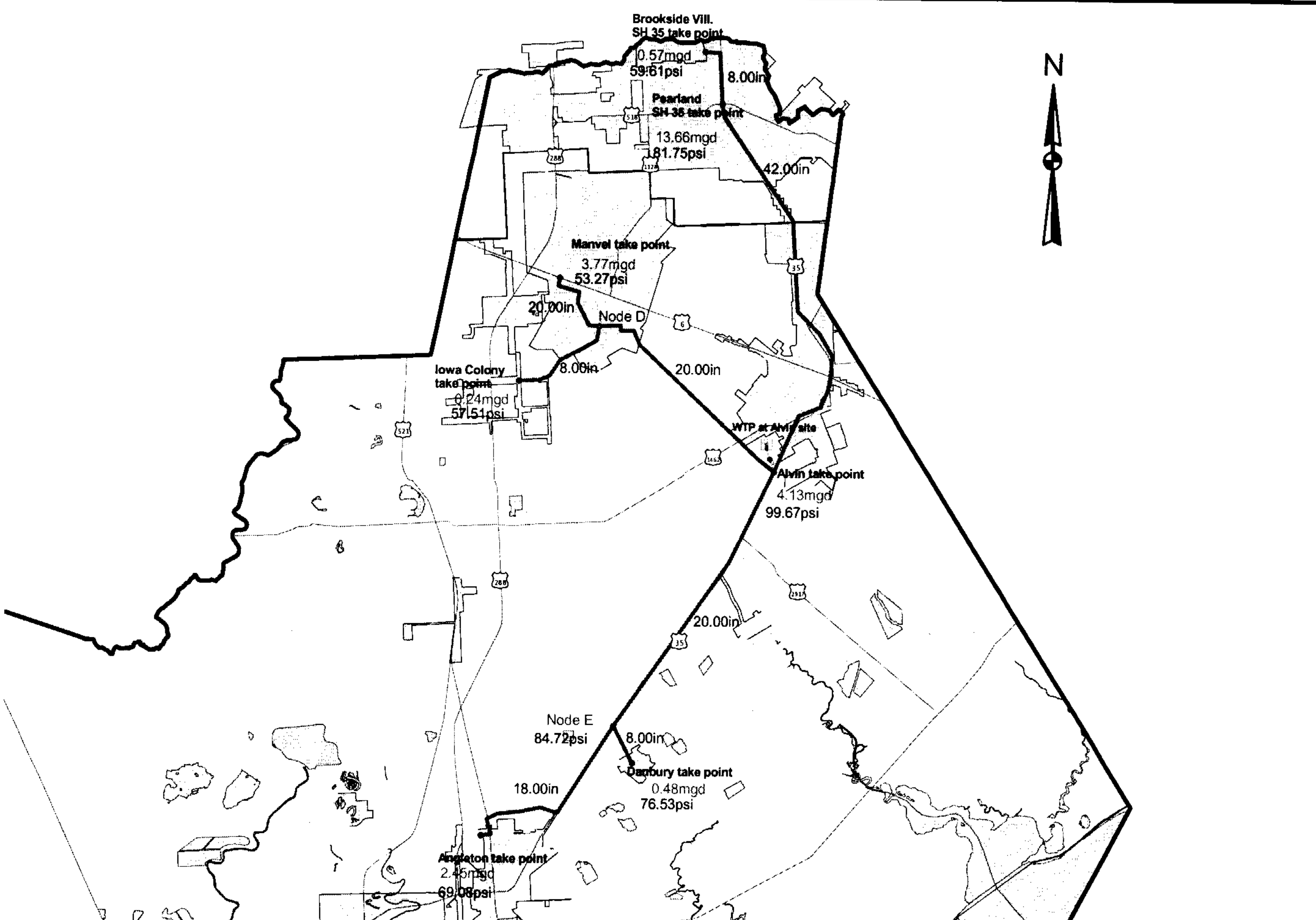
FINISHED WATER MODEL RESULT FOR
SITE A IN MANVEL AT GROUND STORAGE TANKS

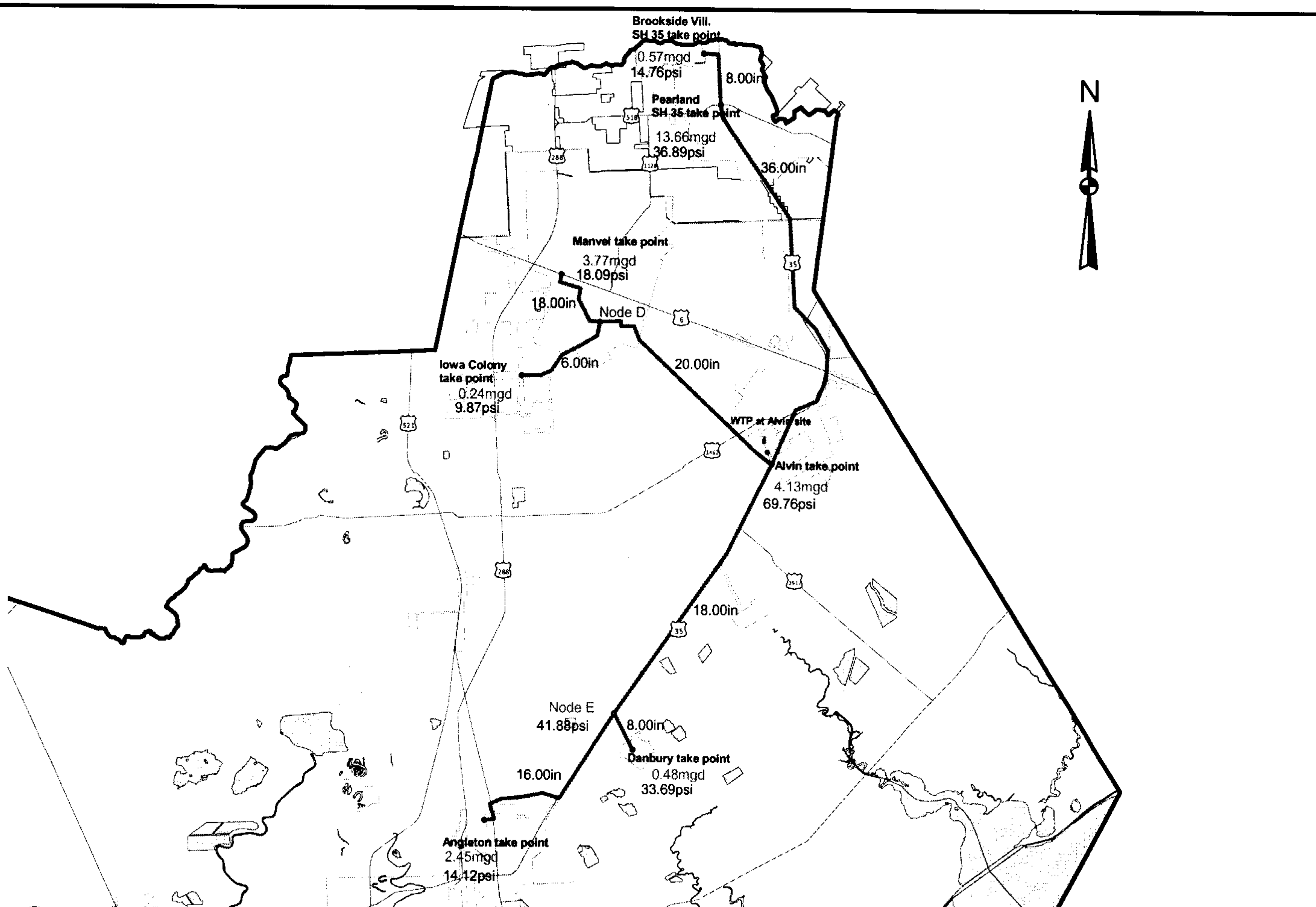
FIGURE 6-8



MID-BRAZORIA COUNTY PLANNING GROUP/TWDB FACILITY PLAN

FINISHED WATER MODEL RESULT FOR SITE E IN ALVIN AT PRESSURE

FIGURE 6-9



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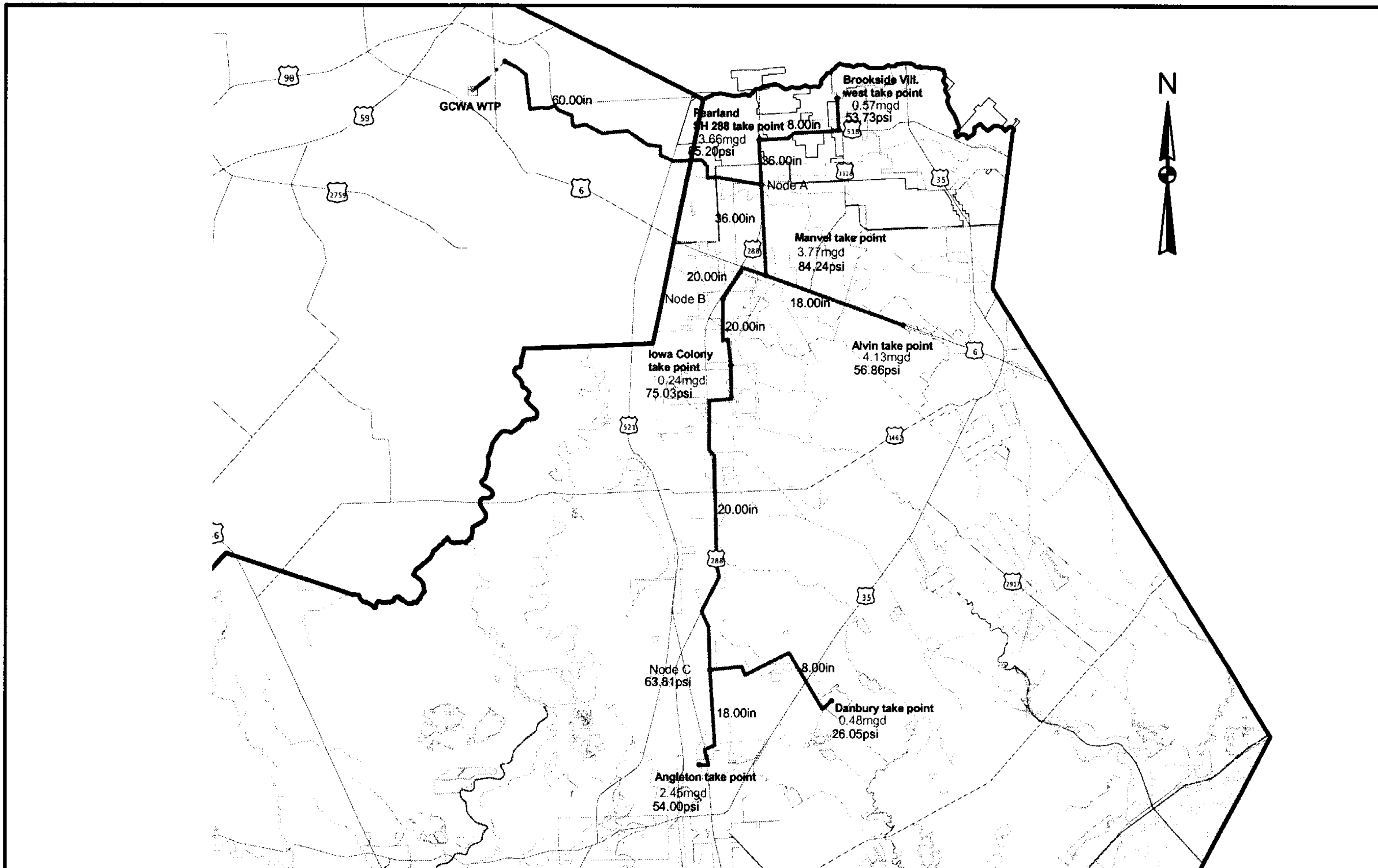
FACILITY PLAN

FINISHED WATER MODEL RESULT FOR
SITE E IN ALVIN AT GROUND STORAGE TANKS

FIGURE 6-10



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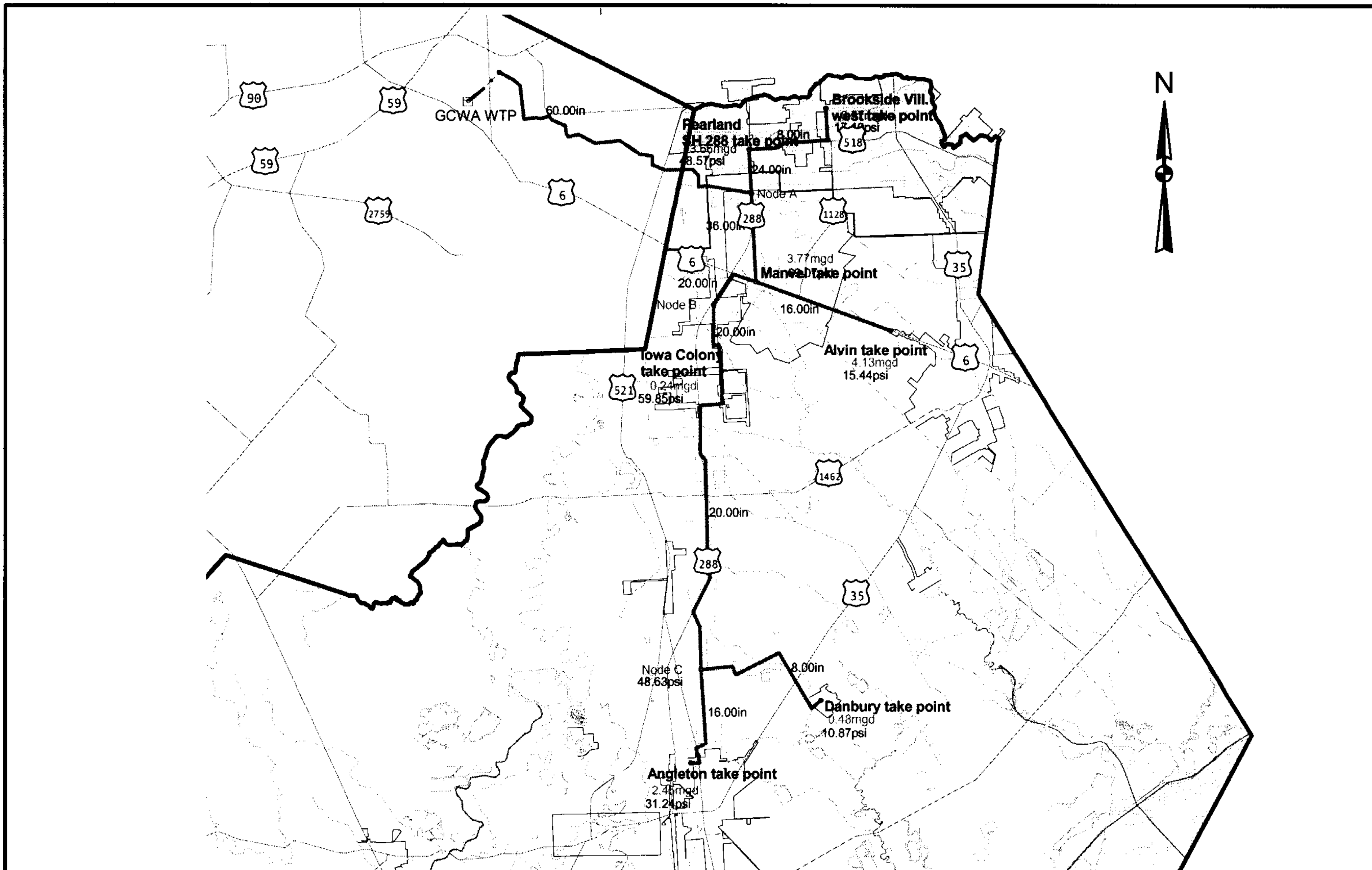
FINISHED WATER MODEL RESULT FOR GCWA WTP AT PRESSURE

FIGURE 6-11



MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

FINISHED WATER MODEL RESULT FOR
GCWA WTP AT GROUND STORAGE TANKS

FIGURE 6-12

TABLE 6-7
MODEL RESULTS FOR AT GROUND STORAGE TANK DELIVERY ALTERNATIVE

Pipeline Segment	Manvel Plant Site		Alvin Plant Site		GCWA Plant Site	
	Length (ft)	Diameter (in)	Length (ft)	Diameter (in)	Length (ft)	Diameter (in)
Manvel to Pearland	28,700	36	-	-	28,700	36
Pearland to Brookside from Site A	*24,800*	*8*	-	-	*24,800*	*8*
Manvel to Alvin	31,300	16	-	-	31,300	16
Manvel to Node B	13,100	20	-	-	13,100	20
Node B to Iowa Colony	15,500	20	-	-	15,500	20
Iowa Colony to Node C	70,400	18	-	-	70,400	20
Node C to Danbury	36,000	8	-	-	36,000	8
Node C to Angleton	23,800	16	-	-	23,800	16
Site E to Pearland	-	-	78,400	36	-	
Pearland to Brookside Village From Site E	-	-	*12,300*	*8*	-	
Site E to Node D	-	-	45,100	20	-	
Node D to Manvel	-	-	14,300	18	-	
Node D to Iowa Colony	-	-	19,900	6	-	
Site E to Node E	-	-	56,100	18	-	
Node E to Danbury	-	-	7,800	8	-	
Node E to Angleton	-	-	37,900	16	-	
Node A to Pearland	9,500	36	-	-	9,500	24
GCWA Plant to Node B	-	-	-	-	71,800	60
Total Pipe in Rural Areas (ft)	228,300		259,500		300,100	
Total Pipe in Urban Areas (ft)	24,800		12,300		24,800	
Total Pipeline Length (ft)	253,100		271,800		324,900	
Total In-Diameter Foot in Rural Areas(in-dia ft)		4,384,000		5,779,800		8,718,800
Total In-Diameter Foot in Urban Areas (in-dia ft)		198,400		98,400		198,400
Total In-Diameter Foot (in-dia ft)		4,582,400		5,878,200		8,917,200
Private Landowner Easements (ft)	55,530		59,400		127,330	

Note: Rural installations are designated in Italic Type (gray)

For each of the scenarios, a high service pump station will be required to deliver water from the water treatment plant to the Participating Utility Take Points. The requirements of the pump station are dependent on the pressure requirements of the Participating Utilities and the headloss associated with flow through the pipelines. To meet the specified pressure and flow requirements at the Participating Utility Take Points, the following pump station pressures will be required. The pump station requirements are shown in **Table 6-8.**

TABLE 6-8
PUMP STATION MODEL RESULTS

Plant Site Alternative	WTP Pump Station Pressure Setting (psi)	
	At Pressure	To GSTs
Manvel Site	95	65
Alvin Site	99	70
GCWA Site	95	80

System Storage and Booster Pump Requirements

Allocation of potable water storage and booster pump requirements in the system depends on the type of connection that the regional system makes at the tie-in point with the individual Participating Utilities systems. If the potable water is delivered under pressure to each Participating Utilities, the water will be delivered at a pressure sufficient to meet state requirements for pressure maintenance of distribution systems. As a result, additional booster pump stations at each Take Point will not be required. Under this scenario, the most cost-effective method for construction of the required system storage is at the water treatment plant instead of distributed in the system at each Take Point. For the purposes of this study, the cost for water delivered at pressure will assume adequate storage at the water treatment plant. Individual Participating Utilities may wish to consider additional operational storage within their own distribution system.

Under the scenario where water is delivered to the Participating Utilities storage tanks, water from the regional water plant will empty into a ground storage tank instead of into the individual Participating Utilities distribution system. Each utility will be required to have a booster pump station to repump the water to distribution system pressure. As a booster station will be required, a small ground storage tank will improve pump operations as well as provide operations storage for the booster pumps. Under this scenario the most cost-effective manner of constructing the necessary storage is to distribute the storage at the Take Points. This will provide the necessary storage for operation of the booster pumps and meet the state guidelines for construction of storage for the regional system.

Based on the expected demand of each Participating Utility, an estimate of the necessary ground storage capacity and booster pump capacity is shown in **Table 6-9.** This table assumes that each community will have enough storage to meet the TNRCC minimum of 200 gallons of storage per connection and that each community has 2.84 residents per connection (1990 census figures). This scenario gives a daily peak system capacity of 0.3 GPM per connection, which is lower than the TNRCC requirement of 0.6 GPM per connection. New wells will have to be constructed by each Participating Utility to meet this requirement.

TABLE 6-9
REQUIRED REGIONAL GROUND STORAGE TANK VOLUME (MGD)

Participating Utility	Year 2050 Planning Area Population	Min. Storage Capacity Required by TNRCC (MG)[1]	Existing GST volume required (MG)	Additional Storage Capacity Required (MG)
Alvin	51,935	3.66	2.125	1.53
Angleton	52,884	3.72	3.65	0.07
Brookside Vill.	3,696	0.26	0	0.26
Danbury	3,381	0.24	0	0.24
Hillcrest	1,696	0.12	.10	0.02
Iowa Colony	1,477	0.10	0	0.10
Manvel	10,606	0.75	.165	0.58
Pearland	91,243	6.43	5.84	0.59
Total for Planning Area	216,918	**15.28**	**11.88**	**3.40**

1) Population / 2.84 persons per connection * 200 gallons per connection

Under the scenario where the Regional Water Facility is directly feeding water into the distribution system, adequate storage to meet state guidelines will be housed at the water treatment plant. The ground storage tanks at the water treatment plant would have a storage volume of 3.40 MG. This volume is marginal for a 25 MGD plant. A storage volume of 7 MGD is planned for the plant.

Under the scenario where the Regional Water Facility is pumping to distributed ground storage, the distributed ground storage tanks will be sized as shown in **Table 6-10**. The sum of these distributed storage tanks and the storage volume at the water treatment plant will be minimum of 16.37 MG.

TABLE 6-10
PARTICIPATING UTILITIES REQUIRED GST VOLUME
UNDER DELIVERY TO GROUND STORAGE TANK SCENARIO (MGD)

Participating Utility	Water Treatment Plant Finished Water Storage (MG)	Distributed Ground Storage Volume to be Constructed (MG)
Alvin	6.25	2.5
Angleton		0
Brookside Vill.		.26
Danbury		.24
Hillcrest		0[1]
Iowa Colony		.10
Manvel		1.95
Pearland		5.07
Total for Planning Area	**6.25**	**10.12**

1) Storage Included in Alvin System

Capital Costs

The capital costs associated with constructing finished water delivery system for each water treatment plant were calculated based in the unit costs summarized in **Table 6-11**. These costs are taken from recent bids and vendor estimates of the capital cost for material and labor in constructing the said facilities. For comparison, the unit costs calculated by Region H for similar facilities are shown. Region H cost estimating schedules from the February 2001 report are attached as **Appendix G**. Region H costs are of a reconnaissance field grade estimates and are more conservative than the unit costs developed from recent bids and vendor estimates. For the purposes of this report, the unit costs developed for this project will be used.

TABLE 6-11
FINISHED WATER DELIVERY UNIT CONSTRUCTION COSTS

Category	Unit Cost	Source	Region H Comparison
Finished Water Pump Station (less than 120 psi)	$56,000 per MGD	Recent Pump Station Bids	$200,000 per MGD
Finished Water Pump Station (less than 60 psi)	$40,000 per MGD	Recent Pump Station Bids	$150,000 per MGD
Pipeline – Rural Installation	$4.00 per in-dia/ft	Recent Pipeline Bids	$6.38 per in-dia/ft
Pipeline – Urban Installation	$5.00 per in-dia/ft	Recent Pipeline Bids	$10.45 per in-dia/ft
Pipeline Easement	$20,000 per Acre	Recent Easement Acquisitions	N/A
2 MG Ground Storage Tank	$750,000	Vendor Estimate	$1,140,000
1 MG Ground Storage Tank	$450,000	Vendor Estimate	$570,000

The probable cost for pipeline installation increases by $1.00 per inch-diameter-foot for urban installation due to constrictions placed upon construction for increased pavement repair, trenchless installation, utility crossings, traffic control, and limited construction work zones. The price of easements includes fees for the cost of the easement plus additional estimates of legal fees, surveying, and abstracting. Given these unit costs, the summary of the capital costs for the ancillary water delivery items for each plant site alternative is shown in **Table 6-12**. All costs are reported in year 2000 dollars.

TABLE 6-12
FINISHED WATER TRANSMISSION CONSTRUCTION ESTIMATE
(YR 2000 $)

Construction Item	Plant Site Alternative (1000's of $'s)					
	Manvel Site		Alvin Site		GCWA Site	
	At Pressure	To Storage Tanks	At Pressure	To Storage Tanks	At Pressure	To Storage Tanks
Finished Water Transmission System						
Pipeline: Rural	$ 18,830	$17,540	$ 26,030	$23,120	$ 36,060	$ 34,880
Pipeline: Urban	$990	$ 990	$ 490	$ 490	$ 990	$ 990
Easements	$760	$ 760	$ 820	$ 820	$1,750	$ 1,750
Subtotal of Pipelines	$20,580	$19,290	$ 27,340	$ 24,430	$ 38,800	$ 37,620
High Service Pump Station	$ 1,400	$ 1,400	$1,400	$ 1,400	$1,400	$ 1,400
Booster PS	$0	$ 1,000	$ 0	$ 1,000	$ 0	$ 1,000
Booster PS GST	$0	$5,540	$ 0	$5,540	$ 0	$5,540
GST Increase @ WTP	$3,080	$ 0	$ 3,080	$ 0	$ 3,080	$ 0
Total Construction Estimate	$25,060	$ 27,230	$31,820	$ 32,370	$ 43,280	$ 45,560

The analysis shows that a plant at the Manvel site delivering water at pressure will have the least capital costs, approximately 2.5 million dollars less than the similar alternative delivering water to storage tanks from the Manvel WTP site. The analysis shows that the Manvel site is approximately 7.5 million dollars less expensive to construct than a similar transmission network from the Alvin site.

Operating and Maintenance Costs

Major components of the finished water O&M costs include booster pump station operation and maintenance of the pipeline. All costs are reported in Year 2000 dollars and shown in **Table 6-13**. The following assumptions were made regarding the operation of the finished water transmission system:

- The cost of electricity was assumed to be $0.06 per KWh
- Maintenance of the finished water pipeline system is equal to .25 percent of the pipeline construction estimate.
- Maintenance of pumps is equal to 3 percent of the pump station construction estimate.
- Water Treatment Plant production of 25 MGD
- Booster Pump Station Operation Head of 50 psi

TABLE 6-13
ANNUAL O&M ESTIMATE FOR FINISHED WATER TRANSMISSION SYSTEMS IN THE YEAR 2050 (YR 2000$)

O&M Item	Plant Site Alternative ($'s)					
	Manvel Site		Alvin Site		GCWA Site	
	At Pressure	To Storage Tanks	At Pressure	To Storage Tanks	At Pressure	To Storage Tanks
Finished Water Transmission System						
WTP High Service Pump Station Operation	$470,000	$320,000	$490,000	$340,000	$470,000	$400,000
Maintenance	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
SubTotal	$510,000	$360,000	$530,000	$380,000	$510,000	$440,000
Booster Pump						
Pump Station Electricity	$0	$250,000	$0	$250,000	$0	$250,000
Maintenance	$0	$30,000	$0	$30,000	$0	$30,000
SubTotal	$0	$280,000	$0	$280,000	$0	$280,000
Pipeline Maintenance	$50,000	$50,000	$70,000	$60,000	$90,000	$90,000
Annual O&M	$560,000	$690,000	$600,000	$720,000	$600,000	$810,000

Alternative Selection

The participating utilities determined that the selection of the plant location would be based on both the economic costs of the alternatives and non-economic factors involved with each plant site alternative. This selection process is discussed in detail in **Section 7** of this report.

RAW WATER DELIVERY SYSTEM

To treat surface water for the Mid Brazoria County area, raw water will need to be brought to the plant site. Per the scope of this project, the raw water transmission alternatives and costs were provided by the Turner Collie and Braden letter report that was submitted to the Chairman of Region H. A copy of the Groups raw water source and alternative evaluation study dated February 2001 is attached as **Appendix E**. It should be noted that there are differences in the facility capacities used in the Region H report and the facility sizes determined as part of this study. Specifically, the following differences will impact the overall costs of the raw water facilities:

1) The water treatment plant capacity between the Region H estimates and the reserve WTP capacity used in this study and

2) The location of the alternative water treatment plant site locations between the Region H report and the sites selected in Section 5 of this report

For the purposes of calculating the capital and O&M costs of a raw water delivery system for Mid-Brazoria Regional Water Plant Facility Plan, modifications to the Region H numbers have been noted and included in the final cost tables. The following is a summary of raw water transportation needs and overall cost impact.

Requirements

To meet a finished water demand of 25 MGD, the water plant will need to sized for an plant influent of 27.5 MGD to account for losses along the treatment train. Approximately 10 percent of the plant influent will be recycled or separated from the water as plant sludge. Accordingly, the raw water supply facilities feeding the plant will have to be sized to accommodate the full design flow of the plant plus appropriate process losses.

Raw Water Sources

Region H has determined that the surface water source for the Mid-Brazoria Region is the Brazos River. Furthermore, Turner Collie and Braden has completed a study on the alternatives of bringing Brazos River water to a Mid-Brazoria County regional water treatment plant. This study was submitted as a letter report to the Chairman of Region H, and is attached as **Appendix E**. In this study, three alternatives for transporting raw water from the Brazos River to a regional water plant site are identified. Those alternatives are:

1) Gulf Coast Water Authority Canals
2) Chocolate Bayou Water Company Canals
3) Brazos River Authority Pipeline

The following is a brief description of each alternative as report by Region H. Additional detail on each alternative can be found in **Appendix E.**

Gulf Coast Water Authority

Gulf Coast Water Authority owns and operates two raw water canals from the Brazos River to Texas City, which carry raw water for industrial, agricultural, and commercial uses for customers in Fort Bend, Brazoria, and Galveston Counties. These canals are located adjacent to the two proposed water treatment plant sites for this study and have ample capacity to carry the required 27.5 MGD from the Brazos River to the plant site.

In this alternative, the MBCPG would purchase raw water on a per gallon contract with the GCWA and this cost would serve as an O&M cost for the production of treated water.

Chocolate Bayou Water Company

Chocolate Bayou Water Company owns and operates a canal system that brings water from the Brazos River to industrial and agricultural customers in Brazoria County. The CBWC canals pass within 2 miles of the proposed water treatment sites and Region H suggests constructing a raw water pipeline and pump station to carry the water from the CBWC canal to the plant site.

Region H proposed that for in this option, the MBCPG initially purchase the water rights owned by CBWC. In owning the rights, the MCBPG would eliminate an annual raw water purchase contract with a political agency holding rights, but would be required to invest capital dollars to initially purchase the rights.

Since the Region H report has been published, the water rights held by CBWC have been reportedly sold to the North Harris County Water Authority for a sum of $100 million dollars, but as of May 24, 2001, the North Harris County Water Authority rejected the final approval of the contract. As a result, the

CBWC rights are still on the market and can still be purchased, but the price of these rights may be different that original reported by Region H.

Brazos River Authority

In this alternative, the MBCPG would contract for raw water with the Brazos River Authority and construct a new raw water pump station and approximately 15 miles of raw water pipeline to transport the required raw water from the Brazos River to the proposed plant site. In this option, the MCBPG would purchase an annual allotment of water from the Brazos River Authority (BRA).

Costs

The costs associated with a raw water delivery system were calculated by Region H and are included in **Appendix H**. The Region H report assumed a maximum raw water flow of 14 MGD and sized the necessary facilities to provide accordingly. For this study, the raw water costs prepared by Region H were updated to reflect changes in the location of the alternate water plant sites. The following summarizes the changes that were made to the original Region H raw water costs analysis:

- Ultimate raw water demand of 27.5 MGD. All pump stations were upsized to handle this ultimate flow and pipeline diameters were increased to reflect the additional capacity required.
- Two Phase construction:
  - 2010: 16.5 MGD Facilities
  - 2030: 11 MGD Facilities
  - Pipelines constructed in first phase
- For the GCWA alternative, elimination of a raw water pipeline and pump station as the GCWA canals are adjacent to the both of the proposed plant sites. Construction of the water plant forebay will be adjacent to the canals and water will flow by gravity into the forebay.
- For the CBWC alternative, a 30-inch raw water pipeline will be used to transport 27.5 MGD to the plant site. The original Region H Report sized their facilities for 14 MGD. As both alternative water treatment plant sites are equidistant from the existing CBWC canals, only one cost estimate was prepared as the required length of raw water pipeline will be the same to both water plant sites from the nearest point on the CBWC canal.
- For the BRA alternative, as the two plant sites are located approximately 14 miles apart, costs for this alternative were determined for both a separate 42" pipeline to Site A in Manvel and to Site E in Alvin. The original Region H Report sized their facilities for 14 MGD.

Figure 6-13 shows a schematic representation of the modified raw water delivery alternatives using in the cost estimate for this study.

Capital Costs

For use in this facility plan, the capital costs associated with constructing raw water conveyance delivery system for each alternative identified by Region H were calculated based in the unit costs provided by Region H unit costs with the exception of the unit raw water pipeline price. A unit price of $4 per inch-diameter-foot of raw water pipeline to reflect recent bid prices on similar projects in the Brazoria County area. **Table 6-14** shows the proposed construction cost for an ultimate raw water flow of 27.5 MGD. Detailed breakdown of each alternative construction cost can be viewed in **Appendix I**.

TABLE 6-14
RAW WATER CONVEYANCE ALTERNATIVE CONSTRUCTION COSTS (YEAR 2000 $)

Construction Item	GCWA	BRA to Site A	BRA to Site E	CBWC
Phase 1 (2010)				
Pump Stations	$0	$5,011,000	$7,219,000	$3,285,000
Pipelines	$0	$6,826,500	$21,948,000	$1,626,000
Water Rights	$0	$0	$0	$6,159,000
SubTotal	**$0**	**$11,837,500**	**$29,167,000**	**$11,070,000**
Phase 2 (2030)				
Pump Stations	$0	$2,491,000	$4,624,000	$889,000
SubTotal	**$0**	**$2,491,000**	**$4,624,000**	**$889,000**
Total Construction		$14,328,500	$33,791,000	$11,959,000

As the raw water can flow by gravity from the GCWA canal to a plant forebay, no additional capital improvements will be necessary to transport the raw water from the Brazos River to the plant site. For both the CBWC and BRA alternatives, new raw water pump stations and pipelines will be necessary to move raw water from the river to the plant site. The estimated capital cost of providing the necessary pump station and pipeline is approximately $14.3 million for the BRA option to Site A, $33.7 million for the BRA option to Site E, and $18.9 million for the CBWC option. The CBWC capital costs include a $6 million dollar allocation for purchase of 25 MGD firm yield water rights at $200 per acre-foot of water.

Operating and Maintenance Costs

O&M costs for providing raw water to the plant site includes booster pump station operation and maintenance, maintenance on the raw water pipeline, and purchase of contract water. All costs are reported in Year 2000 dollars and shown in **Table 6-15**. The following assumptions were made regarding the operation of the raw water transmission system:

- The cost of electricity was assumed to be $.06 per KWh
- Maintenance of the finished water pipeline system is equal to .25 percent of the pipeline construction estimate.
- Maintenance of pumps is equal to 3 percent of the pump station construction estimate.
- Operation at design capacity

TABLE 6-15
RAW WATER CONVEYANCE ANNUAL O&M COSTS (YEAR 2000 $)

O&M Item	GCWA	BRA to Site A	BRA to Site E	CWBC
Phase 1 (2010-2030)				
Phase 1 Flow (MGD)	16.5			
Raw Water Pump Head (psi)	0	40	56	30
Pump Operation	$0	$131,000	$183,000	$131,000
Raw Water Purchase	$542,000	$832,000	$832,000	$0
Maintenance	$0	$166,000	$268,000	$96,000
Total Phase 1 Annual O&M Costs	**$542,000**	**$1,129,000**	**$1,283,000**	**$227,000**
Phase 2 (2010-2030)				
Phase 2 Flow (MGD)	26.5			
Raw Water Pump Head (psi)	0	40	56	30
Pump Operation	$0	$218,000	$306,000	$218,000
Raw Water Purchase	$903,000	$1,386,000	$1,386,000	$0
Maintenance	$0	$342,000	$406,000	$139,000
Total Phase 2 Annual O&M Costs	**$903,000**	**$1,946,000**	**$2,098,000**	**$357,000**

The analysis shows that the operation of raw water system is least expensive under the CWBC alternative. This alternative is approximately 550,000 dollars cheaper per year than the GCWA option. The BRA option has the highest annual O&M costs as a result of the higher unit cost for raw water from the Brazos River Authority and the operation of the pumps to transport the water over 15 miles to the water treatment plant site.

Development of the facility plan to provide the Mid-Brazoria County region with potable water requires selecting a preferred water treatment plant location and associated treated water transmission system. The previous sections have reviewed alternatives for treating Brazos River water and delivering this treated water to the Participating Utilities. This section serves to compare the alternatives and makes facility recommendations. Comparison of these alternatives will be based on the overall project cost, after careful consideration of non-economic factors.

ALTERNATIVE SELECTION PROCESS

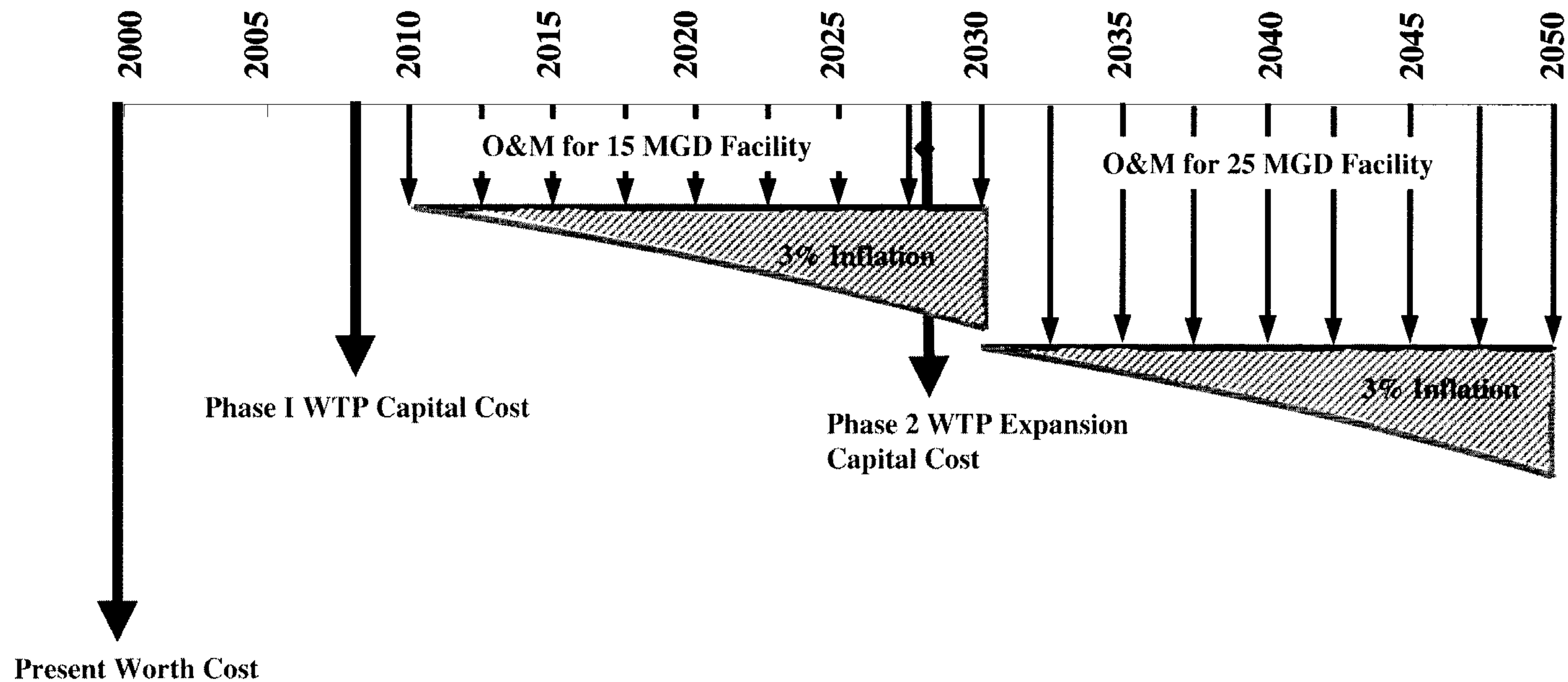
The process for selecting the recommended facility plan includes the development of the lifecycle project costs and the non-economic project impacting each water plant alternative. As these impacts and costs are determined, the alternatives can be compared. Selection of the recommended facility plan will be based on alternatives that offers the greatest flexibility in design, permitting, operations, and public acceptance at the lowest overall project cost. This section is divided into a discussion of the comparison methodology, the project costs of each alternative, and the non-economic impacts of each alternative and culminates in recommended facilities. A discussion of both of the selection criteria follows.

Facility Plan Cost Assumptions and Economic Analysis Methodology

Each alternative has a dollar amount associated with the capital construction of the infrastructure and the operating and maintenance of the facilities. In order to compare these costs, the timing of the expenditures must be considered in the analysis. To account for this time value of money, a present worth analysis will be conducted. The present worth analysis calculates the required investment in the year 2001 to fund the entire project, including capital expenditures and annual operating and maintenance, over the life span of the project.

A synopsis of the analysis is as follows. All economic costs were calculated in terms of year 2000 dollars and then adjusted by the inflation rate to the year that they would be incurred. An inflation rate was used to accurately assess project costs the year they may be incurred so as not to underestimate their present worth cost. The timeline of expenditures is shown in **Figure 7-1**. Once these costs are plotted in time, the amount of money required to be invested today to fund each year's capital or O&M cost based on an annual interest rate is calculated. This is known as the present worth of the project and can used to compare all of the alternatives. The following assumptions were used in this analysis:

1) Water treatment plant will begin operation in the year 2010.
2) Plant capacity will be constructed in two phases.
   a) The first construction period will commence in the year 2006 with completion in the year 2010. The first phase of construction will consist of:
      i) 15 MGD water treatment plant
      ii) Raw water improvements to handle 25 MGD flow for new WTP
      iii) All finished water infrastructure with capacity for 25 MGD
   b) The second phase will commence in the year 2026 with completion of a 10 MGD water treatment plant expansion by the year 2030. The raw water pump stations will also be expanded at this time to meet the increased demand.
3) Annual Inflation Rate = 3 Percent
4) Annual Interest Rate = 6 Percent
5) Water Treatment Plant Annual Production
   a) Year 2010-2030 – 15 MGD
   b) Year 2030-2050 – 25 MGD



Present Worth Analysis Timeline

Figure 7-1

The costs included in this analysis fall into two major categories: Capital costs to construct the infrastructure and operating and maintenance costs to produce and deliver treated water to the Participating Utilities. A discussion of each of these costs follows.

Capital Costs

Capital costs contain three distinct categories: Construction, Engineering, and Contingency. Construction represents the costs associated with the materials and labor to build the facilities. Engineering is costs associated with the design, bid, and oversight of the construction process. Contingency is a factor of safety of the unknown costs and is applied to both the construction and the engineering costs.

Construction

The capital costs include an estimate of the construction costs for a new water treatment plant and distribution system, including but not limited to equipment, land acquisition, site work, concrete, electrical, pipelines, booster stations, contractors overhead and profit, and easements. The costs were compiled from recent projects of similar size and scope. For the purposes of this study, capital costs are assumed to occur at the midpoint of construction.

Engineering

The cost for engineering and construction administration includes the fee for designing, bidding, and administering the construction contract from the conceptual stage to final acceptance of the work. The engineering costs for this project is estimated at fifteen percent of the construction cost and construction administration cost is assumed to be six percent of the construction costs. GCWA administration costs during this phase are estimated at three percent of construction cost.

Contingency

Any construction project can have certain unpredictable expenses, including both minor and major changes in preliminary and final design, estimating deviations, rapid price changes in equipment, labor shortages and strikes. To cover the costs of these unpredictable expenses, an allowance for various contingencies is included to reduce project risk. The contingency will vary according to the type of project, complexity of design, and geographical location. This allowance can be reduced as the design progresses from concept through final construction documents, but some contingency must remain throughout the life of the project as a reserve for events that experience shows will likely occur. Contingency is applied to total construction cost which includes the construction estimate with engineering and construction administration included.

Three types of contingency are included in this job: Engineering Estimating, Cost Estimating, and Construction Bidding and Change Order. The contingency for cost estimating covers the unknown project components and fluctuations in the equipment and labor rates and at this early stage is approximated at twenty percent of the construction cost. At this preliminary stage, it should be recognized that the engineering is not based on detailed information and some level of contingency is needed to cover additional costs as the design evolves in detail. For the purposes of this study, a ten percent engineering estimating contingency will be used. Both the engineering estimating and cost estimating contingency should be reduced as the design progresses from conceptual to final. The last contingency component represents change orders during construction and bidding. The contingency will remain with the project until final acceptance of work and is estimated at 5 percent of the construction cost.

Operating and Maintenance Costs

The operating and maintenance costs for the facility include the costs associated with producing and delivering the water demand to the Participating Utilities. Operation and maintenance costs include, but not limited to the following items:

- Electricity,
- Maintenance,
- Water treatment chemicals,
- Labor,
- Sludge disposal, and
- Administration

WATER TREATMENT PLANT SITE ALTERNATIVE ANALYSIS

In the previous chapters, alternatives for the water treatment process and treatment plant locations were developed. This alternative analysis will focus on the six plant site alternatives discussed in **Section 5**. A summary of these alternatives is:

- Delivery at Pressure to each Participating Utilities take point from:
  - New regional WTP at Site A in Manvel
  - New regional WTP at Site E in Alvin
  - Proposed GCWA Ft. Bend Regional Water Plant in Stafford, Texas
- Delivery to ground storage tanks at each Participating Utilities take point from:
  - New regional WTP at Site A in Manvel
  - New regional WTP at Site E in Alvin
  - Proposed GCWA Ft. Bend Regional Water Plant in Stafford, Texas

For each of these alternatives, the non-economic impacts for each plant site and the economic costs of the construction and operating of the water treatment plant facilities, finished water transmission, and raw water delivery system were developed. These factors were the reviewed and the low-cost alternative that maximizes flexibility in design and plant operations while minimizing impacts to the surrounding community was selected as the recommended facility plan.

Non-Economic Factors

The project impacts not included as costs are termed as non-economic factors. These impacts are often difficult to quantify in terms of dollars and lend themselves to a more subjective analysis. The methodology for the non-economic criteria evaluation for the redundant raw water alternatives and the water treatment process alternatives is a general discussion of the pros and cons of each alternative.

The methodology for the non-economic factor evaluation for the plant site alternatives is a more complex matrix approach involving distinct criteria and a scoring system. Each criterion appears with a general description of the items included in each category.

Public Acceptance:	Aesthetics of water plant Community position Loss of pastures and agricultural land Impact on adjacent land Future land use

Expandability:	Future capacity expansion past year 2050 Adaptability for future treatment requirements
Reliability:	On-site storage capacity Secondary raw water source
Environmental Impacts:	Noise Traffic Wetlands
Permitting:	Regulatory approval Relationship with current land owner

The methodology for evaluating these non-economic factors was first, to establish a relative weight of each of these criteria against one another and second, to score each potential plant site against the criteria. After this was complete, an aggregate score of the sum of the criterion weight times the plant site score was developed. In this manner, subjective factors could be graded and ranked for each alternative. The criteria with the highest grade was given a weight of five, the next highest a four, and so on until the lowest important criteria was assigned a weight of one. The weights assigned by the Participating Utilities to each of the five criteria are shown in **Table 7-1**.

TABLE 7-1
NON-ECONOMIC CRITERIA WEIGHTS

Criteria	Rank
Public Acceptance	2
Expandability	3
Reliability / Raw Water	5
Environmental Impacts	1
Permitting	4

Once the weights were established, each alternative was compared against the criteria and given a favorable, neutral, or unfavorable ranking. A favorable ranking was given a score of 1, neutral a score of 0 and an unfavorable ranking was assigned a -1. A total score for each alternative was then obtained by multiplying the weight of the factor times the "ranking" for each alternative and summing the total for each alternative. This methodology creates a matrix where non-economic factors are reduced to quantifiable terms that can be compared between alternatives.

In selecting the plant site alternative, the plant sites were subjected to a non-economic analysis following the methodology described above. The analysis was used to compare the non-economic factors at the two screened sites (Manvel Site versus the Alvin Site) and the alternative of obtaining treated surface water from the GCWA surface water plant in Fort Bend County. Each site was ranked as favorable, neutral, or unfavorable against each of the five criteria. A summary of the discussion is as follows:

Public Acceptance

Each potential water treatment plant sites are located on open agricultural land adjacent to major thoroughfares. Site A in Manvel is along State Highway 6 corridor, which is anticipated to be a commercial zone. Site E in Alvin is along the State Highway 35 corridor and is within the ETJ of the City of Alvin adjacent to their current city limits. The landowners of each property have been contacted and have indicated the potential to sell the land to the Mid Brazoria County Planning Group for use as a water treatment plant. It is anticipated neither of these sites would be unfavorable in terms of public acceptance and therefore are rated as a positive.

The GCWA plant site is not located within the Mid-Brazoria County region, but is located on a piece of property that is slated for a water plant. Although this location is known as a future location of a water treatment facility and adjacent to an existing wastewater plant and is viewed as an acceptable site, the water treatment plant facility would be owned and operated by another public agency and for that reason, the GCWA site is rated as neutral.

Expandability

Each site was also ranked in terms of the potential to expand the plant above and beyond the year 2050 finished water capacity or raw water reservoir capacity considered in the analysis. As the Alvin site contains in excess of 200 acres, an expanded raw water reservoir of up to three days could be provided, in addition to treatment capacity expansion well past 25 MGD. In addition, this site is downstream of an adjoining larger parcel of land owned by the same landowner for which a large raw water reservoir could be constructed. For these reasons, this site was ranked as favorable. The Manvel and GCWA sites meet the requirements to support the water treatment facilities for this project, but future process expansions are limited by the acreage of land at the site. These sites were ranked as neutral.

Reliability

On the subject of raw water reliability, both the Manvel and Alvin site have the ability to be fed from either the Gulf Coast Water Authority American Canal or Briscoe Canal. The Manvel Site is adjacent to both Lateral 10 and the Briscoe Canal and can install dual feeds from both of these canals. This raw water redundancy greatly reduces the risk of a raw water outage and makes this a favorable site. The Alvin site is adjacent to the Briscoe Canal only and as a result has a common point of failure in the raw water delivery stream. Even though this site is downstream of the GCWA Lateral 10 and can be feed from both canals, this site is ranked as neutral instead of positive as the water must travel through a common canal. Both sites are also within one mile of the Chocolate Bayou Canal, which could serve as another raw water source, thereby enhancing the reliability of raw water for the site.

The GCWA site can only be fed from the GCWA American canal and does not have cost effective alternative raw water supplies and is rated as neutral.

Environmental Impacts

The Manvel site is encumbered by the Chocolate Bayou floodplain and thereby requires additional engineering to mitigate flooding potential in the site. In addition, Brazoria County Drainage District is considering expanding the Bayou to improve storm water drainage and could widen the canal on this property. Due to these concerns, this site is ranked as neutral. The Alvin site also contains two drainage channels that are under consideration for expansion, but due to the large acreage of the site, it is expected that the drainage features will not impact construction of a water treatment plant. As this site does not have any known concerns or other expected concerns, this site is ranked as neutral. The GCWA site does not have any know environmental concerns or other expected surface features which would impact the cost and has been zoned for the construction of a water plant. As a result, this site is ranked as positive.

Permitting

Each site will require permits from the State of Texas to construct and operate the facilities. In general, the permits required at each site will be similar and the obstacles to obtaining each permit will also be similar. For this reason, all sites could be ranked as neutral, but the Alvin site contains an additional layer of permitting that could impact the site. As a condition of placing the water treatment plant on this site, the current landowner would be involved in "wheeling" the raw water to the site. As a third party vendor supplying this water, they would be responsible for meeting state requirements and permits for construction and operation of these facilities. This would be a new venture for this group and could create problems for state acceptance of the project.

Summary

Given these discussions, the rankings were entered into the site selection matrix and the total non-economic score for each site alternative was determined. Each alternative's criteria ranking, criteria weight, and overall score are shown in **Table 7-2**. Both sites have an aggregate score of .33. The Participating Utilities felt that there was no discernable difference between these sites and that siting the plant at the Alvin or Manvel site would have the same impact on the community.

TABLE 7-2
NON-ECONOMIC SITE SELECTION MATRIX

Criteria	Rank	Weight	Manvel	Alvin	GCWA Regional Plant
Public Acceptance	3	20%	1	1	0
Expandability	4	27%	0	1	0
Reliability / Raw Water	5	33%	1	0	0
Environmental Impacts	1	7%	0	0	1
Permitting	2	13%	0	0	0
Total Score		100%	0.53	0.47	.07

Alternative Water Plant Scenario Costs

To identify the economic cost of each water plant scenario, the construction, operation and maintenance costs of the raw water conveyance system improvements, water treatment facilities, and finished water transmission system for each alternative must be summarized. A present worth analysis was used to relate all of these costs to evaluate the comparative costs of these different alternatives.

Raw Water Conveyance Improvements

- In **Section 6** of this report, the raw water improvements for each plant site alternative were identified and the construction and annual operation and maintenance costs were estimated. The raw water improvements will be phased to match the capacity of the water plant and the construction and annual operating costs for a two-phased construction program are shown in **Table 7-3**.

TABLE 7-3
RAW WATER IMPROVEMENT CONSTRUCTION AND O&M COSTS (YR 2000 $)

Cost Item	Alternative			
	Alvin or Manvel WTP Site from CBWC Canal	Alvin or Manvel WTP Site from GCWA Canal	Alvin WTP Site from BRA	Manvel WTP Site from BRA
Capital Costs				
Phase 1 Raw Water Pump Stations	$3,285,000	$0	$7,219,000	$5,011,000
Phase 1 Raw Water Pipeline	$1,626,000	$0	$21,948,000	$6,826,500
Water Rights	$6,159,000	$0	$0	$0
Total Phase 1 Construction	$11,070,000	$0	$29,167,000	$11,837,500
Total Phase 2 Pump Station Construction	$889,000	$0	$4,624,000	$2,491,000
O&M				
Annual O&M Year 2010-2030	$227,000	$542,000	$1,283,000	$1,129,000
Annual O&M Year 2030-2050	$357,000	$903,000	$2,098,000	$1,946,000

The costs presented herewith are developed from the information provided by Region H as modified to meet the modified alternative regional water treatment plant locations. It is noted the actual costs for any of these options are highly variable and depend on many factors yet unknown, including

- The actual cost of the Chocolate Bayou Water Company firm water rights. As the CBWC continues to market their water rights to nearby cities and water authorities, the cost of remaining CBWC rights may be more than initially estimated by Region H. The CBWC initially brokered these rights to the North Harris County Water Authority for a sum of $100M dollars. Due to concerns of the actual firm yield during drought conditions and the regulations surrounding relocation of the take point on the Brazos, no final contract was pursued and the deal has since ended.
- Surface Water Availability on the Brazos River. At this time, the State of Texas indicates that the Brazos River is oversold and is currently working on evaluating the firm yield of the river. The results from the State's evaluation could impact the availability of surface water and the cost thereof
- The final selection of the water treatment plant. If the location of the regional water treatment plant changes, the facilities required to transport raw water to the WTP site will be different than those presented in the is report. As a result, the overall cost of the most cost effective raw water alternative may change.

Finished Water Transmission

In **Section 6** of this report, the finished water transmission system for each water plant alternative was developed. The costs for each component were identified and a summary of these costs is shown in **Table 7-4.** The finished water pipelines will be constructed entirely in Phase 1 to minimize the expense of the overall cost of the transmission program.

TABLE 7-4
FINISHED WATER CONSTRUCTION AND O&M COSTS IN 1000 $(YR 2000 $)

Construction Item	Manvel Site		Alvin Site		GCWA Site	
	At Pressure	To GST	At Pressure	To GST	At Pressure	To GST
Capital Costs						
Phase 1 High Service Pump Stations	$840	$840	$840	$840	$840	$840
Phase 1 Pipelines	$20,580	$19,290	$27,340	$24,430	$38,800	$37,620
Phase 1 Booster PS and GSTs	$1,848	$3,924	$1,848	$3,924	$1,848	$3,924
Total Phase 1 Capital	$23,268	$24,054	$30,028	$29,194	$41,488	$42,384
Phase 2 High Service Pump Stations	$560	$560	$560	$560	$560	$560
Phase 2 Booster PS and GSTs	$1,232	$2,616	$1,232	$2,616	$1,232	$2,616
Total Phase 2 Capital	$1,792	$3,176	$1,792	$3,176	$1,792	$3,176
O&M Costs						
Annual Operating Cost: Year 2010-2030	$370	$460	$410	$490	$410	$550
Annual Operating Cost: Year 2030-2050	$560	$690	$600	$720	$600	$810

Water Treatment Plant Cost

The water treatment plant costs will be based on the capacity of the plant and will be based on a high-rate conventional process. The construction and O&M costs to construct and operate a high-rate conventional plants can be found in the **Appendix F** and are summarized in **Table 7-5**.

For the WTP costs associated with purchasing water from the GCWA Fort Bend Regional Water Treatment Plant, The cost estimates are based on constructing an initial 115 MGD regional WTP with 15 MGD of capacity dedicated to the MBCPG members with a 35 MGD expansion in the year 2030. 10 MGD of this expansion would be dedicated to MCBPG members.

Based on these assumptions, the capital cost for the first phase construction is assumed to be $0.88 per gallon of capacity constructed. The unit rate for the expansion is calculated as $0.71 per gallon of capacity added. The O&M costs to treat and distribute potable water was determined to be $.45 per 1000 gallon during the first twenty years of operation, with a decrease to $0.44 per 1000 gallons when the plant operates at the full 150 MGD capacity. This O&M rate excludes the cost of raw water supply and transportation, which would add another $0.07 per 1000 gallons of raw water delivered to the plant site.

TABLE 7-5
WATER TREATMENT PLANT CONSTRUCTION AND O&M COSTS (YR 2000 $)

Plant Location	Capital		Annual O&M*	
	Phase I Year 2008	Phase II Year 2028	Phase I: 2010-2030	Phase II: 2030-2050
25 MGD in new MBCPG Regional WTP	$22,940,000	$7,925,000	$3,443,000	$4,702,000
25 MGD from proposed GCWA Ft. Bend Regional WTP	$13,950,000	$7,100,000	$2,464,000	$4,015,000

* *Excludes the cost of raw water purchase and transportation to the water plant site*

In addition to the cost of the water treatment plant cost, each alternative plant site has unique costs related to the land acquisition costs, and other facilities which must be improved to make the plant site suitable for a regional water plant.

Land

Each plant site has a cost to acquiring the required land for the water treatment plant site. The unit price of the land varies from site to site. Conversations were held with the landowners of each potential water treatment site to determine if the property could be subdivided or if the property was for sale. The unit price of the property and the minimum acreage that would have to be purchased are shown in **Table 7-6**.

TABLE 7-6
SITE ACQUISITION COSTS

Site	Acreage	Cost Per Acre	Land Cost
Manvel	54	$ 13,000	$ 700,000
Alvin	200	$ 0	$ 0

The Alvin property is owned by a private landowner who, with several stipulations, will donate the land to the MBCPG free of charge for the right to provide the plant with raw water. As a result, the land cost for the Alvin site is zero, but an additional operational and maintenance charge will be assessed for the private landowner to "wheel" the water to the site.

Other Economic Consideration

Additional costs not captured above are expected at both of the water treatment plant location. At the Manvel site, it is expected that a flood protection levee will have to be constructed to protect the portion of the site that is within the 100 year flood plain for being submerged during a flood event. The probable construction cost for such a levee is $60,000.

The Alvin site is provided with the unique stipulation that the water provided to the site must be provided by the private landowner who would be donating the land to the MBCPG for use as a water treatment plant. In addition, the private landowner will construct a reservoir on a portion of their adjacent land to serve as forebay for the plant.

The private landowner has indicated that they would charge a per gallon rate to deliver water to the plant, but at the time of the release of this report, the landowner had not completed an estimated of their unit handling charge. As a result, the O&M calculations for the Alvin site do not include this charge and will need to be modified once the landowner submits their proposal to furnish the water to the Site.

Present Worth Cost Summary

Given the economic assumptions and the construction and operating and maintenance costs provided above, each alternative was subject to a present worth analysis to identify the estimated overall costs of each alternative. Due to the relative aforementioned unknowns associated with the alternative raw water delivery projects, the present worth analysis on the overall project will divided into two distinct sections. The first analysis will focus on the raw water conveyance portion of this project and will evaluate the alternatives in terms of known costs and future impacts to the this cost. The second analysis will develop the overall present worth cost of the alternative water treatment plant sites and the associated finished water transmission alternatives.

Raw Water Conveyance System

The capital and O&M costs for the raw water delivery for each alternative, including contingency and engineering are summarized in the **Appendix I**. A summary of the capital, annual O&M costs, and present worth of each alternative are shown in **Tables 7-7.**

TABLE 7-7
RAW WATER CONVEYANCE ALTERNATIVES PRESENT WORTH SUMMARY (YR 2000 $)

Summary Cost Item	Raw Water Alternative			
	1: GCWA	2: CBWC	3A: BRA to Site A	3B: BRA to Site E
Phase 1 Capital Cost	$0	$14,230,000	$19,527,500	$48,087,000
Phase 2 Capital Cost	$0	$1,479,000	$4,131,000	$7,674,000
Phase 1 Annual O&M	$542,000	$227,000	$1,129,000	$1,283,000
Phase 2 Annual O&M	$903,000	$357,000	$1,946,000	$2,098,000
Present Worth	$15,276,000	$17,873,000	$49,113,000	$75,979,000

Given the assumptions used for the evaluation of each alternative and the overall variability in the raw water costs due to water availability, the following recommendations regarding raw water conveyance to a Mid-Brazoria Regional Water Plant can be made:

1) The BRA options is approximately 3 to 5 times as expensive as either the GCWA or CBWC option and it appears that this is least attractive alternative

2) The relative present worth of the CBWC and GCWA alternative are within the variability or contingency of the assumptions used to develop the cost estimate. As a result, we recommend that that MCBPG proceed to negotiate with both entities to develop a raw water option contract to bring Brazos River water for potable use in the Mid-Brazoria Region. This contract would enable the MCBPG to further solidify the costs associated with bring raw water to the area and would secure raw water availability when the MCBPG is ready to augment their current groundwater supply with treated surface water.

Site Selection and Finished Water Transmission

The capital and O&M costs for each alternative WTP site and finished water transmission system, including appropriate contingency and engineering, are summarized in the **Appendix J**. The corresponding results of the present worth analysis are shown in the **Table 7-8** and exclude the capital cost of the constructing the facilities necessary to bring raw water to the site and the O&M cost of operating said raw water conveyance system over the project horizon.

TABLE 7-8
PLANT SITE ALTERNATIVES PRESENT WORTH SUMMARY (YEAR 2000 $)

Alternative	Present Worth Cost ($M)
Alternative 1A: Manvel Site Delivering Water At Pressure	$160
Alternative 1B: Manvel Site Delivering Water To GSTs	$164
Alternative 2A: Alvin Site Delivering Water At Pressure	$169
Alternative 2B: Alvin Site Delivering Water To GSTs	$170
Alternative 3A: GCWA Fort Bend County Regional WTP Delivering Water At Pressure	$154
Alternative 3B: GCWA Fort Bend County Regional WTP Delivering Water to GSTs	$160

Given the aforementioned assumptions, the analysis shows that purchasing water from the GCWA and constructing a large diameter pipeline to serve the Participating Utilities in the Mid-Brazoria County Region is the most cost effective alternative for converting 25 MGD of water demand from groundwater to surface water by the year 2050. The analysis further shows that within each of the three general alternatives, the option of delivering water at minimum distribution pressure to each of the Participating Utilities take points is more cost effective than delivering water to a ground storage tanks and boosting the water to meet individual Participating Utilities system pressure.

Project Present Worth Costs

To complete the present worth cost of constructing and operating a surface water treatment plant, the costs for raw water conveyance need to be included. **Table 7-9** highlights the range of probable overall project present worth cost assuming raw water costs in accordance with governing assumptions used to in the cost analysis. As the CBWC and GCWA raw water alternatives are within the margin of contingency of each alternative estimate, the overall Project present worth costs are presented as a estimated range.

TABLE 7-9
PLANT SITE ALTERNATIVES PRESENT WORTH SUMMARY (YEAR 2000 $)

Alternative	Plant Site Present Worth Cost ($M)	Raw Water Present Worth Cost ($M)	Total Present Worth Cost ($M)
Alt 1A: Manvel At Pressure	$160	$15.3 - $17.9	$175.3 - $177.9
Alt 1B: Manvel To GSTs	$164	$15.3 - $17.9	$179.3 - $181.9
Alt 2A: Alvin At Pressure	$169	$15.3 - $17.9	$184.3 - $186.9
Alt 2B: Alvin To GSTs	$170	$15.3 - $17.9	$185.3 - $187.9
Alt 3A: GCWA Ft Bend Regional WTP At Pressure	$154	$11.9	$165.9
Alt 3B: GCWA Ft Bend Regional WTP to GSTs	$160	$11.9	$171.9

ALTERNATE WELL OPTION

This section presents the cost associated with meeting the regional water demand with ground water. This cost analysis was done to compare the costs of providing a portion of the regional water demand with treated surface water as described above, with an estimate of the capital and O&M costs necessary to serve this demand with groundwater . For the purposes of this study, it was assumed that each Participating Utility would construct new groundwater wells with a capacity equal to their corresponding reserve capacity in the proposed surface water plant. The groundwater construction would be phased in the same manner as the surface water plant, with the sum of the Participating Utilities added groundwater capacity in the year 2010 equal to 15 MGD with a 10 MGD expansion in the year 2030.

The costs shown in **Table 7-10** highlight the corresponding construction and O&M for adding wells for each of the seven Participating Utilities. These costs include the cost of necessary groundwater storage improvements required to meet TNRCC requirements and the cost of additional booster pumps necessary to provide a residual system pressure of 50 psi. A detailed compilation of the construction and O&M costs for wells, booster pump stations and ground storage tanks required under this option is provided in **Appendix K**.

TABLE 7-10
CONSTRUCTION AND O&M COST FOR ALTERNATE WELL OPTION (YEAR 2000 $)

Participating Utility	Phase 1 (2010-2030)			Phase 2 (2010-2030)		
	Demand (MGD)	Construction	O&M	Demand (MGD)	Construction	O&M
Alvin	2.31	$1,833,000	$190,000	1.82	$1,663,000	$343,000
Angleton	1.34	$682,000	$113,000	1.11	$388,000	$207,000
Brookside Vill.	0.31	$549,000	$30,000	0.26	$198,000	$55,000
Danbury	0.27	$531,000	$27,000	0.21	$193,000	$48,000
Hillcrest Village	0.00	$0	$0	0.02	$0	$0
Iowa Colony	0.14	$427,000	$17,000	0.10	$186,000	$30,000
Manvel	2.26	$1,899,000	$193,000	1.51	$525,000	$320,000
Pearland	7.81	$4,761,000	$664,000	5.85	$3,705,000	$1,161,000
Total	14.44	$10,682,000	$1,234,000	10.86	$6,858,000	$2,164,000

**Included in City of Alvin*

If these construction and O&M costs are subjected to a present worth analysis, the results show that the present worth cost of the "groundwater" option is $52,495,000. This is approximately one-third of the present worth cost of the least expensive surface water conversion alternatives. **Table 7-11** shows a comparison of the total present worth cost associated with the three water supply alternatives. Although this option is economically attractive, continued reliance on groundwater may lead a steady deterioration in groundwater quality and quantity.

TABLE 7-11
TOTAL PRESENT WORTH COST COMPARISON (YR 2000 $)

Water supply alternative	Total Present Worth Cost ($M)
Manvel WTP At Pressure	$175.3 - $177.9
GCWA Ft Bend Regional WTP At Pressure	$165.9
Water Well Option	$52.5

RECOMMENDATIONS OF WATER PLANT FACILITY LOCATIONS

The present worth cost of the plant site alternatives including contingency and engineering ranged from the $166M to $190M including the most likely costs for raw water acquisition and conveyance. The present worth analysis indicates that the most cost effective method to convert 25 MGD of potable water demand for seven Participating Utilities in the Mid-Brazoria County region is to combine forces with several larger entities in Fort Bend and Harris Counties in a larger regional water treatment plant. In this manner, the costs of raw water acquisition and treatment are distributed over a larger base water demand and the unit rate for water treatment is lower.

However, if the MBCPG decided to pursue a separate Mid-Brazoria County regional water plant, the most cost effective alternative including raw water conveyance, as described by Region H and modified in **Section 6,** would be to construct a regional water plant at the Manvel site. The main advantage that the Manvel site over the Alvin site is the distance between the site and the City of Pearland take point. As the City of Pearland is the largest single user in the Mid-Brazoria region, the costs of the transmission line to the City represents a large portion of the overall capital cost necessary to construct a regional plant. The Manvel site is approximately 4 miles closer to the City of Pearland site and benefits from the reduced pipeline length to this point.

In addition, pumping from the Manvel site is less expensive as the high service pumps will operate at a lower head due to the positive elevation difference between the Manvel and the Alvin Site.

Based on the results of this study, the following recommendations are made:

- Begin negotiations with Fort Bend and Harris County cities and municipalities to construct a large capacity high-rate conventional process surface water treatment plant in Stafford, Texas to serve the residents of Harris, Brazoria, and Fort Bend Counties with treated surface water. This alternative has the apparent low present worth cost.

- Begin easement acquisition, permitting, preliminary planning and engineering for water plant site, and transmission main alignments.

- If the MBCPG wishes to construct a Mid Brazoria County Regional Water Plant and not participate in a larger regional water plant, the MBCPG should construct a 25 MGD high-rate conventional surface water treatment plant on the Southeast corner of Highway 6 and Iowa Lane in Manvel, Texas. This site has the apparent low present worth cost for a smaller Mid-Brazoria County regional facility and does not have any permitting issues relating to the conveyance of raw water through a private landowner. A facility plan for implementing this regional treatment plant is developed in **Section 8**.

  Negotiate with both CBWC and GCWA to develop a raw water option contract to bring Brazos River water for potable use in the Mid-Brazoria Region. This contract would enable the MCBPG to further solidify the costs associated with bring raw water to the area and would secure raw water availability when the MCBPG is ready to augment their current groundwater supply with treated surface water.

Based on the evaluation of treatment and distribution alternatives developed in Section 7, the most economically solution to converting to treated surface water is to combine with neighboring communities and construct a larger regional water treatment plant located in Fort Bend County. In this alternative, a finished water pipeline would transport treated water from the water treatment plant to the MBCPG members. It is our recommendation that the MBCPG begin negotiations with Fort Bend and Harris County cities and municipalities to construct a large capacity high-rate conventional process surface water treatment plant in Stafford, Texas to serve the residents of Harris, Brazoria, and Fort Bend Counties with treated surface water. This alternative has the apparent low present worth cost. A proposed facility plan for this alternative was addressed by the Texas Water Development in a report issued November 2000.

If the MBCPG members decide to construct a Mid Brazoria County Regional Water Plant and not participate in a larger regional water plant, it is our recommendation to construct a 25 MGD high-rate conventional surface water treatment plant near Manvel, Texas. Under this alternative, a high rate conventional water treatment plant at the Manvel plant site with an initial capacity of 15 MGD and an ultimate capacity of 25 MGD would be constructed. This section prepares a facility plan for this alternative to serve the growing water demands of the Participating Utilities through the year 2050, given the following regional operating strategy.

REGIONAL OPERATING STRATEGY

The demand projections are based on maintaining groundwater production at the current rate of 11.5 MGD. The water treatment plant capacity is sized to serve the difference between the expected average demand and current groundwater production. The Participating Utilities will provide the infrastructure to meet peak daily demand and to provide water over and above their maximum regional surface water treatment and groundwater capability to meet daily fluctuations in demand.

CAPITAL IMPROVEMENT PROGRAM

The recommended capital improvement programs to design, construct, and operate a regional water treatment plant and associated transmission facilities will utilize phased construction to match expected surface water demand. This plan assumes that the surface water conversion will be initiated in planning area by the year 2010 and that the current groundwater withdrawal will maintain the aquifer level and quality at current standards.

The first phase will involve engineering and construction for a 15 MGD high-rate conventional water plant and the associated water transmission network. This will meet the projected surface water demand through the year 2030. It is recommended that the entire finished water transmission network be constructed during this phase to minimize future expansion and cost. The design and construction for this phase will require approximately four to five years.

The second phase of the project would expand the treatment plant capacity from 15 MGD to 25 MGD. According to the Participating Utility water demand projections, expansion will be required by the year 2030 to meet expected water demand. The construction for the expansion will require to approximately two years.

FACILITIES DESCRIPTION

The facilities to be constructed fall in to three distinct construction packages: water treatment plant, raw water delivery system, and finished water transmission. Each package will be discussed in detail.

Water Treatment Plant

The water treatment plant will be located at the Manvel site and will encompass approximately 50 acres. The site will be fenced and access monitored through a front gate. The site will have a storage reservoir, process equipment and administration and maintenance facilities. The process design will utilize a high-rate conventional process with pulsed upflow clarifiers and deep bed, dual media filters. The process flow diagram for the plant is shown on **Figure 8-1**.

Raw water will stored in a 15 feet deep forebay. Water will then be pumped out of the storage reservoir using vertical turbine pumps to the pulsed-upflow clarifiers after injection of coagulation chemicals. The clarifier effluent will flow through dual media filters containing granular activated carbon. Provisions are made in the site layout for the addition of a future disinfection contact chamber, as future regulations require stricter finished water quality. From the filters, chemicals will be added to control corrosion and provide residual disinfection in the transmission lines and the finished water will be stored in ground storage tanks. High service pumps will then distribute finished water to the take points through the potable water transmission pipelines. Five high service pumps in phase one and two in phase two will be dedicated to provide finished water to the Participating Utilities

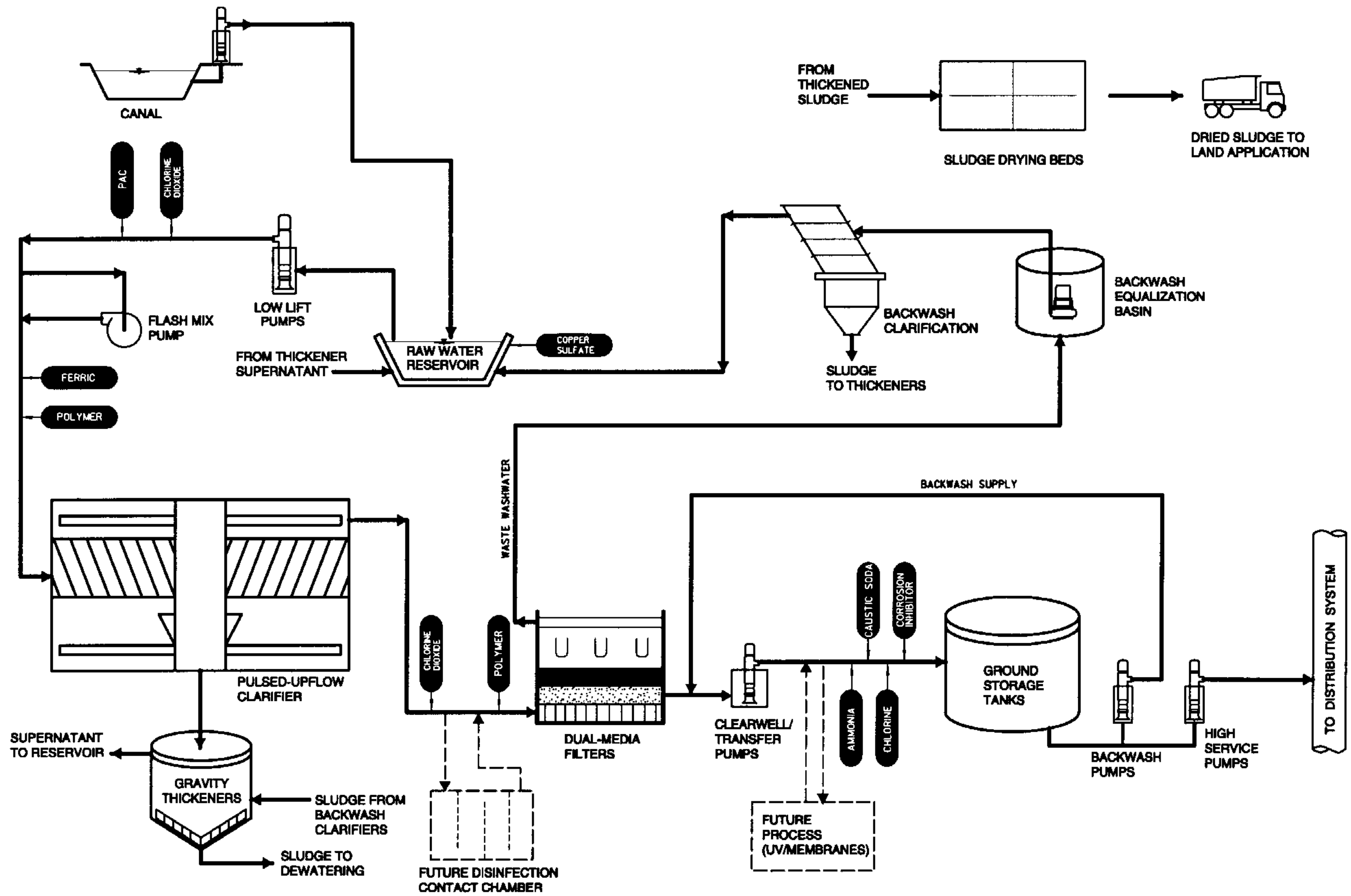
Sludge will be treated through gravity thickeners and sludge drying beds to increase the solids content, thereby decreasing the net volume of sludge requiring ultimate disposal off-site. Design criteria and preliminary sizing of the major process equipment is shown in **Appendix D**. A proposed layout of the major process trains and ancillary facilities are shown on **Figure 8-2**. Facilities shown with dashed lines are future processes and will be built as part of the expansion in the year 2030 or as future regulations require. The layout was designed to maximize common wall construction and to allow for flexibility for additional processes to meet future changes in treatment regulations.

Raw Water Delivery System

Region H has identified the Brazos River as the raw water source for this regional surface water facility. To carry water from the river to the Manvel plant site, the study evaluated the following three alternative mechanisms:

- Gulf Coast Water Authority (GCWA)
- Brazos River Authority (BRA)
- Chocolate Bayou Water Company (CBWC)

An analysis of the economics associated with these three options was developed in Section 7. This cost analysis was based on assumptions regarding the relative availability and stated cost of raw water. Each aforementioned entity has conditions and requirements regarding sale or purchase of raw water which will impact the overall cost of the raw water for this project. Even with the expected variability in the raw water costs, the evaluation showed that the BRA option is significantly less cost effective than the GCWA or CBWC alternatives. The analysis also showed that with the stated assumptions, the overall economic cost of the CBWC and GCWA alternatives were within the variability of the cost estimates. It is recommendation that the MBCPG negotiate with both CBWC and GCWA to develop a raw water option contract to bring Brazos River water for potable use in the Mid-Brazoria Region. This contract would enable the MBCPG to further solidify the costs associated with bring raw water to the area and would secure raw water availability when the MBCPG is ready to augment their current groundwater supply with treated surface water. Due to the high degree of variability associated with the cost of the CBWC raw water due to potential sale of their water rights to an outside entity, the facility plan will include the GCWA alternative as the raw water transportation mechanism for the regional water plant. ***The GCWA option for raw water cost analysis is presented as the baseline known costs for raw*** w:\proj\alvin\report\figure 8-1.dgn 10 SEP 2001 15:25:25



MONTGOMERY WATSON

MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

HIGH-RATE CONVENTIONAL PROCESS SCHEMATIC

FIGURE 8-1

water for this study and is an aid for the Planning Group to negotiate with other entities. This does not in any way preclude the Planning Group members to negotiate for raw water from other entities.

Finished Water Transmission System

From the 25 MGD water treatment plant at the Manvel site, the finished water will be delivered to the Participating Utility take points through the transmission network shown in **Figure 8-3**. The network is designed to deliver finished water at pressure. The utilities will take water at a system pressure of 50 psi and will feed water directly into their distribution system. A summary of projected water demands at utility take points is shown in the **Table 8-1**.

TABLE 8-1
REQUESTED FLOW AT UTILITY TAKE POINTS

Participating Utility	Take Point Number	Address	Average Water Demand (MGD)
City of Manvel	1	Iowa Lane and Hwy 6, Manvel TX	3.77
City of Pearland	2a	SH 288 at 518, Pearland TX	13.66
City of Brookside Village	3a	Garden Road and Brookside Road	0.57
City of Alvin	4a	SH 6, north of Mc Cormick Road	4.13
City of Hillcrest Village	4a	Same as City of Alvin take point	0.07
City of Iowa Colony	5	At the intersection of County Road 64 and Iowa School Road	0.24
City of Danbury	6	5th Street at St. Spur 8	0.48
City of Angleton	7	At the intersection of Henderson Road and Krankawa Road in the North part of the City	2.45

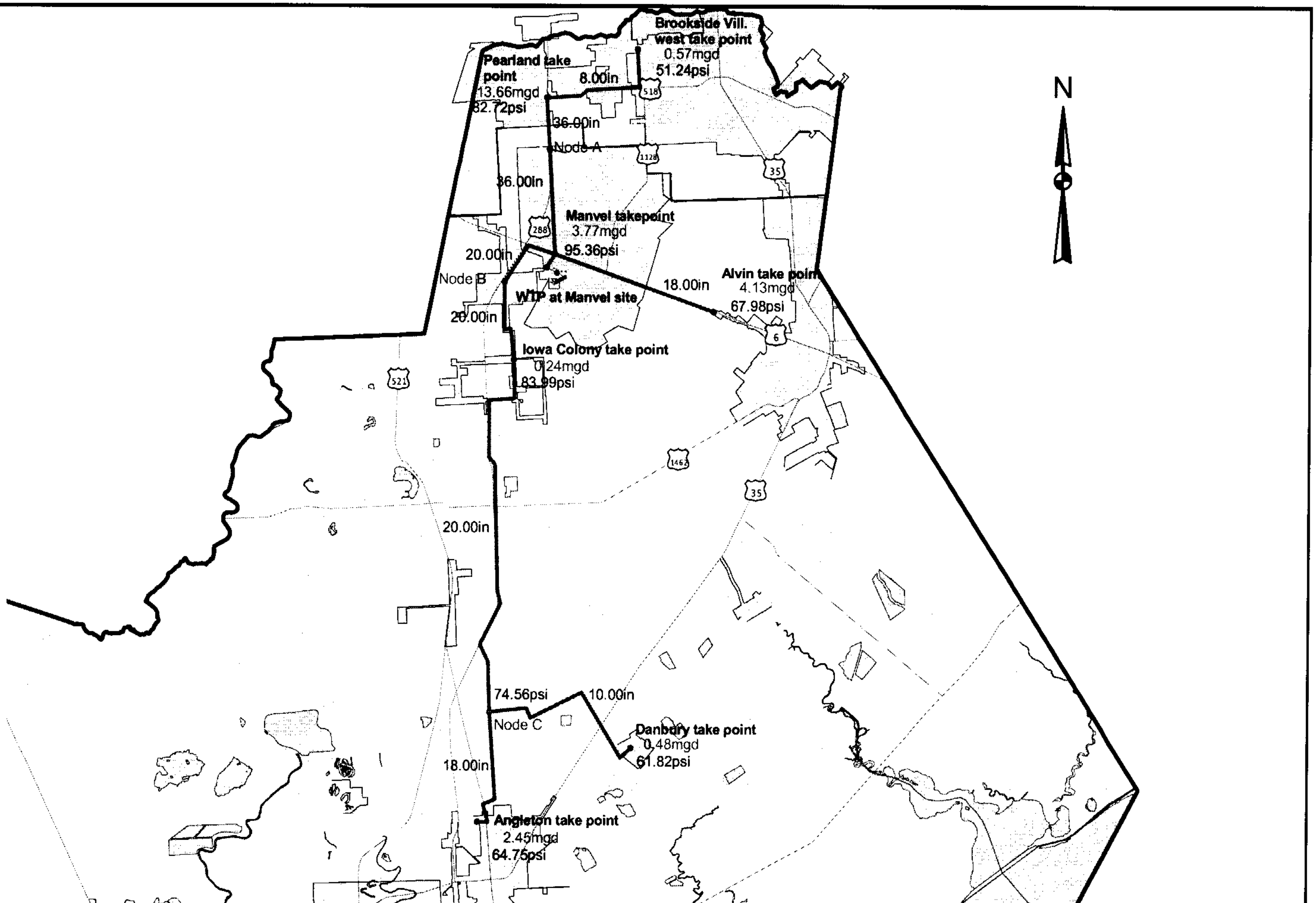
Water Treatment Plant Operations

The water treatment plant will be operated and maintained by the MBCPG. MBCPG will monitor the water quality, make treatment process adjustments, maintain distribution system pressure, and maintain the water treatment and transmission facilities.

Staffing Plan

The plant will be staffed 24 hours per day. The following staff will be required for operation and maintenance of the water plant and finished water transmission network.

- Process Operators– 6
- Electricians and Instrument Technicians – 2
- Maintenance – 3
- Administration – 1
- Plant Superintendent – 1



MID-BRAZORIA COUNTY PLANNING GROUP/TWDB
FACILITY PLAN

FINISHED WATER MODEL RESULT FOR
SITE A IN MANVEL AT PRESSURE

FIGURE 8-3

The plant operations will be divided into three shifts. Two operators will cover the day and swing shifts, with one operator on the night shift. Maintenance and electrical staff will serve as backup operators to handle vacations and sick days. The maintenance and electrical crews will provide O&M services on the raw water delivery system, water treatment plant facilities, and finished water transmission system.

The operators will handle daily laboratory functions for process adjustments at the new plant.

Operations Control

The regional water plant will be controlled through a Supervisory Control and Data Acquisition (SCADA) system. The SCADA system will provide a platform that will not only provide monitoring and control of the operation facilities, but also provide an interface to other applications including:

- Maintenance management system,
- Electronic operation and maintenance manuals,
- Laboratory information management system,
- Advanced operational strategies and planning through water system hydraulics and water quality models,
- Energy management system,
- Facilities security and protection through a Site Security and Video Surveillance System, and
- Management information system.

UTILITY SERVICE CONCEPTS

Electrical

The plant will require electrical service to power the water plant facilities, including low lift pumping, high service pumping, and plant process equipment. It is estimated that the daily electrical demand for a 25 MGD plant will be approximately 20 MW. We recommend that this demand be met through redundant substation feeds from a local electrical utility provider. Conversations with Reliant Energy indicate that power for the plant could be obtained from the Karsten and Manvel substations, thereby provided redundant feeds.

Sanitary

We recommend that the water treatment plant wastewater be collected and transported to the City of Manvel wastewater treatment plant. Normal wastewater production at the plant will be less than 500 gallons per day with maximum daily production in the range of 2000 gallons per day.

Sludge Processing

Sludge processing at the plant will consist of gravity thickeners and sludge drying beds. The resulting sludge cake will have a solids content of approximately 45 percent. Once the sludge is adequately dried, the sludge will be hauled off-site by third party vendors for land application. Conversations with various vendors indicate that the cost for hauling and disposing of the centrifuge sludge will be approximately $325 per truckload. As each sludge drying bed holds 320 cubic yards of dried sludge. As each truck can hold 22 cubic yards, approximately 15 truckloads of sludge will be produced each month.

Transportation

The Manvel site is located adjacent to Highway 6 just east of State Highway 288. These thoroughfares are more than sufficient to support chemical delivery trucks, sludge trucks, and general operations associated with the plant. A truck scale should be installed inside the water treatment plant site to gauge chemical deliveries and sludge disposal.

Storm Sewer Management

It is anticipated that storm water from the site will be collected and discharged into Chocolate Bayou. Permits from the Brazoria County Drainage District and TNRCC will be required.

OPINION OF PROBABLE COSTS

Construction

A summary of the preliminary opinion of probable construction costs for the recommended facility plan is shown in **Table 8-2**. The costs for the major process components, the raw water delivery system, and the finished water pipelines are provided. These costs are reported in year 2000 dollars and will have to be adjusted for the actual cost in the year of construction. As the design of the facility advances, the level of contingency may be reduced. Without contingency, the estimated capital cost for the first phase of the project, including raw water delivery improvements, water treatment plant, and finished water pipelines is $47 million. The estimated capital cost for the 10-MGD expansion by the year 2030 is $10 million. With a 35 percent contingency, the estimated capital costs for the first phase of construction and the year 2030 water treatment plant expansion are $63 million and $13 million, respectively for the first phase of construction and the year 2030 water treatment plant expansion. A breakdown of these unit costs by construction package, engineering, and contingency for the 25 MGD facility is shown in **Figure 8-4.**

FIGURE 8-4
UNIT COST OF 25 MGD SURFACE WATER FACILITY

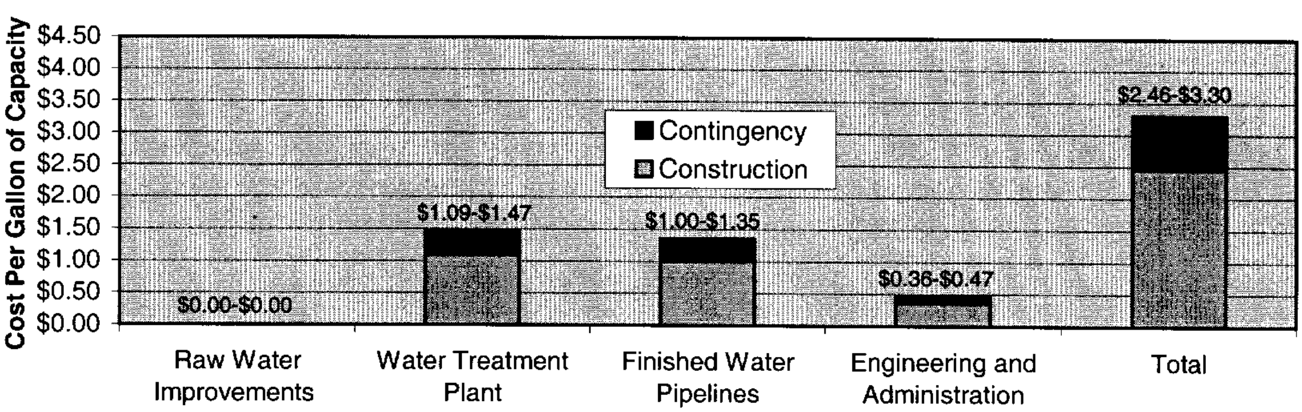


TABLE 8-2
PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

ITEMS	COST ($, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant		
Property	$700,000	-
Flood Plain Mitigation	$60,000	-
Sitework	$3,500,000	-
Yard Piping	$1,275,000	$850,000
Low Lift Pumping	$660,000	$132,000
Mixing/Flocculation/Sedimentation	$655,000	$515,000
Filters	$4,100,000	$1,367,000
Transfer Pumping	$660,000	$120,000
PAC System	$250,000	-
Backwash Equalization Tank	$232,000	-
Backwash Clarification	$53,000	$53,000
Gravity thickeners/holding tanks	$8,000	$8,000
Chemical Systems, Building, Tanks	$3,850,000	$1,485,000
Sludge lagoons	$592,000	$296,000
Ground Storage Tanks	$1,600,000	$1,200,000
Electrical, Instrumentation, and Controls	$2,267,000	$783,000
Mobilization	$591,000	$204,000
Construction Mgmt, Insurance, Bonds, Profit	$2,638,000	$912,000
Sub Total	$23,691,000	$7,925,000
Finished Water Transmission		
High Service Pump Station	$840,000	$560,000
Booster Pump Station and Ground Storage	$1,848,000	$1,232,000
Pipelines	$19,820,000	-
Easements	$760,000	-
Sub Total	$23,268,000	$1,792,000
Raw Water Improvements[1]	*$-*	*$-*
Sub Total	$-	$-
Construction Total	$46,959,000	$9,717,000
Engineering Contingency (10%)	$4,700,000	$ 970,000
Construction Contingency (5%)	$2,350,000	$ 490,000
Cost Contingency (20%)	$9,390,000	$1,940,000
Subtotal	$16,440,000	$3,400,000
Engineering	$9,510,000	$1,970,000
Construction Administration	$3,170,000	$ 660,000
MBCPC Administration	$1,900,000	$ 390,000
Total Capital	$77,979,000	$16,142,000

1. GCWA Raw Water Alternative

Therefore, the capital outlay for the first phase is estimated to be between $2.46 and $3.30 dollars per gallon of capacity constructed, including water treatment plant, finished water pipelines, raw water delivery improvements, engineering, construction oversight and contingency.

Operating and Maintenance

The estimated operating and maintenance costs for the water treatment plant, raw water delivery system, and finished water transmission are shown in **Table 8-3**. Annual operating costs over the first 20 years of operation will be $4.3 million, with annual O&M costs jumping to $6.1 million after the expansion in the year 2030. This cost represents a unit cost of $0.78 per 1000 gallon produced during the first 20 years and a unit rate reduction to $0.67 per 1000 gallon after the plant is expanded to its ultimate capacity of 25 MGD.

TABLE 8-3
PRELIMINARY OPINION OF ANNUAL O&M COSTS

Category	Annual O&M Costs (YR 2000 $)	
	Year 2010-2030 Flow = 15 MGD	Year 2030-2050 Flow = 25 MGD
Electrical		
Raw Water	-	-
Plant Process	$269,000	$363,000
High Service Pumps	$282,000	$470,000
Sub Total	$551,000	$833,000
Chemical	$1,043,000	$1,738,000
Sludge Disposal	$74,000	$123,000
Maintenance		
Raw Water	-	-
Plant Process	$390,000	$525,000
Finished Water	$88,000	$90,000
Sub Total	$478,000	$615,000
GAC Replacement	$350,000	$583,000
Staff	$718,000	$770,000
Administration	$600,000	$600,000
Cost of Raw Water	$422,000	$703,000
Total Annual O&M		

Funding Mechanism

Funding for the project will be based on grants, loans from the TWDB, revenue bonds based on the sale of water, or taxes depending on how the Authority is structured to finance projects.

Resource Management Authority

To implement a regional water treatment and transmission system for the Mid Brazoria County Participating Utilities, the members of the MBCPG will need to join or form an authority with the means to control, store, preserve, and distribute water for domestic and commercial purposes. Moreover, this Authority must have legal power to contract for water of Texas and should have entitlement to incur debt to finance and operate the regional facilities. A review of available alternative for use by the MBCPG to implement can be viewed in **Appendix B**. It is our recommendations that the MBCPG work with their legislators to develop and implement a regionally acceptable Authority with the power to negotiate a raw water contract or sale to facilitate the possibility of implementing this or a larger regional facility plan.

Section 9
Projected Wholesale Rates

The cost of constructing, operating, and maintaining the regional surface water treatment and transmission program as presented in Section 8, will be shared by the Participating Utilities. This section reviews the estimated capital and O&M costs, available funding mechanisms, and projected water demand to estimate a wholesale water rate for the planning region. The wholesale water rate analysis is based on the treatment plant located at site A in the City of Manvel. It should be noted that all economic rates presented in this section are for planning purposes only and do not represent final rates that Participating Utilities will pay for wholesale water. This section assumes that the MBCPG will finance, construct, and operate the new regional water facilities.

The construction costs for the water plant, transmission network, and canal raw water costs will be borne by each of the Participating Utilities based on their contracted reserve capacity. O&M costs will be based on each Participating Utility's wholesale water bill.

Capital Debt Retirement

It is anticipated that the MBCPG would secure grants or bonds in the amounts necessary to finance the initial construction of the water treatment plant, transmission network, and raw water improvements. Thirty-year financing will provide funding for debt and MBCPG administration costs associated with the revenue bonds needed to construct the project. Prorated capital debt service for each Participating Utility will be fixed throughout the lifespan of the bond. Prorated rates will be based on the amount of contract water purchased and the extent of infrastructure constructed to transport finished water to the individual Participating Utilities.

The total capital debt retirement costs associated with design and construction of raw water improvements, water treatment plant, and transmission network are uniformly distributed to each Participating Utility. Uniformly distributed costs are based on relative percentage of capacity that each Utility "reserves" in the regional water plant. Each Participating Utility pays the same debt service rate associated with constructing the water plant, raw water improvements, and transmission network. This cooperative type plan allows potential utilities in outlying areas to participate in the regional water supply facility at the same rate as the utilities located much closer to the facility. By adding more participating utilities, the design capacity of the regional water plant becomes larger and a unit capital and O&M cost savings can be realized because of the economy of scale.

WHOLESALE WATER RATES

Wholesale water rate analysis has been performed to project the wholesale water rates. The analysis is based on the following assumptions:

- The facility plan presented in Section 7 will serve the region through the year 2050.
- All numbers presented in the rates are Year 2000 dollars.
- The financial debt service rates are calculated at an estimated interest rate of six percent and a debt service period of 30 years.
- Rates for debt service such as water plant and distribution network construction will be based on Participating Utilities' contract reserve capacity (i.e. the debt service will be applied to each Utility's contracted reserve capacity).
- O&M rates will apply to actual water use (take-or-pay).

MBCPG will obtain grants (as available), loans, and sell bonds to construct a 15 MGD water treatment plant and transmission network in the year 2010. All Participating Utilities would pay the same wholesale water rate regardless of their location or reserve contract amount. The estimated wholesale water rate that each utility would pay under this scenario is $1.82 per 1,000 gallons, and is presented in **Table 9-1**. The annual debt service payment till the year 2030 will be $5,573,148.

TABLE 9-1
ESTIMATED WHOLESALE WATER RATE ($/1000 GALLONS)
INITIAL 15 MGD PHASE - YEAR 2010

Customer	Reserve Capacity Rate			Take or Pay Rate	Estimated Total Rate
	Debt Service Water Treatment Plant and Transmission Network	Raw Water Cost	Subtotal Reserve Capacity	O&M	
Utilities in Planning Region	$1.02	$0.10	$1.12	$0.70	$1.82

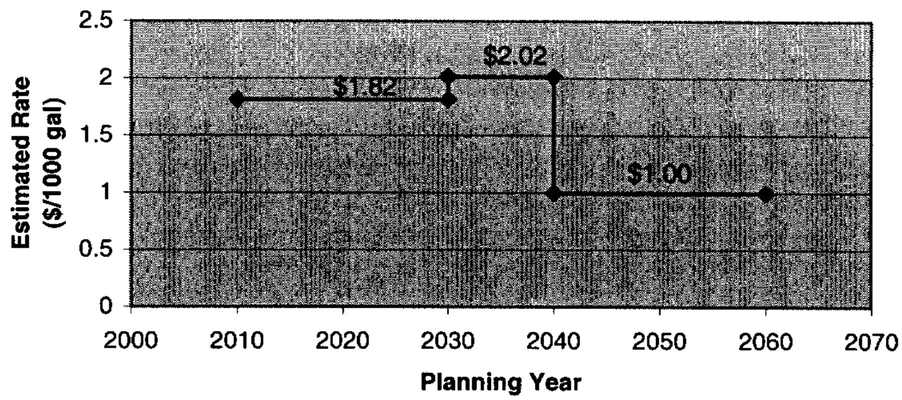
At year 2030, the plant would undergo an expansion to 25 MGD. **Table 9-2** shows the estimated impact to wholesale water rates under the expanded plant. The estimated wholesale water rate for this phase is $1.00 per 1000 gallons, while the annual debt service payment from the year 2030 onwards will be $1,172,196.

TABLE 9-2
ESTIMATED WHOLESALE WATER RATE ($/1000 GALLONS)
10 MGD PLANT EXPANSION - YEAR 2030

Customer	Reserve Capacity Rate			Take or Pay Rate	Estimated Total Rate
	Debt Service Water Treatment Plant	Raw Water Cost	Subtotal Reserve Capacity	O&M	
Utilities in Planning Region	$0.32	$0.10	$0.42	$0.58	$1.00

Figure 9-1 shows the estimated wholesale water rates for planning purposes as a function of time.

FIGURE 9-1
ESTIMATED WHOLESALE WATER RATE



GCWA Regional Plant Alternative

These wholesale water rates calculated for the treatment plant located in the City of Manvel, can be compared to wholesale water rates that each utility would have to pay if finished water is taken from the GCWA plant located in Fort Bend County.

The estimated wholesale water rate that each utility would pay under this scenario is $1.85 per 1,000 gallons, and is presented in **Table 9-3**. The annual debt service payment till the year 2010 will be $6,687,681.

TABLE 9-3
ESTIMATED WHOLESALE WATER RATE ($/1000 GALLONS)
INITIAL 15 MGD PHASE - YEAR 2010

Customer	Reserve Capacity Rate			Take or Pay Rate	Estimated Total Rate
	Debt Service Water Treatment Plant and Transmission Network	Raw Water Cost	Subtotal Reserve Capacity	O&M	
Utilities in Planning Region	$1.22	$0.10	$1.32	$0.52	$1.85

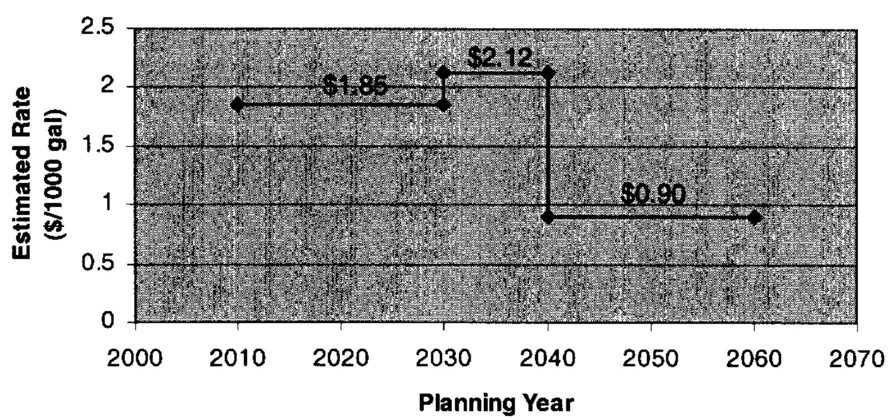
At year 2030, the plant would undergo an expansion to 25 MGD. **Table 9-4** shows the estimated impact to wholesale water rates under the expanded plant. The estimated wholesale water rate for this phase is $0.90 per 1000 gallons, while the annual debt service payment from the year 2030 onwards will be $1,072,674.

TABLE 9-4
ESTIMATED WHOLESALE WATER RATE ($/1000 GALLONS)
10 MGD PLANT EXPANSION – YEAR 2030

Customer	Reserve Capacity Rate			Take or Pay Rate	Estimated Total Rate
	Debt Service Water Treatment Plant	Raw Water Cost	Subtotal Reserve Capacity	O&M	
Utilities in Planning Region	$0.29	$0.10	$0.39	$0.51	$0.90

Figure 9-2 shows the estimated wholesale water rates for planning purposes as a function of time.

FIGURE 9-2
ESTIMATED WHOLESALE WATER RATE



Section 9
Projected Wholesale Rates

Summary

The wholesale water rate analysis conducted for the Participating Utilities shows that the wholesale water rates for water plant located at the Manvel site, and the for the GCWA water plant are comparable. A present worth analysis was conducted in Section 7, which showed that purchasing water from the GCWA and constructing a large diameter pipeline to serve the Participating Utilities was the most cost-effective alternative.

Appendix A
Bibliography

Bibliography

1. Texas Water Development Board: Region H Water Plan, January 2001. Prepared by the Joint Venture of Brown & Root and Turner Collie & Braden, Ekistics Corp. and LBG-Guyton Associates.
2. USGS Water Quality Monitoring Network Data – Station 08114000 Brazos River at Richmond, TX.
3. Regional Surface Water Treatment Plant Feasibility Study for Brazoria, Fort Bend, and Wet Harris Counties, Gulf Coast Water Authority, July 2000. Prepared by Montgomery Watson.
4. Chapter 26, Site Selection Plant Arrangement
5. Kawamura, Susumu, *Intergating Design of Water Treatment Facilities*, John Wiley and Sons, 1991
6. Brazoria County Texas, Soil Survey, United States Department of Agriculture.
7. Briscoe Production Company, Letter dated February 15, 2001.
8. Tuner Collie & Braden: Alternative Water Supply Study for Region H Water Planning Group, February 2001, letter report submitted to the Chairman of Region H.
9. Texas Constitution Article 16 – General Provisions, Section 59 "Conservation and Development of Natural Resources; Conservation and Reclamation Districts."
10. Texas Statues Water Code – Chapter 36 "Groundwater Conservation Districts" Subchapter A. General Provisions.
11. Texas Statues Water Code – Chapter 51 "Water Control and Improvement Districts" Subchapter A. General Provisions.
12. Texas Statues Water Code – Chapter 65 "Special Utility Districts" Subchapter A. General Provisions.

Appendix B
Water Conservation and Drought Contingency Plan; Resource Management Authority Alternatives.

Mid-Brazoria County Planning Group
Water Conservation Drought Contingency Plan

The Mid-Brazoria County Planning Group (MBCPC) was formed to investigate the feasibility of creating a regional water authority to provide wholesale surface water to its members. The planning study is partially funded by the Texas Water Development Board (TWBD). TWBD requires that entities for whom it provides planning grants must create a Water Conservation Plan (WCP) and a Drought Contingency Plan (DCP) as a part of the planning process. If it proves feasible for the MBCPC to become a wholesale water provider, it must formally create a water district. The MBCPC will be referred to as "the District" in this document. The WCP and DCP will be adopted by the District when it is formed.

The objective of a WCP is to conserve water supplies and reduce the quantity of water and wastewater that facilities must handle. WCPs promote policies and goals to achieve long-term water use reduction. The objective of a DCP is to establish temporary procedures to reduce water consumption for the duration of an emergency situation.

Service Area Description

The District will provide wholesale water for municipal use to Alvin, Angleton, Brookside Village, Danbury, Hillcrest, Iowa Colony, Manvel, and Pearland. These communities are all located in Brazoria County. The year 2000 population and average water demands as reported to TWBD by the Region H planning group are shown below in **Table 1.**

TABLE 1
YEAR 2000 POPULATION AND AVERAGE WATER DEMAND

Customer City	Year 2000 Planning Area Population	Year 2000 Average Day Water Demand (mgd)
Alvin	24,075	2.94
Angleton	23,870	2.89
Brookside Village	2,059	0.25
Danbury	1,870	0.22
Hillcrest	1,000	0.11
Iowa Colony	851	0.11
Manvel	5,152	0.63
Pearland	42,000	4.32
Total	100,877	11.47

Data regarding projected population and water use for the customer cities were collected from the TWDB, the Gulf Coast Water Authority (GCWA), and questionnaires provided to the cities.

The TWDB population and water use projections will serve as a basis for the State's Year 2002 Water Plan. For the WCP, TWDB Region H data will be used as the official projected population and water use for the planning area as shown below in **Table 2.**

TABLE 2
PROJECTED POPULATION FOR CUSTOMER CITIES

Customer City	2000	2010	2020	2030	2040	2050
Alvin	24,075	28,723	33,822	40,240	45,715	51,935
Angleton	23,870	28,737	34,037	40,661	46,773	52,884
Brookside Vill.	2,059	2,282	2,551	2,934	3,337	3,696
Danbury	1,870	2,174	2,442	2,802	3,079	3,381
Hillcrest	891	995	1,245	1,479	1,592	1,696
Iowa Colony	851	922	1,086	1,272	1,375	1,477
Manvel	5,152	6,084	7,080	8,352	9,412	10,606
Pearland	31,983	42,347	53,105	65,569	77,338	91,243
Total for Planning Area	90,751	112,264	135,368	163,309	188,621	216,918

The water demands used for this WCP are shown below in **Table 3**.

TABLE 3
PROJECTED AVERAGE WATER DEMAND (MGD)
FOR CUSTOMER CITIES

Participating Utility	2000	2010	2020	2030	2040	2050
Alvin	2.94	3.27	4.86	5.62	6.26	7.05
Angleton	2.89	3.28	3.68	4.23	4.73	5.34
Brookside Vill.	0.25	0.27	0.28	0.31	0.34	0.38
Danbury	0.22	0.24	0.25	0.27	0.30	0.32
Hillcrest	0.11	0.12	0.14	0.16	0.17	0.18
Iowa Colony	0.11	0.11	0.13	0.46	0.15	0.16
Manvel	0.63	2.23	3.11	3.57	3.91	4.40
Pearland	4.32	8.66	10.93	13.16	15.21	17.94
Total for Planning Area	11.47	18.18	23.37	27.78	31.07	35.77

The District will not provide wastewater service to its customers. Each customer city secures separate wastewater services. Therefore, the District will not have direct knowledge of wastewater generation in the potential service areas. The aim of the District is to develop a WCP that will conserve water on a wholesale basis.

Conservation Goals

The goal of a WCP is reduce water consumption. Reducing unaccounted-for water is the most direct contribution that a wholesale water provider can make to water conservation. Unaccounted-for water is the difference between the quantity of water that is withdrawn from a source of supply and the amount that is actually delivered to its customers. The goal of the District is to keep unaccounted-for water less than 5 percent. Additional water savings proposed in the Texas Water Development Board's Region H Water Plan are shown in **Table 4**. These savings are projected to occur due to the use of Advanced Conservation practices mentioned below. In general, Advanced Conservation practices are those that are more aggressive in terms of the timing of their usage (pro-actively managed to occur at a sooner time) or the application of additional conservation practices.

TABLE 4
COMPONENTS OF MUNICIPAL WATER CONSERVATION SAVINGS

Area of Municipal Water Use Savings Potential	Expected Conservation Savings	Advanced Conservation Savings
Indoor Plumbing Savings	20.5 gpcd	21.7 gpcd
Seasonal Water Savings	7.0% of total seasonal use	20% of total seasonal use
Dry-Year Irrigation Savings	10.5% of dry year seasonal use	20% of dry year seasonal use
Other Municipal Savings	5% of total average year use	7.5% total average year use

Table 5 presents the estimated water savings accrued by using advanced conservation practices in residential complexes. It should be noted that these are maximum possible savings, which may be difficult to attain as most residential complexes already employ water saving devices like low-flow shower heads and faucet aerators.

TABLE 5
INDOOR PLUMBING SAVINGS (MGD)

Customer City	2000	2010	2020	2030	2040	2050
Alvin	0.52	0.62	0.73	0.87	0.99	1.13
Angleton	0.52	0.62	0.74	0.88	1.01	1.15
Brookside Vill.	0.04	0.05	0.06	0.06	0.07	0.08
Danbury	0.04	0.05	0.05	0.06	0.07	0.07
Hillcrest	0.02	0.02	0.03	0.03	0.03	0.04
Iowa Colony	0.02	0.02	0.02	0.03	0.03	0.03
Manvel	0.11	0.13	0.15	0.18	0.20	0.23
Pearland	0.69	0.92	1.15	1.42	1.68	1.98
Total savings for Planning Area	1.97	2.44	2.94	3.54	4.09	4.71

Table 6 presents the estimated savings in seasonal water use by using advanced conservation practices for the sum of all municipal utilities in the MBCPG.

TABLE 6
SEASONAL WATER SAVINGS (MGD)

Year	2000	2010	2020	2030	2040	2050
Total for savings Planning Area	0.46	0.53	0.61	0.71	0.81	0.93

Table 7 presents the estimated savings under the "other municipal savings" category as mentioned in **Table 4**.

TABLE 7
OTHER MUNICIPAL SAVINGS (MGD)

Customer City	2000	2010	2020	2030	2040	2050
Alvin	0.22	0.25	0.27	0.32	0.35	0.40
Angleton	0.22	0.25	0.28	0.32	0.35	0.40
Brookside Vill.	0.02	0.02	0.02	0.02	0.03	0.03
Danbury	0.02	0.02	0.02	0.02	0.02	0.02
Hillcrest	0.01	0.01	0.01	0.01	0.01	0.01
Iowa Colony	0.01	0.01	0.01	0.01	0.01	0.01
Manvel	0.05	0.05	0.06	0.07	0.07	0.08
Pearland	0.32	0.40	0.47	0.57	0.66	0.78
Total savings for Planning Area	0.86	1.00	1.14	1.34	1.51	1.73

Table 8 assigns a dollar value to the total estimated water savings mentioned above. These were calculated by using the water rates calculated in **Section 9**.

TABLE 8
ESTIMATED TOTAL SAVINGS ($)

Year	2000	2010	2020	2030	2040	2050
Total for savings Planning Area	$840,000	$1,013,000	$1,197,000	$1,429,000	$1,638,000	$1,882,000

Practices to Measure Water Diverted from Source and Delivered to Customers

The projected water source for the District is the Brazos River. Water will be diverted from GCWA's canal system and delivered to the District's plant site via a short side stream canal. At the water treatment plant, the water will be pumped into the plant process train. Flow will be measured at the diversion point from GCWA and at the raw water pump station.

Finished water will be delivered to the customer cities' take points via transmission mains. Flow will be monitored at the District's finished water pump station and at the take points.

Monitoring and Record Management Program

The District's flow meters will be monitored 24 hours per day by a SCADA system. The central monitoring location will be at the water treatment plant. The flow monitoring installations will be checked weekly unless greater frequency is warranted.

Records will be kept in accordance with TNRCC rules and regulations. Records will be retained in accordance with the records retention schedules issued by the Texas State Library and Archives Commission as provided by §203.041 (a)(2), Local Government Code.

Metering, Leak Detection, & Repair Program

In order to prevent loss of water through leaks in the District system, the District will:

- Test and calibrate all metering equipment.
- Purchase leak detection equipment and test the transmission system for leaks.
- Inspect the diversion canal for leaks or unauthorized withdrawals.
- Make timely repairs of leaks.

Contract Requirement of Customer Water Conservation Plan

Customers who enter into contracts for wholesale water service will be required to develop and implement a WCP. The customer WCPs will be required to use proven conservation strategies including:

- Consumer education

  The Participating Utilities will inform the customers of ways to conserve water. The following methods can be used to inform water users:

  - Periodic Newspaper Articles
  - Water Saving Brochure Handouts at billing office
  - Water Saving tips on water bills
  - Periodic mail outs of brochures on Water Saving Tips inside and outside the home
  - Assisting customers at their homes and business to help locate water leaks

  Suggestions on ways to save water which may be included in the information, are listed below

  A. Bathroom:

     1. Take a shower instead of taking a bath. Showers with low-flow showerheads often use less water.
     2. Install a low-flow showerhead that limits the flow from the shower to less than three gallons per minute.
     3. Take short showers and install a cutoff valve or turn the water off while soaping and back on again only to rinse.
     4. Do not use hot water when cold water will do. Water and energy can be saved by washing hands with soap and cold water; hot water should only be added when hands are especially dirty.
     5. Reduce the level of water being used in the bath tub by one or two inches if a shower is not available.
     6. Turn water off when brushing teeth until it is time to rinse.
     7. Do not let the water run when washing hands. Instead, hands should be wet, and water should be turned on again to rinse. A cutoff valve may also be installed on the faucet.
     8. Shampoo hair in the shower. Shampooing in the shower takes only a little more water than is used to shampoo hair during a bath and much less than shampooing and bathing separately.

9. When shaving, fill the lavatory basin with hot water instead of letting the water run continuously.

10. Test toilets for leaks. Add a few drops of food coloring or a dye tablet to the water in the tank, but do not flush the toilet. Watch to see if the coloring appears in the bowl within few minutes. If it does, the toilet has a silent leak that needs to be repaired.

11. Use a toilet tank displacement devise such as a plastic bottle that is filled with stones or water, recapped and placed in the toilet tank. These devices will reduce the volume of water in the tank but will still provide enough for flushing. (Bricks are not recommended since they will crumble and could damage the working mechanism.) Displacement devices are not recommended with new low-volume flush toilets.

12. Never use the toilet to dispose off cleansing tissues, cigarette butts or other trash. This wastes a great deal of water and also places unnecessary load on the sewage treatment plant or septic tank.

13. When remodeling a bathroom or building a new home, install a new low-volume flush toilet that uses only 1.6 gallons per flush.

14. Install faucet areators to reduce water consumption.

B. Kitchen:

1. Scrape the dishes clean instead of rinsing them before washing. There is no need to rinse unless they are heavily soiled.

2. Use a pan of water or place a stopper in the sink for washing and rinsing pots, pans, dishes and cooking implements, rather than turning on the water faucet each time a rinse is needed.

3. Never run the dishwater without a full load. This practice will save water, energy, detergent and money.

4. Use the garbage disposal sparingly or start a compost pile.

5. Keep a container of drinking water in the refrigerator. Running water from the tap until it is cool is wasteful. Both water and energy can be saved by keeping cold water in a picnic jug on a kitchen counter to avoid opening the refrigerator door frequently.

6. Use a small pan of cold water when cleaning vegetables, rather than letting the water run over them.

7. Use only a little water in the pot and put a lid on it for cooking most food.

8. Always keep water conservation in mind, and think of other ways to save in the kitchen. Small kitchen savings, from not making too much coffee or letting ice cubes melt in a sink, can add up in a years time.

C. Laundry:

1. Wash only a full load when using an automatic washing machine (32 to 59 gallons are required per load).

2. Whenever possible, use the lowest water level setting on the washing machine for light or partial loads.

3. Use cold water as often as possible to save energy and to conserve the hot water for uses that cold water cannot serve.

D. Appliances and Plumbing:

1. Check water requirements of various models and brands when considering purchasing any new appliance. Some use less water than others.

2. Check all water line connections and faucets for leaks. A slow drip can waste as much as 170 gallons of water each day, or 5,000 gallons per month.

3. Learn to repair faucets so that drips can be corrected promptly. It is easy to do costs very little, and can mean substantial savings in plumbing and water bills.

4. Check for hidden water leakage such as a leak between the water meter and the house. To check, turn off all indoor and outdoor faucets and water-using appliances. If the meter continues to run or turn, a leak probably exists and needs to be located.

5. Insulate all hot water pipes to reduce the delays (and wasted water) experienced while waiting for water to "run hot".

6. Do not set the heater thermostat is too high. Extremely hot settings waste water and energy because the water often has to be cooled with cold water before it can be used.

7. Use a moisture meter to determine when houseplants need water. More plants die form over-watering than from being on the dry side.

E. Out-of-door Use:

1. Water only when needed. Look at the grass, feel the soil, or use a soil moisture meter to determine when to water.

2. Do not over-water. Soil can absorb only so much moisture, and the rest simply runs off. A timer will help, and either a kitchen timer or an alarm clock will do. One and a half inches of water applied once a week in the summer will keep most of Texas grasses alive and healthy.

3. Water lawns early in the morning during the hot summer months. Other wise, much of the water used on the lawn can simply evaporate between the sprinkler and the grass.

4. To avoid excessive evaporation, use a sprinkler that produces large drops of water rather than a fine mist. Sprinklers that send droplets out on a low angle also help control evaporation.

5. Set automatic sprinkler systems to provide thorough, but infrequent watering. Pressure regulation devices should be set to design specifications. Rain shut off devices can prevent watering in the rain.

6. Use drip irrigation systems for bedded plants, trees, shrubs, or turn soaker hoses upside down so the holes are on the bottom. This will help avoid evaporation.

7. Water slowly for better absorption, and never water on windy days.

8. Position sprinklers and hoses so they will not be watering the streets or sidewalks.

9. Condition the soil with mulch or compost before planting grass or flower beads so that water will soak in rather than run off.

10. Fertilize lawns at least twice a year for root stimulation, but do not over fertilize. Grass with a good root system makes a better use of less water and is more drought tolerant.

11. Do not scalp lawns when mowing during hot weather. Taller grass holds moisture better. Grass should be cut fairly often, so that only ½ to ¾ inch is trimmed off.
12. Use a watering can or hand water with the hose in small areas of the lawn that need more frequent watering.
13. Use water-wise plants. Choose plants that have low water requirements, are drought tolerant, and are adapted to the area where they are to be planted.
14. Consider decorating some areas of the lawn with wood chips, rocks, gravel, or other materials now available that require no water at all.
15. Do not "sweep" walks and driveways with the hose. Use a broom or rake instead.
16. When washing the car, use a bucket of soapy water and turn on the hose only for rinsing.

- Water conservation plumbing codes
- Water conservation rate structures

  A water rate structure that encourages water conservation will be implemented. An example of this is using an increasing block rate method to determine the monthly water bill.

- Universal metering and meter maintenance program
- Leak detection and repair
- Water conservation plumbing retrofit program

  This measure will involve the distribution of low-flow showerheads, toilet tank dams, and leak detection tablets to residents.

  Homes built before 1980 generally do not have low flow showerheads, low flush toilets or faucet operators. In Texas, the state has required 1.6 gpf toilets, 3.0 gpm showerheads, and 2.5 gpm faucets since 1992. To promote indoor water conservation, the homeowners would be given retrofit kits with sufficient equipment and instructions to retrofit two bathrooms. Retrofit kits would contain easy-to-install low flow showerheads, faucet aerators, and toilet tank retrofit devices. Customers in existing buildings that do not have water saving devices will be encouraged to replace their old plumbing fixtures.

- Appliance Labeling

  An appliance-labeling program would provide customers with point-of-purchase information, including an equipment tag, similar to the Appliance Energy Efficient programs operated by electric utilities. Water efficient appliances would receive a distinguishing label so that they stand out on the retail sales floor. The tag would also show how each appliance compares with others in its category. The MBCPG would have to work closely with appliance manufacturers and electric and gas utilities to develop equipment tags. Dealers would be trained to use the labels and point-of-purchase materials. The MBCPG would then mount a campaign encouraging customers to buy water saving appliances.

- Water-efficient landscaping

  This program will offer incentives to new and existing single- and small multifamily customers to install water-efficient landscaping and irrigation systems. Multifamily customers with more than three acres of turf could qualify for one of the other nonresidential audit/rebate programs.

Incentives could take the form of rebates for replacing turf with water-efficient landscaping. Suggested rebates could be made available for each of the items below.

- New landscaping with a limit on the amount of turf.
- Relandscaping involving turf removal.
- If the customer chose to install an in-ground irrigation system to serve new turf areas, the system would be designed with low-precipitation-rate sprinkler heads that achieve 100 percent coverage and include a controller that allows three irrigation cycles per day.
- If the customer was removing turf to earn a rebate, and if an in-ground irrigation system was already in place, the system would be modified so the valves serving any remaining turf and the valves serving the new low-water-conserving landscaping would be on separate stations.

Drought Contingency Plan

DCPs are necessary to conserve water supplies for the highest priority uses in times of shortage and to preserve the water necessary for human sustenance. Drought conditions are usually the result of extended periods of below average rainfall, but could result from equipment failure. This plan will provide an orderly procedure for the curtailment of water to customer cities.

Public and Agency Involvement

The provisions of the DCP will apply to all customers of the District. Before implementing the plan, the District will afford its customers an opportunity to comment by:

- Furnishing a copy of the draft plan for comment
- Conducting a public meeting on the draft plan
- Publishing notices in area newspapers about the public meeting

The District service area is located within Region H Water Planning Group. The adopted DCP will be furnished to the planning group.

Triggering Conditions and Response Stages

Drought triggers for individual customer cities and the corresponding responses will be as follows:

- ***Mild drought*** will be initiated by water use equal to or greater than 85 percent of customer's average contract quantity for 5 consecutive days. The District will:
  - Notify the customer of the drought condition level.
  - Require the customer to begin their DCP for a mild condition.
  - Require that the customer publish an article in the local newspaper and issue a press release to the electronic media.
- ***Moderate drought*** will be initiated by water use equal to or greater than 90 percent of the customer's average contract quantity for 4 consecutive days. The District will:
  - Notify the customer of the drought condition level.
  - Require that the customer begin their DCP for a moderate condition.
  - Require that the customer publish an article in the local newspaper and issue a press release to the electronic media.

- Monitor the customer's DCP response.

- ***Severe drought*** will be initiated by water use equal to or greater than 95 percent of the customer's average contract quantity for 3 consecutive days. The District will:
  - Notify the customer of the drought condition level.
  - Require the customer to begin their DCP for a severe condition.
  - Require the customer to publish an article in the local newspaper and issue a press release to the electronic media.
  - Monitor the customer's DCP response.
  - Allocate water as needed.
- ***Critical drought*** will be initiated by water use equal to or greater than 100 percent of the customer's average contract quantity for 3 consecutive days. The District will:
  - Notify the customer of the drought condition level.
  - Require the customer to begin their DCP for a critical condition.
  - Require the customer to publish an article in the local newspaper and issue a press release to the electronic media.
  - Request strict enforcement of the DCP by the customer.
  - Monitor the customer's DCP response.
  - Allocate water as needed.

System-wide triggers will be based on water levels in the lower Brazos River. This information will be obtained through GCWA. System wide drought triggers are as follows:

- ***Normal, wet conditions.***
  - Hempstead Gage stage greater than or equal to 14.00 feet or 2200 cubic feet per second (cfs).
  - Richmond Gage stage greater than or equal to 12.19 feet or 1700 cfs.
- ***Mild drought conditions.***
  - Hempstead Gage stage less than or equal to 13.71 feet or 2000 cfs.
  - Richmond Gage stage less than or equal to 11.93 feet or 1500 cfs.
- ***Moderate drought conditions.***
  - Hempstead Gage stage less than or equal to 13.41 feet or 1800 cfs.
  - Richmond Gage stage less than or equal to 11.65 feet or 1300 cfs.
- ***Severe drought conditions.***
  - Hempstead Gage stage less than or equal to 12.93 feet or 1500 cfs.
  - Richmond Gage stage less than or equal to 11.23 feet or 1000 cfs.

In the event that a system-wide drought stage is triggered, all customer cities will be required to respond according to the corresponding individual system responses.

Termination of Drought Response Stages

Individual customer drought response stages will be terminated by the District when customer water use is reduced to less than 85 percent of average contract values for 3 consecutive days. The District will notify the affected customer city when drought conditions are terminated.

System-wide drought response stages will be terminated when river levels return to normal conditions. The District will notify the customer cities when this condition has been reached.

Water Allocation Procedures

Water allocation procedures will begin when drought conditions reach the severe stage. At this stage customers may be restricted to 85 percent of their average contract amount. The customers may supplement their water use with their own groundwater wells.

Variances

The District may grant a temporary variance if implementation of water allocation procedures could cause an emergency condition affecting public health, welfare, or safety if one or more of the following conditions are met:

- Compliance with the plan cannot be technically accomplished.
- Alternative methods can be implemented which will achieve the same level of water reduction.

Customers requesting a variance from the DCP must file a petition with the District within 5 days after allocation procedures have been implemented. The petition must include the following information:

- Detailed statement of how the allocation adversely effects the petitioner.
- Description of the relief required.
- Period time for the variance is sought.
- Alternative measures that the petitioner proposes to implement.

Variances will include a timetable for compliance and will expire when allocation procedures are no longer in effect.

Enforcement

The provisions of the DCP shall be included in each customer contract. Failure of customers to comply may be subject to civil action to enjoin the non-compliant customers for breach of contract.

Plan Review and Revisions

The District will review and update the DCP at least every 5 years.

Reservoir Operations Plan

The District has no plans to construct or operate a reservoir.

Means for Implementation and Enforcement

The General Manager of the District or an appointed representative will act as the Administrator for the WCP. The Administrator will oversee the execution and implementation of the plan as well as all record keeping for the program. To initiate the WCP, the Board of Directors of the District will:

- Pass a resolution adopting the plan.
- Adopt an ordinance to implement the legal documents necessary to enforce the plan.

Mid-Brazoria County Planning Group
Resource Management Authority Alternatives

To implement a regional water treatment and transmission system for the Mid Brazoria County Participating Utilities, the members of the MBCPG will need to join or form an authority with the means to control, store, preserve, and distribute water for domestic and commercial purposes. Moreover, this Authority must have legal power to contract for water of Texas and should have entitlement to incur debt to finance and operate the regional facilities.

In addition to forming an Authority to implement and operate the required facilities, the MBCPG may also wish to evaluate groundwater conservation to ensure that this vital resource is protected to meet the MBCPG members existing and future demand.

Groundwater Protection

Under current Texas water law, surface water is controlled and allocated by the State of Texas. Groundwater, on the other hand, falls under the "rule of capture", where groundwater belongs to the entity that can capture it. Unless special legislature is enacted, groundwater in the State of Texas is unregulated and a private or public entity could install and operate a new water well to achieve the maximum production allowable by the underground conditions. Pumping by one particular well or well owner is not limited by the impact of that well or well owner on other adjacent wells. In essence, a well owner may pump as much water as feasible, even if that production level will decrease the water level in such a manner where adjacent wells will go "dry".

The Texas Constitution through Section 59 of Article XVI provides for the creation of groundwater conservation districts. More specifically, Section 59 reads:

"In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs of their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management."

Chapter 36 of the Texas Water Code stipulates the requirements for creation and management of a groundwater conservation district. This code provides for the establishment of authorities with the power to regulate spacing of water wells, the production from water wells, or both.

This section reviews the options available to the MBCPG to provide an Authority to manage, construct, and oversee this vital project.

A review of current Texas law indicates the following three general options available to the MBCPG:

1) Contract through an existing regional water control and improvement district with legal authority to construct, implement, finance, operate and maintain facilities necessary to provide potable water to the members of the Mid-Brazoria County Planning Group.

2) Create a new regional water authority to construct, implement, finance, operate, and maintain the regional water facilities

3) Create a non-profit water corporation to construct, implement, finance, operate, and maintain the regional water facilities

Contract with Existing Authority

Within the South Central Texas area, the Brazos River Authority (BRA) and the Gulf Coast Water Authority (GCWA) are existing regional water providers created by the legislature to conserve, transport and distribute water to public and private corporations. These entities are existing regional water providers that:

a) have legal authority to provide water to communities within the MBCPG,

b) have experience operating a surface water plant treating Brazos River water,

c) have sufficient bonding capabilities to finance the project.

A review of each of these existing political subdivisions follows:

Gulf Coast Water Authority

Gulf Coast Water Authority has the authority "to conserve, store, transport, treat and purify, distribute, sell and deliver water, both surface and underground, to persons, corporations, both public and private, political subdivisions of the State and others, and may purchase, construct, or lease all property, works, and facilities, both within and without the District necessary for such purposes" (59th Legislature, Chapter 712). The Gulf Coast Water Authority is headquartered in Texas City, Texas and currently operates numerous facilities including the Dr. Thomas Mackey Water Treatment Plant in Texas City, Texas which treats and distributes water diverted from the Brazos River to customers throughout the Gulf Coast Region.

Brazos River Authority

The Brazos River Authority was created by the Texas Legislature in 1929 with statutory authority to conserve and develop the surface water resources of the entire Brazos River basin in Texas, and make those resources available for all beneficial uses. The Brazos River Authority is headquartered in Waco, Texas and currently operates several water treatment plants along the Brazos river..

Create New Regional Authority

Section 59 of the Article XVI of the Texas Constitution authorizes the creation and operation of regional districts for water, sanitary sewer, drainage, and municipal solid waste disposal. Under this law, the MBCPG could create a regional authority to finance, manage, and operate the facilities to bring treated surface water to the area and conserve the existing groundwater resources. Creation of a new authority can be brought about by one of two general means. The MBCPG could follow the rules outlined under existing Texas Water Code to form an Authority charged with creating, managing, implementing, and operating a regional water treatment and distribution facilities, or the MBCPG could petition the State of Texas Legislature to promulgate the creation of a new district.

Creation of a New Authority under Existing Rules

Under the Texas Water Code, the state legislature has established rules for establishing new political subdivisions of the state charged with providing wholesale potable water. The Texas Water Code allows for the formation of the one of the following with power to control water of the State:

- Water Control and Improvement District (WCID), Texas Water Code Chapter 51
- Municipal Utility District (MUD), Texas Water Code Chapter 54
- Water Improvement District(WID), Texas Water Code Chapter 55
- Regional District (RD), Texas Water Code Chapter 59

Any authority created under one of the provisions of Texas Water Code would allow the MBCPG members to form a regional political subdivision of the State of Texas with the power to:

- Purchase, own, hold, lease, and otherwise acquire sources of water supply,
- Build, operate, and maintain facilities for the transportation of water, and
- Sell water to towns, cities, and other political subdivisions of this state, to private business entities, and to individuals.

Each District created under an existing Texas Water Code provision will have an elected board of directors and can own land, condemn property, and can furnish water for domestic, commercial, or industrial purposes. The difference in which legal framework a new Authority is created under depends on how the MBCPG wishes to structure the Authority. In general, the differences between the existing alternate types of Districts are the rules for District formation and the financial capabilities of the District.

District Formation

The following is a generalized list of steps required to formulate a new District under the Texas Water Code. The steps vary by which Authority the MBCPG would choose to form and a detailed list of general steps is presented below in Table 3-8. One assumption governing this table is that the land area to be included in the proposed district would fall within a single county and that no other district would encompass the same land. If the proposed district encompasses land in more than one county or includes land charted into another district of the same type, the steps towards Authority formation will include several additional steps, including final review and approval by the Texas Natural Resources Conservation Commission (TNRCC).

TABLE 3-8 - STEPS TO CREATING A REGIONAL WATER DISTRICT RULES UNDER EXISTING TEXAS WATER CODE PROVISIONS

	WCID	MUD	WID	RD
Petition by:	A petition for creation must be signed by at least 50 residents of the proposed district			Petition by County Commissioners
Initial Consideration by:	Consideration of Petition by County Commissioners (Single County District)	Resolution in Support by an City in the Proposed District	County Commissioner Approval for General Election	Resolution in Support by an City in the Proposed District
Review Authority:		Recommendation by County Commissioners		
Final Approval:	Confirmation Vote from Municipal Electors	TNRCC Board Approval	Confirmation Vote from Municipal Electors	TNRCC Board Approval

Financial Powers

By creating a District charged with providing wholesale water to the residents of the mid Brazoria County region, each region has rules for how the District can obtain operating and capital funds and who must approve expenditure of those funds. Each of the aforementioned existing District frameworks provides for the authority to levy ad valorem property taxes. Each type of District can issue debt through bonds backed either by property taxes or revenue form the facilities to be constructed with the bonds. Bonds backed by property taxes must be approved by a majority vote of the District residents. Revenue bonds may be issued by District Board Resolution, but are subject to certain provision under each type of District.

Under a WCID, the District is required to assess taxes until the District can prove, by showing 3 years of history, that revenue from facilities finances through the bonds can meet the debt on the structure without default. At that point, the WCID can suspend ad valorem taxes. If revenue falls short, taxes must be reissued to cover the debt of the financed facility. A MUD must receive TNRCC approval for any bond issuance covering a project that existing outside of an established municipality or City ETJ.

Legislate a New District

The MBCPG can proceed with the creation of a new regional water district under Section 59 of Article XVI of the Texas Constitution. The MBCPG would need to have a state legislator sponsor a bill in the State of Texas House or Senate hereby legislating the creation of the new district. Similarly, the Brazos River Authority and the Gulf Coast Water Authority were both created in this fashion. It is plausible that an Authority could be legislated for the mid-Brazoria County Region with the power to conserve and regulate groundwater usage and to conserve, transport and distribute water to public and private corporations. In having the legislature craft a bill creating a new authority, the legislature will include the powers of the new district including provisions for appointing or electing directors, funding mechanisms, reporting, and service area. Last, it is likely the legislature would consider the value of creating a new Authority within areas of an existing river authority, presumably overlapping an existing represented jurisdiction with the capability to already provide service.

Create Local Government Corporation

Chapter 67 of the Texas Water Code outlines provisions for the creation and operation of a nonprofit corporation with the authority to build, operate, and maintain water treatment and distribution facilities. The proposed corporation would make an application to the Secretary of the State in the same manner as a private corporation and would have the ability to issue bonds, notes, or warrants to finance any project. The corporation may contract with any political subdivision, federal agency, or other entity for the acquisition, construction, or maintenance of a project or improvement for an authorized purpose.

Alternative Summary

Table 3-9 summarizes the benefits and obstacles to creating and operating a regional water authority under one of the discussed alternatives. By contracting with an existing authority of the State of Texas, the MBCPG would not need to formulate any other regional district. If the MBCPG chooses to create a new district, it is recommended that a Regional District (RD) be formed under the Texas Water Code. As mentioned in **Table 3-8**, a RD can be formed with the least number of political steps. The RD requires the least amount of political support and does not require a municipal election. The RD will be self-sufficient and flexible. WCIDs and MUDs require municipal confirmation votes, thus additional time and political obstacles are encountered.

TABLE 3-9: RESOURCE MANAGEMENT ALTERNATIVES

Alternative	Advantages	Disadvantages
Contract with Existing Authority	• Existing Authority with power to implement and finance necessary improvements • No requirement for creation of another regional authority • Leverage Administration Costs Across Larger Area • Experience in O&M of Regional Water Treatment and Distribution Systems	• No Protection of Groundwater Sources • No Representation on Board
Create New District Under Existing Water Code Rules and Regulations	• No additional rules required to establish authority • Authority can be created with a petition, approval of county commissioners and voters of new District	• Require approval of voters • Perception of entity with unlimited taxing potential.
Create New Authority by Legislative Action	• Authority creation does not require petition or voter approval • Rules and governing provisions can be customized • Can establish power to regulate groundwater protection and potable water treatment and distribution	• Legislature may not pass bill creating new district • Legislature may not usurp existing river authority with capability to provide service.
Establish a Non Profit Water Corporation	• Creation through application to Texas Secretary of State • Can design, build, and operate water treatment and distribution facilities	• No Taxing Authority • No Authority to Regulate Groundwater Withdrawal • Borrowed money is not tax exempt and therefore usually carries higher interest rate

Appendix C
TWDB Population and Water Use Projections

POPULATION & CONSUMPTIVE WATER DEMAND FORECASTS
(Water use in acre-feet per year)
PREPARED BY TURNER COLLIE & BRADEN INC.

BRAZORIA COUNTY
MOST LIKELY GROWTH SCENARIO

Forecast Item	1990	2000	2010	2020	2030	2040	2050
ALVIN							
Population	19,220	24,075	28,723	33,822	40,240	45,715	51,935
1990 Use	2,589						
Below Normal Rainfall							
* Expected Conservation		3,290	3,668	4,092	4,733	5,274	5,934
Advanced Conservation		3,182	3,443	3,826	4,462	5,018	5,643
Normal rainfall							
Expected Conservation		3,020	3,378	3,751	4,327	4,762	5,410
Advanced Conservation		2,912	3,185	3,523	4,102	4,609	5,178
ANGLETON							
Population	17,140	23,870	28,737	34,037	40,661	46,372	52,884
1990 Use	2,015						
Below Normal Rainfall							
* Expected Conservation		3,235	3,670	4,117	4,737	5,298	5,983
Advanced Conservation		3,128	3,444	3,850	4,509	5,090	5,746
Normal rainfall							
Expected Conservation		2,887	3,219	3,621	4,190	4,622	5,272
Advanced Conservation		2,781	3,058	3,394	3,963	4,467	5,036
BAILEY'S PRAIRIE							
Population	634	735	758	769	812	857	903
1990 Use	89						
Below Normal Rainfall							
* Expected Conservation		108	106	102	104	106	110
Advanced Conservation		105	98	93	96	100	104
Normal rainfall							
Expected Conservation		102	99	96	97	99	103
Advanced Conservation		99	93	88	91	94	97
BRAZORIA							
Population	2,717	3,276	3,945	4,619	5,461	5,829	6,222
1990 Use	339						
Below Normal Rainfall							
* Expected Conservation		382	430	471	538	562	592
Advanced Conservation		371	402	434	508	535	565
Normal rainfall							
Expected Conservation		357	393	434	495	510	544
Advanced Conservation		341	371	404	465	489	516
BROOKSIDE VILLAGE							
Population	1,470	2,059	2,282	2,551	2,934	3,337	3,696
1990 Use	207						
Below Normal Rainfall							
* Expected Conservation		283	297	311	345	385	422
Advanced Conservation		274	276	285	322	362	397
Normal rainfall							
Expected Conservation		251	260	272	302	333	365
Advanced Conservation		242	242	251	283	318	348

CLUTE							
Population	8,910	10,445	12,963	15,169	17,936	19,144	20,433
1990 Use	1,282						
Below Normal Rainfall							
* Expected Conservation		1,579	1,830	2,039	2,351	2,466	2,609
Advanced Conservation		1,533	1,742	1,920	2,230	2,359	2,495
Normal rainfall							
Expected Conservation		1,381	1,597	1,784	2,049	2,123	2,266
Advanced Conservation		1,345	1,525	1,682	1,949	2,059	2,174
DANBURY							
Population	1,447	1,870	2,174	2,442	2,804	3,079	3,381
1990 Use	177						
Below Normal Rainfall							
* Expected Conservation		246	266	279	308	332	360
Advanced Conservation		236	245	255	286	310	338
Normal rainfall							
Expected Conservation		197	209	218	242	255	280
Advanced Conservation		189	195	203	227	244	266
FREEPORT							
Population	11,389	14,344	15,374	16,696	18,796	20,062	21,413
1990 Use	2,426						
Below Normal Rainfall							
* Expected Conservation		3,069	3,151	3,291	3,622	3,798	4,029
Advanced Conservation		2,989	2,997	3,086	3,432	3,640	3,862
Normal rainfall							
Expected Conservation		2,443	2,497	2,601	2,842	2,966	3,142
Advanced Conservation		2,377	2,376	2,450	2,737	2,876	3,046
HILLCREST							
Population	695	891	995	1,245	1,479	1,592	1,696
1990 Use	101						
Below Normal Rainfall							
* Expected Conservation		127	134	157	182	189	200
Advanced Conservation		121	123	144	169	178	186
Normal rainfall							
Expected Conservation		118	126	148	169	177	184
Advanced Conservation		115	116	135	157	166	175
HOLIDAY LAKES							
Population	1,039	1,423	1,833	2,264	2,782	3,256	3,811
1990 Use	141						
Below Normal Rainfall							
* Expected Conservation		175	203	231	274	314	363
Advanced Conservation		163	172	178	215	248	286
Normal rainfall							
Expected Conservation		158	181	203	240	274	320
Advanced Conservation		145	152	155	184	212	243

IOWA COLONY							
Population	675	851	922	1,086	1,272	1,375	1,477
1990 Use	95						
Below Normal Rainfall							
* Expected Conservation		123	128	143	161	170	178
Advanced Conservation		120	119	130	149	160	169
Normal rainfall							
Expected Conservation		118	121	135	152	159	169
Advanced Conservation		115	113	124	143	151	159
JONES CREEK							
Population	2,160	2,532	3,187	3,729	4,409	4,706	5,023
1990 Use	272						
Below Normal Rainfall							
* Expected Conservation		343	400	439	504	527	557
Advanced Conservation		332	371	401	469	496	523
Normal rainfall							
Expected Conservation		272	314	343	390	406	428
Advanced Conservation		261	293	313	365	385	405
LAKE JACKSON							
Population	22,776	27,171	32,034	37,429	44,287	50,046	56,555
1990 Use	3,266						
Below Normal Rainfall							
* Expected Conservation		3,683	4,091	4,528	5,208	5,717	6,461
Advanced Conservation		3,591	3,840	4,235	4,912	5,494	6,145
Normal rainfall							
Expected Conservation		3,591	3,948	4,360	5,011	5,549	6,208
Advanced Conservation		3,470	3,731	4,067	4,762	5,269	5,955
MANVEL							
Population	3,733	5,152	6,084	7,080	8,352	9,412	10,606
1990 Use	519						
Below Normal Rainfall							
* Expected Conservation		710	784	856	983	1,075	1,212
Advanced Conservation		687	730	785	917	1,013	1,140
Normal rainfall							
Expected Conservation		624	681	746	852	928	1,033
Advanced Conservation		601	634	690	795	886	986
OYSTER CREEK							
Population	912	1,205	1,266	1,482	1,752	1,870	1,996
1990 Use	130						
Below Normal Rainfall							
* Expected Conservation		185	184	204	234	245	259
Advanced Conservation		178	173	188	218	230	244
Normal rainfall							
Expected Conservation		147	146	161	183	191	201
Advanced Conservation		142	136	149	173	180	190

PEARLAND (P)							
Population	17,234	29,480	39,464	49,742	61,929	73,332	86,834
1990 Use	2,788						
Below Normal Rainfall							
* Expected Conservation		4,458	5,569	6,631	8,046	9,364	11,088
Advanced Conservation		4,293	5,217	6,129	7,562	8,871	10,408
Normal rainfall							
Expected Conservation		4,260	5,305	6,352	7,700	8,953	10,505
Advanced Conservation		4,128	4,995	5,850	7,215	8,461	9,921
RICHWOOD							
Population	2,732	3,203	4,170	4,959	5,961	6,797	7,750
1990 Use	294						
Below Normal Rainfall							
* Expected Conservation		377	448	505	588	647	738
Advanced Conservation		362	420	461	541	609	694
Normal rainfall							
Expected Conservation		326	383	428	494	548	616
Advanced Conservation		312	355	394	461	518	582
SURFSIDE BEACH							
Population	611	769	837	995	1,178	1,371	1,534
1990 Use	156						
Below Normal Rainfall							
* Expected Conservation		222	232	265	309	353	393
Advanced Conservation		216	220	248	291	336	373
Normal rainfall							
Expected Conservation		199	209	239	279	318	354
Advanced Conservation		195	199	225	264	304	337
SWEENY							
Population	3,297	3,680	4,180	4,891	5,782	6,172	6,589
1990 Use	414						
Below Normal Rainfall							
* Expected Conservation		457	482	526	596	623	657
Advanced Conservation		437	445	487	557	587	619
Normal rainfall							
Expected Conservation		416	435	477	537	560	591
Advanced Conservation		400	407	438	505	532	561
WEST COLUMBIA							
Population	4,372	5,482	6,035	6,720	7,671	8,363	9,118
1990 Use	530						
Below Normal Rainfall							
* Expected Conservation		744	763	798	877	936	1,011
Advanced Conservation		712	710	731	816	880	950
Normal rainfall							
Expected Conservation		584	601	624	678	711	776
Advanced Conservation		565	554	572	636	684	735

COUNTY - OTHER							
Population	68,544	78,720	83,556	91,092	102,276	111,831	135,982
1990 Use	9,652						
Below Normal Rainfall							
* Expected Conservation		10,902	10,811	11,160	12,051	12,786	15,400
Advanced Conservation		10,461	10,069	10,146	11,142	12,042	14,497
Normal rainfall							
Expected Conservation		9,567	9,491	9,716	10,432	11,016	13,251
Advanced Conservation		9,214	8,842	8,909	9,754	10,529	12,657
MUNICIPAL TOTALS							
Population	191,707	241,233	279,519	322,819	378,774	424,518	489,838
1990 Use	27,482						
Below Normal Rainfall							
* Expected Conservation		34,698	37,647	41,145	46,751	51,167	58,556
Advanced Conservation		33,491	35,256	38,012	43,803	48,558	55,384
Normal rainfall							
Expected Conservation		31,018	33,593	36,709	41,661	45,460	52,018
Advanced Conservation		29,949	31,572	34,016	39,231	43,433	49,567
MANUFACTURING	199,242	228,424	257,569	274,057	288,204	316,451	344,404
S.E. POWER COOLING	0	0	0	0	0	0	0
MINING	954	1,511	1,305	1,169	1,114	1,043	1,063
IRRIGATION	113,389	131,207	118,758	108,276	104,256	101,833	101,833
LIVESTOCK	1,261	1,066	1,066	1,066	1,066	1,066	1,066

TOTAL COUNTY WATER USE	342,328						
Below Normal Rainfall							
* Expected Conservation		396,906	416,345	425,713	441,391	471,560	506,922
Advanced Conservation		395,699	413,954	422,580	438,443	468,951	503,750
Normal Rainfall							
Expected Conservation		393,226	412,291	421,277	436,301	465,853	500,384
Advanced Conservation		392,157	410,270	418,584	433,871	463,826	497,933

* Municipal use for cities excludes any wholesale municipal sales and identified sales to industrial users
* Below normal rainfall with expected conservation is the primary municipal water use scenario.

Appendix D
Treatment Plant Design Criteria and Preliminary Sizing

Appendix D
Water Treatment Plant Design Criteria and Preliminary Sizing

DESIGN CRITERIA FOR 25 MGD HIGH-RATE CONVENTIONAL TREATMENT PLANT

Criteria	Unit	Value	
Plant Capacity			
Finished Water Flow	MGD	27	
Raw Water Flow	MGD	27	
Raw Water Reservoir			
Capacity	MGD	48	
Area	acres	10	
Depth	ft	15	
Storage Volume	day	2	
Low Lift Pumping			
Number of Units	each	3	
Type	Vertical Turbine		
Pump Capacity	MGD	8.5	
Pump Head	ft	50	
Total Installed Motor Capacity	HP	400	
Mixing			
No. of Pumps	each	2	
Type of Pump	Vertical Centrifugal		
Capacity	MGD	1.3	
Clarifier			
Clarifier Type	Pulsed-Upflow		
		Phase 1	Phase 2
Unit Capacity	MGD	15	10
Number of Units	each	2	1
Length	ft	128	93
Width	ft	46	42
Average Daily Sludge Flow	gpd	383,000	
Media Filters			
Type	Deep Bed, Dual Media (GAC/Sand)		
No.	each	8	
Surface Area Per Filter	ft^2	521	
Transfer Pumping			
Number of Units	each	3	
Type	Vertical Turbine		
Pump Capacity	MGD	8.5	
Pump Head	ft	50	
Total Installed Motor Capacity	HP	400	
High Service Pumping			
Number of Units	each	5	
Type	Vertical Turbine		
Pump Capacity	MGD	25	
Pump Head	Ft	170	
Total Installed Motor Capacity	HP	1065	

Appendix D
Water Treatment Plant Design Criteria and Preliminary Sizing

DESIGN CRITERIA FOR 25 MGD HIGH-RATE CONVENTIONAL TREATMENT PLANT SOLIDS PROCESSING

Criteria	Unit	Value
Gravity Thickener		
Type	Circular, Center Rake	
Solids Capacity	Ft^2	923
Hydraulic Capacity	Ft^2	1,113
No of Units	Each	2
SWD	Ft	14
Diameter	Ft	38
Percent Solids	%	6
Waste Washwater Equalization		
Type	Rectangular, Sloped Bottom	
Number of Units	Each	2
Length	Ft	93
Width	Ft	23.21
SWD	Ft	16
Storage Volume	Gal	515,700
Average Daily Backwash Flow	Gpd	464,130
Waste Washwater Clarification		
Clarifier Type	Lamella	
Diameter	Ft	31
Effective Area	Ft^2	597
Total Settling Area	Ft^2	746
Number of Units	Each	2
Recycle Pumps		
Number of Units	Each	3
Type	Vertical Turbine	
Capacity	Gpm	240
Motor Size	Hp	10
Sludge Drying Bed		
Total effective area	Ft^2	182,000
Number of Units	Each	6
Length	Ft	500
Width	Ft	61
Percent Solids	%	45
Average Annual Quantity Disposed	Cy	500,000

Appendix D
Water Treatment Plant Design Criteria and Preliminary Sizing

DESIGN CRITERIA FOR 25 MGD HIGH-RATE CONVENTIONAL TREATMENT PLANT BUILDINGS

Criteria	Unit	Value
Administration	Ft^2	
Laboratory	Ft^2	1,500
Offices / Reception	Ft^2	3,000
Conference	Ft^2	1,000
Restrooms / Lockers / Kitchen	Ft^2	1,000
Control Room	Ft^2	1,000
File Storage	Ft^2	1,000
General Storage	Ft^2	1,500
Total	Ft^2	10,000
Maintenance Building		
Garage	Ft^2	3,000
Instrument / Mechanics Shop	Ft^2	4,000
Offices / Restroom	Ft^2	1,000
Storage	Ft^2	5,000
Total	Ft^2	13,000
Chemical Building	Ft^2	10,000
Outside Chemical Storage	Ft^2	15,000
Ground Storage		
Number of Units	Each	4
Diameter	Ft	131
Height	Ft	30

Appendix E
TC&B Alternative Water Supply Study Report

Turner Collie & Braden Inc.
Engineers • Planners • Project Managers

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February 27, 2001

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ALVIN
UTILITIES

Mr. Jim Adams, P.E.
Region H Chairman
San Jacinto River Authority
P.O. Box 329
Conroe, Texas 77305

Re: Mid-Brazoria County Regional Water Planning Area
Alternative Water Supply Study for Region H Water Planning Group
TWDB Contract No. 99-483-294

Dear Mr. Adams:

Turner Collie & Braden Inc. is pleased to present you with the results of the above-mentioned study. The purpose of this letter report is to present the results of the Alternative Water Supply Study prepared for the Mid-Brazoria County Regional Water Planning Area ("the Planning Area"). The following letter report summarizes the scope of work addressed, the methodology used, and the results obtained during completion of the study. This study was authorized by the TWDB to be performed with contingency funds through the Region H Regional Water Planning Group.

Purpose and Objectives

The Mid-Brazoria County Planning Area encompasses much of the northern portion of Brazoria County including the municipalities of Alvin, Angleton, Danbury, Hillcrest, Iowa Colony, Manvel, Brookside Village, and the portion of Pearland within Brazoria County. It is included within the Region H Regional Planning Group established by the TWDB as a result of Senate Bill 1. *Exhibit 1* provides a map of the overall Planning Area indicating the locations of municipalities, major roadways, canal alignments, and the proposed location for a regional water treatment plant for the Planning Area.

The current Region H water plan does not identify shortages for any communities other than Alvin, Angleton, and Pearland. Region H addressed the City of Alvin shortage through municipal conservation and a new contract for water from the Gulf Coast Water Authority (GCWA). Pearland currently has a water contract, which expires after the year 2010, with the GCWA for 5,559 acre-feet per year. However, it is understood for this study that Pearland currently has no infrastructure in place to use this contract water for potable means. Pearland's shortage was addressed by Region H through an extension of this contract. Angleton has a water contract with the Brazosport Water Authority (BWA) for 1,815 acre-feet per year of treated surface water expiring after the year 2040. The City of Angleton is currently using this contract water to serve their municipal needs. Region H addressed the shortage for Angleton through an extension to this water contract. The remainder of the Planning Area is expected to continue to use groundwater.

The communities involved in the Mid-Brazoria County Planning Area have several concerns. First, they are concerned about the continued availability of groundwater in a county that does not have a groundwater conservation district to protect and conserve the supply. The community officials recognize that Region H only allocated groundwater based on the sustainable yield of the aquifer, but there is no legal requirement for such a limitation. Nothing prevents a large water-user from moving into the area and pumping large quantities of groundwater from the aquifer and potentially affecting all of the current users. Second, the communities in the Planning Area want to know the costs of the various supply choices available to them so they can make an informed decision regarding their future water supply or supplies. Third, participants realize that two supply sources increase the reliability of each of their systems.

For the reasons noted above, the Mid-Brazoria County Planning Group submitted an application for funding for a facilities plan to the Texas Water Development Board. TWDB received and reviewed the application and funded a portion of it. However, all of the task items dealing with the alternative sources of supply available to the area were removed from the facilities planning grant application and the Group was informed that this portion of the work requires a contingency funds request to the Region H Regional Water Planning Group. This directive from TWDB resulted in the separation of the following scope of services from the facilities planning grant and the accomplishment of these tasks through an amendment to the Region H planning scope. The individual tasks are as shown below.

Scope of Work

The following scope of work was completed for this study:

1) Define the population projections for the Planning Area for the 50-year planning period 2000 through 2050.

2) Define the total municipal water demand projections for the Planning Area for the 50-year planning period 2000 through 2050.

3) Define the municipal surface water demand projections for the Planning Area for the 50-year planning period 2000 through 2050.

4) Review and revise the recommended water management strategy included in the Region H planning documents for meeting water shortages in the City of Alvin to include additional capacity sufficient to meet the water needs of the Planning Area.

5) Assess the feasibility and economics of diverting raw water directly from the Brazos River to a regional water treatment plant to serve the Planning Area.

6) Assess the feasibility and economics of diverting raw water from existing Chocolate Bayou Water Company canals to a regional water treatment plant to serve the Planning Area.

7) Compare the costs of alternative water supplies and present the advantages and disadvantages of each alternative.

8) Compare the cost of converting to a dual water source (surface and groundwater) to the cost of continuing to use groundwater as the primary source of water for the Planning Area.

Population and Water Demands

The population and water demand projections used in this study were obtained from the Region H planning documents. The Region H Planning Group provided projections of population and water demand for all counties within the Region H study area for the 50-year planning period from 2000 to 2050.

The population projections for the municipalities included in the Planning Area were obtained directly from Region H planning documents. The Region H planning documents also provide county-other population projections for all of Brazoria County. However, the Planning Area for this study does not encompass all of Brazoria County. Therefore, the county-other population projections for the Mid-Brazoria Planning Area were made by applying a population density factor (capita per area), developed for the entire Brazoria County area, to the non-incorporated area within the Planning Area. *Table 1* provides a summary of the population projections for the Planning Area for the 50-year planning period.

Table 1
Mid-Brazoria Planning Area Population Projections

	Population Projections					
Year	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Alvin	24,075	28,723	33,822	40,240	45,715	51,935
Angleton	23,870	28,737	34,037	40,661	46,372	52,884
Danbury	1,870	2,174	2,442	2,804	3,079	3,381
Hillcrest	891	995	1,245	1,479	1,592	1,696
Iowa Colony	851	922	1,086	1,272	1,375	1,477
Manvel	5,152	6,084	7,080	8,352	9,412	10,606
Brookside Village	2,059	2,282	2,551	2,934	3,337	3,696
Pearland	29,480	39,464	49,742	61,929	73,332	86,834
Brazoria County-Other	25,097	26,637	29,039	32,605	35,650	43,349
Total	**113,345**	**136,018**	**161,044**	**192,276**	**219,864**	**255,858**

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Mr. James Adams, P.E.
February 27, 2001
Page 4

Total water demand projections for the municipalities included in the Planning Area were obtained directly from Region H planning documents. The Region H planning documents also provide county-other water demand projections for all of Brazoria County. However, the Planning Area for this study does not encompass all of Brazoria County. Therefore, the county-other water demand projections for the Mid-Brazoria County Planning Area were made by applying a water usage factor (acre-feet per capita), developed for the entire Brazoria County incorporated area, to the population of the non-incorporated area within the Planning Area. *Table 2* provides a summary of the water demand projections for the Planning Area for the 50-year planning period.

Table 2
Mid-Brazoria Total Water Demand Projections

	Water Demand (acre-feet per year)					
Year	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Alvin	3,290	3,668	4,092	4,733	5,274	5,934
Angleton	3,235	3,670	4,117	4,737	5,298	5,983
Danbury	246	266	279	308	332	360
Hillcrest	127	134	157	182	189	200
Iowa Colony	123	128	143	161	170	178
Manvel	710	784	856	983	1,075	1,212
Brookside Village	283	297	311	345	385	422
Pearland	4,458	5,569	6,631	8,046	9,364	11,088
Brazoria County-Other	3,476	3,446	3,558	3,842	4,076	4,909
Total	**15,948**	**17,962**	**20,144**	**23,337**	**26,163**	**30,286**

Based on the Region H plan, most of the above municipalities would continue to meet their projected water demands through continued groundwater use. The cities of [redacted]. The cities of [redacted] would require [redacted]s to meet projected demands. According to Region H, approximately [redacted]or the Planning Area [redacted]

Therefore, in conformance with the results from Region H planning, it has been assumed for this study that 50 percent of the total water demand in the Planning Area will be met through additional surface water supplies. This [redacted] will serve [redacted] the cities of [redacted], and [redacted] as well as that population in Brazoria County-Other. [redacted] the [redacted] and [redacted] It has been assumed, for convenience in this study, that these existing water contracts would either be cancelled, transferred, or maintained. If the contracts were maintained and extended over time, this would then free up surface water supplies that could be used to meet projected water demands in other areas (i.e.

Brazoria County-Other) of the Planning Area. *Table 3* provides a summary of the estimated surface water demands for the Planning Area for the 50-year planning period.

Table 3
Mid-Brazoria Surface Water Demand Projections

	Surface Water Demand (acre-feet per year)					
Year	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Alvin	1,645	1,834	2,046	2,367	2,637	2,967
Angleton	1,618	1,835	2,059	2,369	2,649	2,992
Danbury	123	133	140	154	166	180
Hillcrest	64	67	79	91	95	100
Iowa Colony	62	64	72	81	85	89
Manvel	355	392	428	492	538	606
Brookside Village	142	149	156	173	193	211
Pearland	2,229	2,785	3,316	4,023	4,682	5,544
Brazoria County-Other	1,738	1,723	1,779	1,921	2,038	2,455
Total	**7,974**	**8,981**	**10,072**	**11,669**	**13,082**	**15,143**

Groundwater Supply Source

For this study, two groundwater supply scenarios have been investigated. The first scenario is included as a means of cost comparison only and assumes that the Planning Area will be served throughout the study period using 100 percent groundwater, with the exception of the 1,815 acre-feet of treated surface water currently used by Angleton. It should be noted that Region H has indicated that the sustainable yield of the groundwater supply in this area would not support this level of groundwater use in the Planning Area. Again, this scenario is included for cost comparison purposes only. The second scenario, more in line with Region H, assumes that groundwater will be supplemented by a surface water supply source of 50 percent of the total demand.

Information obtained from the Planning Area participants and from the Texas Natural Resource Conservation Commission (TNRCC) public water supply system database was reviewed to estimate the total existing well capacity in the Planning Area. The TNRCC database provides total well capacity information for public water supply systems in Texas. According to this information, additional well capacity will be required for the Planning Area in order to meet the projected 2050 water demands assuming no supplemental source from surface water. Approximately 1,500 gallons per minute of additional well capacity was estimated to be required in the Planning Area to meet the projected water demand for the planning decade 2050 assuming that no additional surface water supply is provided for in the area. For this study, it was assumed that this additional well capacity would be required in the 2040 planning decade.

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Although there appears to be ample groundwater sources to meet short-term and even near long-term water demands, concerns associated with subsidence, future limitations on groundwater pumping, and potential groundwater quality issues indicate that planning for a second source of water (i.e., surface water) is prudent. The Planning Area will maximize usability of each water source, conserve available groundwater, and reduce subsidence by combining surface water and groundwater.

There is no good repository of groundwater quality data for private well owner. However, based on conversations with the Brazoria County Health Department and the TNRCC, there does appear to be some groundwater quality issues associated with high levels of total dissolved solids in wells, particularly in the southern portion of the region. These quality issues could be exacerbated by a continued reliance on groundwater as the primary water source for the area.

Alternative Surface Water Supply Sources

Alternative water supplies identified for this study include available or potentially available supplies from the Gulf Coast Water Authority (GCWA), Brazos River Authority (BRA) and the Chocolate Bayou Water Company (CBWC). For this study it was assumed that water would be diverted from the existing Briscoe Canal in the GCWA system, existing canals in the CBWC system, and directly from the Brazos River in the BRA system.

Gulf Coast Water Authority

Supply Source Alternative 1

Under this scenario, the Planning Area would develop and construct a regional water treatment plant at a site currently owned by the City of Alvin for use in meeting the long-term surface water needs in the Planning Area. The Planning Area would purchase contract water from GCWA, beginning immediately, to meet the projected surface water demands for the area. Water would be [redacted] the existing GCWA Briscoe Canal located south of Alvin, to the proposed [redacted]. See *Exhibit 2* for the location of the facilities. This alternative is a version of the selected surface water option provided for Alvin only in the Region H plan, but scaled up to provide the estimated needs of the Mid-Brazoria Planning Area.

Brazos River Authority

The BRA commonly makes water available for sale under long-term contracts for municipal, industrial, irrigation and other uses throughout the Brazos River basin and the adjacent coastal areas. The BRA currently has a standard System Water Availability Agreement under which water supply is contracted for long-term use. Currently, all of the BRA's available water supply in its basinwide system is committed; however, efforts are underway to increase the amount of system water supply available for contract.

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The BRA estimates that approximately 75,000 acre-feet per year of increased system water supply could be made available for contract through the return of excess water supply currently under contract by industrial customers; increased firm yield in the BRA's system of reservoirs; and potential third-party, long-term lease of water supplies. This estimated water supply exceeds the 2050 projected water demands for the Planning Area.

In addition, the development of proposed reservoirs in the Brazos River basin could also provide for additional future long-term sources of water for the Planning Area. Proposed reservoirs in the Brazos River basin for this 50-year study period include Little River Reservoir in Milam County, and Allen Creek Reservoir in Austin County, both of which are included in the Region H plan.

For the purpose of developing a cost comparison with other alternatives, it was assumed that the Brazos River water would be obtained through a pump station and pipeline from the Brazos River directly to the proposed regional plant identified above. In fact, the canals mentioned in the alternatives above could be used to convey water purchased from the BRA, but it was not possible to determine a conveyance cost for such water in the canals if the canals were used strictly for conveyance and if the water was not purchased from the canal owner.

Supply Source Alternative 2

Under this scenario, the Planning Area would develop and construct a regional water treatment plant at the Alvin site for use in meeting the long-term surface water needs in the Planning Area. The Planning Area would purchase contract water from the BRA, beginning immediately, to meet the projected surface water demands for the area. Water would be diverted directly from the Brazos River from a new raw water pump station to the proposed regional water treatment plant. See *Exhibit 2* for the locations of these described facilities.

Chocolate Bayou Water Company

Water obtained from the Chocolate Bayou Water Company differs from the previous alternatives by the fact that CBWC is interested in selling the rights to water supplies that they currently own and control. All of the other alternatives noted above involve contracts for water service with contract costs that must be paid for as long as the water is being used and in fact even prior to the water being used if access to the supply is to be guaranteed. The water obtained from CBWC would be from a purchase of the water rights, which would result in a capital cost that would be financed for a period of time. At the end of that time, the water would be paid for and no further cost per acre-foot of raw water used would be incurred. Over a long period of time this would result in significant cost savings.

Supply Source Alternative 3

Under this scenario, the Planning Area would develop and construct a regional water treatment plant at the Alvin site for use in meeting the long-term surface water needs in the Planning Area. The Planning Area would purchase water rights from CBWC to meet the projected surface water demands for the area.

Water would be diverted from the existing CBWC canal system to the proposed regional water treatment plant. See *Exhibit 2* for the locations of these described facilities.

Estimates of Probable Costs for Surface Water Development

Planning level costs were developed following the methodology prepared in the Senate Bill 1 Region H Planning report, *"Cost Estimating Procedures TWDB Region H."* Detailed cost analysis spreadsheets, provided in *Appendix A*, were prepared for each water supply source alternative. The cost estimating spreadsheets, provided in *Appendix A*, develop two main categories of costs: project costs, which include capital costs and other project-related costs, and annual costs. All costs are adjusted to the second quarter of 1999 to be consistent with Region H.

These spreadsheets develop the detailed costs for each major item identified as well as present a summary of costs associated with each supply source alternative. The Region H cost methodology was used so that cost comparisons developed in this effort would be comparable to those developed in the Region H effort. *Appendix B* provides a copy of the Region H cost estimating procedures.

It should be noted here that the Region H cost estimation worksheets include averages of costs that are greatly influenced by construction in highly congested areas. It is anticipated that costs developed specifically for Brazoria County will be lower. However, the purpose of this study is solely to compare the alternatives. As long as all alternatives are compared in terms of Region H costs, then the comparison is equitable among alternatives.

For this study, only the costs for water supply (i.e., cost of water, conveyance, and treatment) were developed. The costs associated with distribution are not included in the costs estimates developed for this study. It was assumed, for each alternative, that a regional water treatment plant would be constructed and that treated water would be distributed to the individual users. The costs for distribution were assumed to be the same for each alternative. The purpose of this study is to provide a relative comparison of costs between alternative water sources and not to serve as a means to develop water rates or a detailed facility plan.

Estimates of Probable Costs for Groundwater Development

Costs associated with the continued use of groundwater as a water source for the area include well operation and maintenance (O&M), rehabilitation, and replacement. For this study, costs associated with well O&M and rehabilitation were estimated using a study previously conducted by TC&B for the Fort Bend County Surface Water Supply Corporation, dated November 1997. Costs associated with well O&M and rehabilitation, developed for the November 1997 study, were adjusted based on Engineering News Record (ENR) cost factors to present day values. On that basis, the estimated costs for well O&M

and rehabilitation, used in this study, is $0.41 per 1,000 gallons and $0.03 per 1,000 gallons, respectively.

As mentioned previously, this study assumes that approximately 1,500 gallons per minute (gpm) of additional well capacity will be required in the Planning Area to meet projected water demands for the area, assuming no contribution from a supplemental surface water supply. For this study, it was assumed that new wells would be constructed to produce approximately 1,000 gpm per well. Therefore, this study assumed that two new wells would be constructed in the planning year 2040 to meet projected 2050 water demands.

Based on Region H costs, the average cost of a 1,000-gpm water well is approximately $500,000, in round numbers. Therefore, the cost of additional well capacity, for the scenario that does not include surface water supply, is $1,000,000. The debt service associated with the new well costs was assumed to begin in 2040 at 6 percent interest over a ten-year service period resulting in an annual cost of $135,870.

Discussion of Results

Surface Water Cost Analysis

Table 4 provides a summary of the annual costs developed for each alternative surface water source for this study. *Table 4* includes costs associated with capital, operation and maintenance, engineering, water supply, land, environmental, and debt service for each alternative. All costs are annualized costs and are provided in units of dollars per 1,000 gallons for each planning decade.

Table 4
Surface Water Cost Estimate Summary

Year	GCWA	BRA	CBWC
	($/1,000 gallons)	($/1,000 gallons)	($/1,000 gallons)
2010	$2.20	$2.99	$2.22
2020	$2.27	$3.04	$2.28
2030	$2.35	$3.31	$2.37
2040	$1.52	$2.04	$1.49
2050	$1.41	$1.89	$1.39

Based on the cost estimates developed for this study, the following observations are made:

1) The GCWA alternative source supply provides the lowest cost of water in the planning years 2010, 2020, and 2030.

2) The CBWC alternative source supply provides the lowest cost of water in the planning years 2040 and 2050.

3) The BRA alternative source supply provides the highest cost of water in all the planning years studied.

The GCWA alternative source supply and the CBWC alternative source supply each consisted of pump stations and pipelines of similar sizes and lengths (plus or minus 2 miles); therefore, infrastructure costs for these alternatives were similar. The BRA alternative source supply required the pumping of water from the Brazos River to the regional treatment plant approximately 14 miles. Therefore the infrastructure associated with the BRA alternative source supply was more expensive.

It should be noted that an arrangement could potentially be made to purchase carrying capacity in existing CBWC or GCWA canals to convey water purchased from the BRA to a location closer to the proposed regional treatment plant to significantly reduce costs associated with this alternative. However, this was not analyzed for this study due to the significant unknowns in costs associated with this potential contractual arrangement.

The cost differences between the GCWA and the CBWC supply source alternatives were primarily associated with how the raw water would be purchased from the two entities. Water purchased from the GCWA will be in the form of contract water. The contract water rate used for the GCWA for this study was $29.32 per acre-feet per year. This expense is assumed to be constant for every planning decade and would be based on the amount of water contracted each year. The cost of contract water is not based on use but is instead based on the volume contracted by a customer of GCWA for a given time period. For this study, $29.32 per acre-feet was used for each planning decade. No increase in raw water costs was incorporated into the analysis. However, as demands increase over the 50-year planning period, GCWA is expected to acquire additional water from the BRA per the Region H plan. The actual source or cost of this additional BRA supply is unknown at this time; but it could impact future contract rates.

CBWC is interested in selling their water rights. Due to current market conditions associated with surface water, the value for these rights is unknown and can only be determined through negotiations between CBWC and an interested buyer. A value of $200 per acre-feet was used for this analysis. A value of $200 per acre-feet results in annual costs for the 2010 planning decade that are relatively competitive with the GCWA alternative. The purchase of water rights above $200 per acre-feet would result in annual costs higher than the GCWA alternative.

This water cost would be incurred once and would guarantee the purchaser of the volume of water purchased in perpetuity. No additional costs associated with the purchase of water would be incurred following the purchase of water rights. Therefore, the advantages associated with this alternative are not realized until the later planning decades after the debt service for the earlier decades is paid off. This advantage would only be further realized in decades beyond the 50-year planning period.

In addition, it was assumed that the Planning Area would purchase only the volume of water rights from the CBWC required to meet their 2050 water need. CBWC owns water rights in excess of 200,000 acre-feet, of which approximately 80,000 acre-feet are considered firm yield rights. CBWC may be more likely to sell their firm yield rights in full as opposed to a portion of the total required to meet the Planning Area's water needs. If purchased in full, the Planning Area would have to make a larger initial financial commitment than was assumed in the study, and if deemed appropriate, could sell some or all of the excess rights to a third party to help defray costs. However, due to the degree of uncertainty associated with this issue, the CBWC alternative was assessed assuming the purchase of only the water rights required to meet 2050 water demands. The requirement to purchase CBWC water rights in full, as opposed to the assumptions for this study, would reduce the economic advantages associated with this alternative in the outer years, particularly if a third-party buyer of the excess capacity could not be identified.

There are considerable similarities in cost among the various alternatives. It should also be emphasized that the purpose of developing the cost estimates for each source is to provide a common reference for comparison. Many assumptions had to be made which impacted the analysis because some of the information that is needed can only be obtained through protracted contract negotiations. However, the analysis does provide a common means of comparing the alternatives if one recognizes the need to investigate further. The other salient point here is that the costs are close enough to each other that, in all likelihood, the selection of the final alternative will be based on factors other than cost alone.

Comparison of Groundwater and Surface Water Supply Costs

A cost comparison was also conducted between groundwater and surface water supplies for the Planning Area. For this study, it was assumed that the Planning Area would convert up to 50 percent of the total water demand to a surface water supply while meeting the remaining 50 percent with existing groundwater supplies. Therefore, a groundwater cost component exists with each alternative surface water supply.

Cost estimates for the 50-year planning period were prepared for the following scenarios: 1) the total projected water demand for the Planning Area would be met by 100 percent groundwater supplies, with the exception of the Angleton contract water from the BWA (1,815 acre-feet) and 2) a "blended" water supply consisting of 50 percent surface water and 50 percent groundwater would be used to meet projected demands. Groundwater costs were developed using unit costs for O&M and rehabilitation, discussed in previous sections of this report. For comparison purposes, the total annual costs used for the surface water component of this analysis were based on obtaining water from the GCWA from the Briscoe Canal (see *Appendix A*).

The costs associated with the Angleton surface water contract were also added to the 100-percent groundwater alternative. Based on Region H, the contract cost for treated water from the GCWA is $225 per acre-feet. This cost was applied to the 1,815 acre-feet of contract water every year for the 50-year study period for this alternative.

Appendix C summarizes the annual costs over the 50-year planning period for the two scenarios referenced above. The shaded columns represent the annual unit costs ($ per 1,000 gallons) associated with using only groundwater to meet projected demands and the use of "blended" water to meet demands. *Attachment C* graphically illustrates this comparison.

Table 5 below provides the summary of cost comparison for this analysis on a dollar per 1,000 gallons basis.

Table 5
Summary of Cost Comparison

Year	Groundwater Cost ($/1,000 gallons)	Blended Water Cost ($/1,000 gallons)
2010	$0.52	$1.32
2020	$0.51	$1.36
2030	$0.50	$1.35
2040	$0.51	$1.00
2050	$0.50	$0.95

Based on this analysis, the cost of using groundwater as the sole source of water for the Planning Area would remain virtually constant, between $0.52 and $0.50, throughout the planning period, not accounting for inflation. The cost of converting to a blended water source would decrease over time, as debt service is paid down, from a high of $1.36 in the year 2020 to a low of $0.95 in the year 2050.

It should be noted here that the management strategy currently incorporated in the Region H water plan for the City of Alvin, namely water service from GCWA, appears to be the most cost-effective option based on the information available. This information will be presented to the Mid-Brazoria Regional Planning Area for their determination as to whether or not to continue this strategy. The decision of whether an amendment to the plan is needed can only be made by the Mid-Brazoria Group after their consideration of the foregoing information.

Turner Collie & Braden Inc.

We appreciate the opportunity to work with you on this project and look forward to a continued relationship with you in the future. If you have any questions concerning this report or wish to discuss it in more detail, please feel free to call Michael Reedy at (713) 267-3127 or Mark Lowry at (713) 267-3293.

Sincerely,
Turner Collie & Braden Inc

Michael V. Reedy, P.E.
Project Manager

Mark Lowry, P.E.
Technical Director

DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES

REBECCA G. OLIVE, P.E.

49625

TEXAS SERIAL NO.

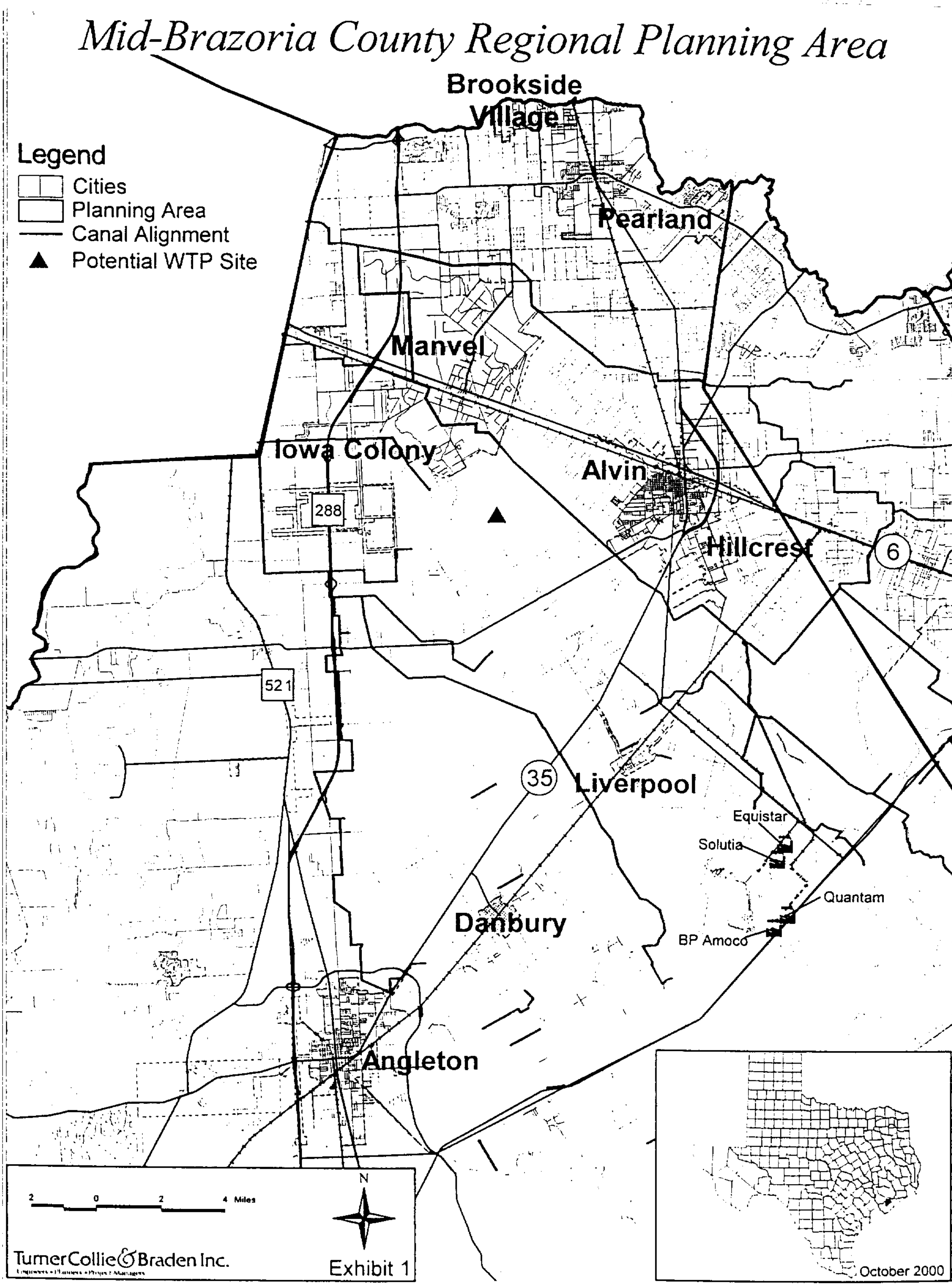
2/27/01

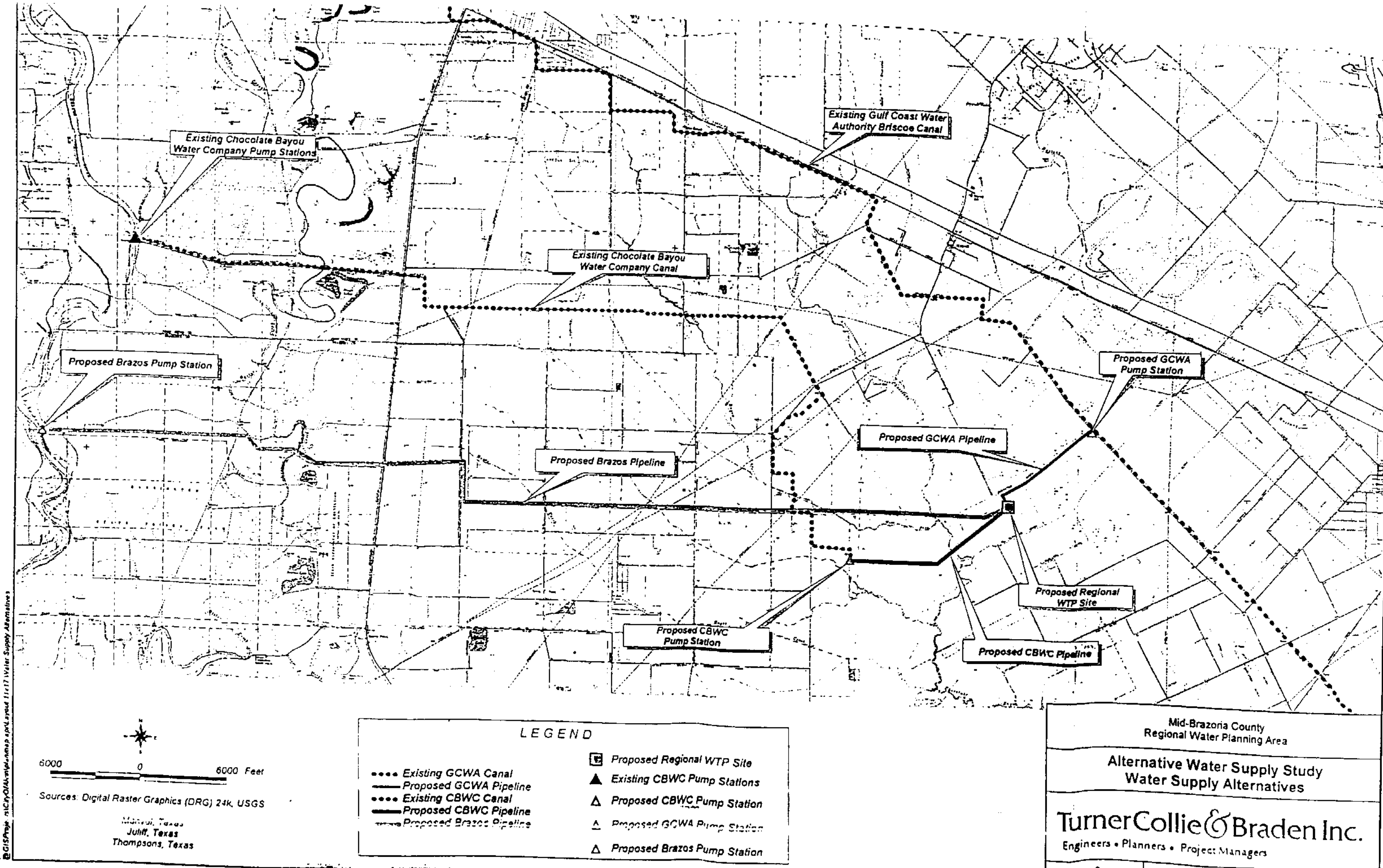
DATE

Rebecca G. Olive, P.E.
Associate Vice President

MR/pr

Copy: Mr. Dick Carter, P.E.
City of Alvin
Director of Public Works
and Engineering


Mid-Brazoria County Regional Planning Area
Legend
Cities
Planning Area
Canal Alignment
Potential WTP Site
Brookside Village
Pearland
Manvel
Iowa Colony
Alvin
Hillcrest
288
6
521
35
Liverpool
Equistar
Solutia
Quantam
BP Amoco
Danbury
Angleton
2 0 2 4 Miles
N
TurnerCollie&Braden Inc.
Exhibit 1
October 2000



Mid-Brazoria County
Regional Water Planning Area

Alternative Water Supply Study
Water Supply Alternatives

Turner Collie & Braden Inc.
Engineers • Planners • Project Managers

2	37-00610-002	January 2001

Appendix A

Surface Water Supply Cost Analysis Spreadsheets

GCWA Briscoe Canal Pump Station Pipeline

Lpipeline =	10350	Length	Fitting Fac	Rural	Urban
[redacted]		9000	1.15	9000	0

mgd	gpm per line
16	5556
	0
	0

Plant Component	Flow			Pipe Dia	Pipe Area	Velocity	
	mgd	gpm	cfs	inches	ft^2	fps	
14 mgd option	8	5556	12.38	18	1.767	7.00	
14 mgd option	8	5556	12.38	[redacted]	2.182	5.67	[redacted]
14 mgd option	8	5556	12.38	22	2.640	4.69	

Hazen and Williams
C= 110

100 psi =
230 ft

Briscoe Canal WL = 45
Proposed Treatment Plant WL = 40
Assumed Static (feet) = -5
Discharge Pressure = 23
Total Static = 18

Power Cost =.
0.06
Hours =
8760

90 mgd option

Q	Q	Pipe	Pipe A	Vel	Length	Fric Loss (ft)	Static	TDH	Brake	Pipe	Pump Sta	Total		Annual Power	Annual Power
gpm	cfs	inches	ft^2	fps	ft	C=	Head		HP	Cost	Cost	Cost		Cost	KW-HR
						110	ft	ft							
5556	12.38	18	1.77	7.00	10350	118.51	18	137	479	$1,863,000	$4,245,000	$6,108,000		$188,000	3,128,000
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5556	12.38	22	2.64	4.69	10350	44.60	18	63	220	$2,587,500	$1,947,000	$4,534,500		$87,000	1,435,000

Cost estimate Mid-Brazoria Regional Water Planning
GCWA, Supply Source Alternative No. 2

12/19/00
Prepared by JA

Cost Estimating Worksheet

Scenario 1: 14 MGD untreated water will be purchased from GCWA and diverted to the proposed water plant

Phase I: 8 MGD (2010)

Item	Notes	Unit Cost	Percentage	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$2,766,000	60%	1	LS	$1,659,600
Intake Structure		$1,659,600	20%	1	LS	$331,920
Power Connection		125	60%	312	HP	$23,396
Standby Power		$1,659,600	35%	1	LS	$580,860
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		9,000	LF	$900,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	60%	1	LS	$16,484,400
Standby Power		16,484,400	35%	1	LS	$5,769,540
Power Connection		125	60%	6,060	HP	$454,500
Purchase Contract Water (2001-2009)		$29.32	9	8,959	AF	$2,364,101
Total Capital Cost						**$28,568,317**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		900,000	$	$270,000
Other Facilities		35%		25,304,216	$	$8,856,475
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	100%	12	acres	$99,174
Right of Way Pipeline in urban areas		10,748	100%	0	acres	$0
Pump Station Site acquisition		2,000	100%	4	acres	$8,000
Water Treatment Plant Site acquisition		2,000	100%	20	acres	$40,000
Property Surveying		10%		147,174	$	$14,717
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	100%	2	Mile	$42,614
Other		100%	100%	48,000	Land$	$48,000
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$2,847,000
Total Project Cost						**$40,794,297**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$2,963,661
Pipeline O&M		1.0%		900,000	$	$9,000
Intake and Pump Stations O&M		2.5%		2,595,776	$	$64,894
Water Treatment Plant O&M		$2,730,000	60%	1	LS	$1,638,000
Pumping Energy Costs		$0.06	60%	2,038,000	kW-hr	$73,368
Plant Energy Costs		$0.06	60%	39,586,000	kW-hr	$1,425,096
Purchase of Raw Water		$29.32		8,959	acft	$262,665
Total Annual Cost - 2010						**$6,436,685**
Available Project Yield (acft/yr)				8,959	acft/yr	8,959
Annual Cost of Water ($/acft)						$718
Annual Cost of Water ($/1000 gal)						$2.20

Cost estimate Mid-Brazoria Regional Water Planning
GCWA, Supply Source Alternative No. 2

12/19/00
Prepared by JA

Cost Estimating Worksheet

Scenario 1: 14 MGD untreated water will be purchased from GCWA and diverted to the proposed water plant

Phase II: 9 MGD (2020)

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$2,766,000	10%	1	LS	$276,600
Intake Structure		$276,600	20%	1	LS	$55,320
Power Connection		125	10%	312	HP	$3,899
Standby Power		$276,600	35%	1	LS	$96,810
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		125	10%	6,060	HP	$75,750
Total Capital Cost						**$4,217,369**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		4,217,369	$	$1,476,079
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	0	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$456,000
Total Project Cost						**$6,149,449**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$446,751
Annual Cost from Phase I						$6,436,685
Pipeline O&M		1.0%		0	$	$0
Intake and Pump Stations O&M		2.5%		432,629	$	$10,816
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,038,000	kW-hr	$12,228
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$29.32		1,120	acft	$32,833
Total Annual Cost - 2020						**$7,449,828**
Available Project Yield (acft/yr)				10,078	acft/yr	**10,078**
Annual Cost of Water ($/acft)						$739
Annual Cost of Water ($/1000 gal)						$2.27

Cost estimate Mid-Brazoria Regional Water Planning
GCWA, Supply Source Alternative No. 2

12/19/00
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from GCWA and diverted to the proposed water plant						
Phase III: 10 MGD (2030)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$2,766,000	10%	1	LS	$276,600
Intake Structure		$276,600	20%	1	LS	$55,320
Power Connection		125	10%	312	HP	$3,899
Standby Power		$276,600	35%	1	LS	$96,810
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		9,000	LF	$900,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 60"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						**$5,117,369**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		900,000	$	$270,000
Other Facilities		35%		4,217,369	$	$1,476,079
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	12	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$550,000
Total Project Cost						**$7,413,449**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$538,579
Annual Cost from Phase II						$7,449,828
Pipeline O&M		1.0%		900,000	$	$9,000
Intake and Pump Stations O&M		2.5%		432,629	$	$10,816
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,038,000	kW-hr	$12,228
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$29.32		1,120	acft	$32,833
Total Annual Cost - 2030						**$8,563,800**
Available Project Yield (acft/yr)				11,198	acft/yr	**11,198**
Annual Cost of Water ($/acft)						$765
Annual Cost of Water ($/1000 gal)						$2.35

Cost estimate Mid-Brazoria Regional Water Planning
GCWA, Supply Source Alternative No. 2

12/19/00
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from GCWA and diverted to the proposed water plant						
Phase IV: 12 MGD (2040)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$2,766,000	10%	1	LS	$276,600
Intake Structure		$276,600	20%	1	LS	$55,320
Power Connection		$125	10%	312	HP	$3,899
Standby Power		$276,600	35%	1	LS	$96,810
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 60"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$4,217,369
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		$4,217,369	$	$1,476,079
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$456,000
Total Project Cost						$6,149,449
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$446,751
Annual Cost from Phase III						$5,600,139
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$432,629	$	$10,816
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,038,000	kW-hr	$12,228
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$29.32		2,240	acft	$65,666
Total Annual Cost - 2040						$6,646,116
Available Project Yield (acft/yr)				13,438	acft/yr	$13,438
Annual Cost of Water ($/acft)						$495
Annual Cost of Water ($/1000 gal)						$1.52

Cost estimate Mid-Brazoria Regional Water Planning
GCWA, Supply Source Alternative No. 2

12/19/00
Prepared by JA

Cost Estimating Worksheet

Scenario 1: 14 MGD untreated water will be purchased from GCWA and diverted to the proposed water plant

Phase V: 14 MGD (2050)

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$2,766,000	10%	1	LS	$276,600
Intake Structure		$276,600	20%	1	LS	$55,320
Power Connection		$125	10%	312	HP	$3,899
Standby Power		$276,600	35%	1	LS	$96,810
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 60"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$4,217,369
Engineering, Legal Costs and Contingencies						
Pipeline		30%		$0	$	$0
Other Facilities		35%		$4,217,369	$	$1,476,079
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$456,000
Total Project Cost						$6,149,449
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$446,751
Annual Cost from Phase IV						$6,199,365
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$432,629	$	$10,816
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,038,000	kW-hr	$12,228
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$29.32		1,568	acft	$45,966
Total Annual Cost - 2050						$7,225,642
Available Project Yield (acft/yr)				15,677	acft/yr	$15,677
Annual Cost of Water ($/acft)						$461
Annual Cost of Water ($/1000 gal)						$1.41

Brazos River Authority Pump Station Pipeline

Lpipeline =	83950	Length	Fitting Fac	Rural	Urban
Number Lines = 2		73000	1.15	73000	0

mgd	gpm per line
16	5556
	0
	0

Plant Component	Flow			Pipe Dia	Pipe Area	Velocity	
	mgd	gpm	cfs	inches	ft^2	fps	
14 mgd option	8	5556	12.38	18	1.767	7.00	
14 mgd option	8	5556	12.38	20	2.182	5.67	USE!
14 mgd option	8	5556	12.38	22	2.640	4.69	

Hazen and Williams
C= 110

100 psi =
230 ft

Brazos River WL =	50
Proposed Treatment Plant WL =	40
Assumed Static (feet) =	-10
Discharge Pressure =	23
Total Static =	13

Power Cost =.
0.06
Hours =
8760

90 mgd option

Q	Q	Pipe	Pipe A	Vel	Length	Fric Loss (ft)	Static	TDH	Brake	Pipe	Pump Sta	Total		Annual Power	Annual Power
gpm	cfs	inches	ft^2	fps	ft	C=	Head		HP	Cost	Cost	Cost		Cost	KW-HR
						110	ft	ft							
5556	12.38	18	1.77	7.00	83950	961.25	13	974	3417	$15,111,000	$12,506,000	$27,617,000		$1,340,000	22,321,000
5556	12.38	20	2.18	5.67	83950	575.41	13	588	2064	$16,790,000	$10,508,000	$27,298,000	USE!	$809,000	13,481,000
5556	12.38	22	2.64	4.69	83950	361.73	13	375	1314	$20,987,500	$8,504,000	$29,491,500		$516,000	8,586,000

Cost estimate Mid-Brazoria Regional Water Planning
BRA, Supply Source Alternative No. 3

12/19/00
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from BRA and diverted to the proposed water plant						
Phase I: 8 MGD (2010)						
Item	Notes	Unit Cost	Percentage	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$10,508,000	60%	1	LS	$6,304,800
Intake Structure		$6,304,800	20%	1	LS	$1,260,960
Power Connection		125	60%	2,064	HP	$154,780
Standby Power		$6,304,800	35%	1	LS	$2,206,680
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		73,000	LF	$7,300,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	60%	1	LS	$16,484,400
Standby Power		16,484,400	35%	1	LS	$5,769,540
Power Connection		125	60%	6,060	HP	$454,500
Purchase Contract Water (2001-2009)		$27	9	8,959	AF	$2,177,037
Total Capital Cost						**$42,112,697**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		7,300,000	$	$2,190,000
Other Facilities		35%		32,635,660	$	$11,422,481
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	100%	101	acres	$804,408
Right of Way Pipeline in urban areas		10,748	100%	0	acres	$0
Pump Station Site acquisition		2,000	100%	4	acres	$8,000
Water Treatment Plant Site acquisition		2,000	100%	20	acres	$40,000
Property Surveying		10%		852,408	$	$85,241
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	100%	14	Mile	$345,644
Other		100%	100%	48,000	Land$	$48,000
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$4,391,000
Total Project Cost						**$61,447,470**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$4,464,092
Pipeline O&M		1.0%		7,300,000	$	$73,000
Intake and Pump Stations O&M		2.5%		9,927,220	$	$248,180
Water Treatment Plant O&M		$2,730,000	60%	1	LS	$1,638,000
Pumping Energy Costs		$0.06	60%	13,481,000	kW-hr	$485,316
Plant Energy Costs		$0.06	60%	39,586,000	kW-hr	$1,425,096
Purchase of Raw Water		$45.00		8,959	acft	$403,135
Total Annual Cost - 2010						**$8,736,820**
Available Project Yield (acft/yr)				8,959	acft/yr	**8,959**
Annual Cost of Water ($/acft)						**$975**
Annual Cost of Water ($/1000 gal)						**$2.99**

Cost estimate Mid-Brazoria Regional Water Planning
BRA, Supply Source Alternative No. 3

12/19/00
Prepared by JA

Cost Estimating Worksheet

Scenario 1: 14 MGD untreated water will be purchased from BRA and diverted to the proposed water plant

Phase II: 9 MGD (2020)

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$10,508,000	10%	1	LS	$1,050,800
Intake Structure		$1,050,800	20%	1	LS	$210,160
Power Connection		125	10%	2,064	HP	$25,797
Standby Power		$1,050,800	35%	1	LS	$367,780
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		125	10%	6,060	HP	$75,750
Total Capital Cost						**$5,439,277**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		5,439,277	$	$1,903,747
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	0	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$588,000
Total Project Cost						**$7,931,023**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$576,180
Annual Cost from Phase I						$8,736,820
Pipeline O&M		1.0%		0	$	$0
Intake and Pump Stations O&M		2.5%		1,654,537	$	$41,363
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	13,481,000	kW-hr	$80,886
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$45.00		1,120	acft	$50,392
Total Annual Cost - 2020						**$9,996,157**
Available Project Yield (acft/yr)				10,078	acft/yr	**10,078**
Annual Cost of Water ($/acft)						$992
Annual Cost of Water ($/1000 gal)						$3.04

Cost estimate Mid-Brazoria Regional Water Planning
BRA, Supply Source Alternative No. 3

12/19/00
Prepared by JA

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from BRA and diverted to the proposed water plant						
Phase III: 10 MGD (2030)						
Pump Stations						
Raw water Pump Station		$10,508,000	10%	1	LS	$1,050,800
Intake Structure		$1,050,800	20%	1	LS	$210,160
Power Connection		125	10%	2,064	HP	$25,797
Standby Power		$1,050,800	35%	1	LS	$367,780
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		73,000	LF	$7,300,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						**$12,739,277**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		7,300,000	$	$2,190,000
Other Facilities		35%		5,439,277	$	$1,903,747
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	101	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$1,347,000
Total Project Cost						**$18,180,023**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$1,320,759
Annual Cost from Phase II						$9,996,157
Pipeline O&M		1.0%		7,300,000	$	$73,000
Intake and Pump Stations O&M		2.5%		1,654,537	$	$41,363
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	13,481,000	kW-hr	$80,886
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$45.00		1,120	acft	$50,392
Total Annual Cost - 2030						**$12,073,073**
Available Project Yield (acft/yr)				11,198	acft/yr	**11,198**
Annual Cost of Water ($/acft)						$1,078
Annual Cost of Water ($/1000 gal)						$3.31

Cost estimate Mid-Brazoria Regional Water Planning
BRA, Supply Source Alternative No. 3

12/19/00
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from BRA and diverted to the proposed water plant						
Phase IV: 12.6 MGD (2040)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$10,508,000	10%	1	LS	$1,050,800
Intake Structure		$1,050,800	20%	1	LS	$210,160
Power Connection		$125	10%	2,064	HP	$25,797
Standby Power		$1,050,800	35%	1	LS	$367,780
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$5,439,277
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		$5,439,277	$	$1,903,747
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$588,000
Total Project Cost						$7,931,023
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$576,180
Annual Cost from Phase III						$7,608,981
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$1,654,537	$	$41,363
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	13,481,000	kW-hr	$80,886
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$45		2,240	acft	$100,784
Total Annual Cost - 2040						$8,918,711
Available Project Yield (acft/yr)				13,438	acft/yr	$13,438
Annual Cost of Water ($/acft)						$664
Annual Cost of Water ($/1000 gal)						$2.04

Cost estimate Mid-Brazoria Regional Water Planning
BRA, Supply Source Alternative No. 3

12/19/00
Prepared by JA

Cost Estimating Worksheet

Scenario 1: 14 MGD untreated water will be purchased from BRA and diverted to the proposed water plant

Phase V: 14 MGD (2050)

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$10,508,000	10%	1	LS	$1,050,800
Intake Structure		$1,050,800	20%	1	LS	$210,160
Power Connection		$125	10%	2,064	HP	$25,797
Standby Power		$1,050,800	35%	1	LS	$367,780
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$5,439,277
Engineering, Legal Costs and Contingencies						
Pipeline		30%		$0	$	$0
Other Facilities		35%		$5,439,277	$	$1,903,747
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$588,000
Total Project Cost						$7,931,023
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$576,180
Annual Cost from Phase IV						$8,342,531
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$1,654,537	$	$41,363
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	13,481,000	kW-hr	$80,886
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Purchase of Raw Water		$45		2,240	acft	$100,784
Total Annual Cost - 2050						$9,652,260
Available Project Yield (acft/yr)				15,677	acft/yr	$15,677
Annual Cost of Water ($/acft)						$616
Annual Cost of Water ($/1000 gal)						$1.89

Chocolate Bayou Pump Station Pipeline

Lpipeline =	13340	Length	Fitting Fac	Rural	Urban
[redacted]		11600	1.15	11600	0

mgd	gpm per line
16	5556
	0
	0

Plant Component	Flow			Pipe Dia	Pipe Area	Velocity	
	mgd	gpm	cfs	inches	ft^2	fps	
14 mgd option	8	5556	12.38	18	1.767	7.00	
14 mgd option	8	5556	12.38	[redacted]	2.182	5.67	[redacted]
14 mgd option	8	5556	12.38	22	2.640	4.69	

Hazen and Williams
C= 110

100 psi =
230 ft

End of Existing Canal WL = 40
Proposed Treatment Plant WL = 40
Assumed Static (feet) = 0
Discharge Pressure = 23
Total Static = 23

Power Cost =.
0.06
Hours =
8760

90 mgd option

Q	Q	Pipe	Pipe A	Vel	Length	Fric Loss (ft)	Static	TDH	Brake	Pipe	Pump Sta	Total		Annual Power	Annual Power
gpm	cfs	inches	ft^2	fps	ft	C=	Head		HP	Cost	Cost	Cost		Cost	KW-HR
						110	ft	ft							
5556	12.38	18	1.77	7.00	13340	152.75	23	176	616	$2,401,200	$5,464,000	$7,865,200		$242,000	4,027,000
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5556	12.38	22	2.64	4.69	13340	57.48	23	80	282	$3,335,000	$2,503,000	$5,838,000		$111,000	1,844,000

Cost estimate Mid-Brazoria Regional Water Planning
Chocolate Bayou, Supply Source Alternative No. 3

2/26/01
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from Chocolate Bayou and diverted to the proposed water plant						
Phase I: 8 MGD (2010)						
Item	Notes	Unit Cost	Percentage	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$3,558,000	60%	1	LS	$2,134,800
Intake Structure		$2,134,800	20%	1	LS	$426,960
Power Connection		$125	60%	401	HP	$30,102
Standby Power		$2,134,800	35%	1	LS	$747,180
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		11,600	LF	$1,160,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	60%	1	LS	$16,484,400
Standby Power		16,484,400	35%	1	LS	$5,769,540
Power Connection		$125	60%	6,060	HP	$454,500
Purchase Water Rights		$200	100%	15,677	AF	$3,135,400
Total Capital Cost						**$30,342,882**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		1,160,000	$	$348,000
Other Facilities		35%		26,047,482	$	$9,116,619
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	100%	16	acres	$127,824
Right of Way Pipeline in urban areas		10,748	100%	0	acres	$0
Pump Station Site acquisition		2,000	100%	4	acres	$8,000
Water Treatment Plant Site acquisition		2,000	100%	20	acres	$40,000
Property Surveying		10%		175,824	$	$17,582
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	100%	2	Mile	$54,924
Other		100%	100%	48,000	Land$	$48,000
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$2,958,000
Total Project Cost						**$43,061,831**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$3,128,395
Pipeline O&M		1.0%		1,160,000	$	$11,600
Intake and Pump Stations O&M		2.5%		3,339,042	$	$83,476
Water Treatment Plant O&M		$2,730,000	60%	1	LS	$1,638,000
Pumping Energy Costs		$0.06	60%	2,622,000	kW-hr	$94,392
Plant Energy Costs		$0.06	60%	39,586,000	kW-hr	$1,425,096
Existing CBWC Facility Energy Costs		$0.06	60%	2,622,000	kW-hr	$94,392
Total Annual Cost - 2010						**$6,475,351**
Available Project Yield (acft/yr)				8,959	acft/yr	**8,959**
Annual Cost of Water ($/acft)						**$723**
Annual Cost of Water ($/1000 gal)						**$2.22**

Cost estimate Mid-Brazoria Regional Water Planning
Chocolate Bayou, Supply Source Alternative No. 3

2/26/01
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from Chocolate Bayou and diverted to the proposed water plant						
Phase II: 9 MGD (2020)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$3,558,000	10%	1	LS	$355,800
Intake Structure		$355,800	20%	1	LS	$71,160
Power Connection		125	10%	401	HP	$5,017
Standby Power		$355,800	35%	1	LS	$124,530
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		125	10%	6,060	HP	$75,750
Total Capital Cost						**$4,341,247**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		4,341,247	$	$1,519,436
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	0	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$469,000
Total Project Cost						**$6,329,683**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$459,845
Annual Cost from Phase I						$6,475,351
Pipeline O&M		1.0%		0	$	$0
Intake and Pump Stations O&M		2.5%		556,507	$	$13,913
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Existing CBWC Facility Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Total Annual Cost - 2020						**$7,491,088**
Available Project Yield (acft/yr)				10,078	acft/yr	**10,078**
Annual Cost of Water ($/acft)						$743
Annual Cost of Water ($/1000 gal)						$2.28

Cost estimate Mid-Brazoria Regional Water Planning
Chocolate Bayou, Supply Source Alternative No. 3

2/26/01
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from Chocolate Bayou and diverted to the proposed water plant						
Phase IV: 12.6 MGD (2040)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$3,558,000	10%	1	LS	$355,800
Intake Structure		$355,800	20%	1	LS	$71,160
Power Connection		$125	10%	401	HP	$5,017
Standby Power		$355,800	35%	1	LS	$124,530
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$4,341,247
Engineering, Legal Costs and Contingencies						
Pipeline		30%		0	$	$0
Other Facilities		35%		$4,341,247	$	$1,519,436
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$469,000
Total Project Cost						$6,329,683
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$459,845
Annual Cost from Phase III						$5,508,376
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$556,507	$	$13,913
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Existing CBWC Facility Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Total Annual Cost - 2040						$6,524,113
Available Project Yield (acft/yr)				13,438	acft/yr	$13,438
Annual Cost of Water ($/acft)						$486
Annual Cost of Water ($/1000 gal)						$1.49

Cost estimate Mid-Brazoria Regional Water Planning
Chocolate Bayou, Supply Source Alternative No. 3

2/26/01
Prepared by JA

Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from Chocolate Bayou and diverted to the proposed water plant						
Phase III: 10 MGD (2030)						
Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Pump Stations						
Raw water Pump Station		$3,558,000	10%	1	LS	$355,800
Intake Structure		$355,800	20%	1	LS	$71,160
Power Connection		125	10%	401	HP	$5,017
Standby Power		$355,800	35%	1	LS	$124,530
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		11,600	LF	$1,160,000
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						**$5,501,247**
Engineering, Legal Costs and Contingencies						
Pipeline		30%		1,160,000	$	$348,000
Other Facilities		35%		4,341,247	$	$1,519,436
Land Acquisition						
Right of Way Pipeline in rural areas		8,000	0%	16	acres	$0
Right of Way Pipeline in urban areas		10,748	0%	0	acres	$0
Pump Station Site acquisition		2,000	0%	4	acres	$0
Water Treatment Plant Site acquisition		2,000	0%	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0%	0	Mile	$0
Other		100%	0%	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6.0%				
Rate of Return on Investments		4.0%				
Duration of Project (yr)		2.0				$590,000
Total Project Cost						**$7,958,683**
Annual Costs						
Debt Service (6%, 30 years)		6.0%		30	yr	$578,190
Annual Cost from Phase II						$7,491,088
Pipeline O&M		1.0%		1,160,000	$	$11,600
Intake and Pump Stations O&M		2.5%		556,507	$	$13,913
Water Treatment Plant O&M		2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Existing CBWC Facility Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Total Annual Cost - 2030						**$8,636,771**
Available Project Yield (acft/yr)				11,198	acft/yr	**11,198**
Annual Cost of Water ($/acft)						$771
Annual Cost of Water ($/1000 gal)						$2.37

Cost estimate Mid-Brazoria Regional Water Planning
Chocolate Bayou, Supply Source Alternative No. 3

2/26/01
Prepared by JA

Item	Notes	Unit Cost	Percentage per phase	Quantity	Units	Updated Cost
Cost Estimating Worksheet						
Scenario 1: 14 MGD untreated water will be purchased from Chocolate Bayou and diverted to the proposed water plant						
Phase V: 14 MGD (2050)						
Pump Stations						
Raw water Pump Station		$3,558,000	10%	1	LS	$355,800
Intake Structure		$355,800	20%	1	LS	$71,160
Power Connection		$125	10%	401	HP	$5,017
Standby Power		$355,800	35%	1	LS	$124,530
Piping						
Open Cut Trenches						
Pipe @ 20" in rural areas		$100		0	LF	$0
Pipe @ 20" in urban areas		$165		0	LF	$0
Trenchless construction						
Pipe @ 20"		$1,295		0	LF	$0
Water Treatment Plant		$27,474,000	10%	1	LS	$2,747,400
Standby Power		$2,747,400	35%	1	LS	$961,590
Power Connection		$125	10%	6,060	HP	$75,750
Total Capital Cost						$4,341,247
Engineering, Legal Costs and Contingencies						
Pipeline		30%		$0	$	$0
Other Facilities		35%		$4,341,247	$	$1,519,436
Land Acquisition						
Right of Way Pipeline in rural areas		$8,000	0	0	acres	$0
Right of Way Pipeline in urban areas		$10,748	0	0	acres	$0
Pump Station Site acquisition		$2,000	0	4	acres	$0
Water Treatment Plant Site acquisition		$2,000	0	20	acres	$0
Property Surveying		10%		0	$	$0
Environmental & Archaeology Studies and Mitigation						
Pipeline		$25,000	0	0	Mile	$0
Other		100%	0	0	Land$	$0
Remaining Interest During Construction						
Loan Rate		6%				
Rate of Return on Investments		4%				
Duration of Project (yr)		2				$469,000
Total Project Cost						$6,329,683
Annual Costs						
Debt Service (6%, 30 years)		6%		30	yr	$459,845
Annual Cost from Phase IV						$6,064,268
Pipeline O&M		1%		0	$	$0
Intake and Pump Stations O&M		2.5%		$556,507	$	$13,913
Water Treatment Plant O&M		$2,730,000	10%	1	LS	$273,000
Pumping Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Plant Energy Costs		$0.06	10%	39,586,000	kW-hr	$237,516
Existing CBWC Facility Energy Costs		$0.06	10%	2,622,000	kW-hr	$15,732
Total Annual Cost - 2050						$7,080,006
Available Project Yield (acft/yr)				15,677	acft/yr	$15,677
Annual Cost of Water ($/acft)						$452
Annual Cost of Water ($/1000 gal)						$1.39

Appendix B

Cost Estimating Procedures TWDB Region H

COST ESTIMATING PROCEDURES
TWDB REGION H

The cost estimates of this study are expressed as one of three main categories that were dictated by TWDB guidelines: capital costs, other project costs, and annual project costs. Capital costs consist of all material, labor, and equipment expenses that are expended in the construction activities of a project. Other project costs include expenses that are not directly associated with the construction activities, such as engineering, land and easement acquisition, environmental studies, mitigation, and construction interest. Annual project costs consist of all costs that are incurred by the project upon implementation, either in repayment of borrowed funds or operating and maintaining the facility. Table 1 illustrates the primary components of the preliminary cost estimate. Cost estimating methods for the technical evaluation of alternatives considered for use in Texas TWDB Region H are explained in the following sections.

TABLE 1 MAJOR ESTIMATING CATEGORIES

PROJECT COSTS

CAPITAL COSTS	OTHER PROJECT COSTS
1. **Pump Stations**	1. **Engineering, Financial & Legal Services, and Contingencies**
2. **Pipelines**	- Includes Design, Bidding & Construction Phase Services, Geotechnical, and Surveying
3. **Water Treatment Plants**	2. **Land and Easements**
4. **Water Storage Tanks**	- Land Purchases
5. **Off-Channel Reservoirs**	- Temporary Easements
6. **Well Fields**	- Permanent Easements
- Injection	- Includes Legal Services, Sales Commisions, & Surveying
- Recovery	3. **Environmental - Studies and Mitigation**
- ASR Wells	- Environmental & Archaeology Studies
7. **Dams & Reservoirs**	- Permitting
8. **Relocations**	- Mitigation
9. **Water Distribution System Improvements**	4. **Interest During Construction**
10. **Other Items**	

ANNUAL COSTS
1. **Debt Service**
2. **Operation & Maintenance (O&M)**
3. **Pumping Energy Costs**
4. **Purchase of Water (if applicable)**

1 CAPITAL COSTS

Capital costs, generally known as construction costs, have been compiled from a variety of reliable sources and analyzed for trends that can be used for estimating purposes. Once a trend has been identified, a set of representative values is entered into a cost table, from which the user can easily and efficiently locate a cost estimate. Each cost table is explained in the detail in the following sections. All data was adjusted to the Second Quarter of 1999 by using the Engineering News Record's Construction Cost Index (ENR CCI) ratio. The ENR CCI value for the Second Quarter of 1999 is 6018, determined by averaging the index values of April, May, and June of 1999 (6008, 6006, and 6039, respectively). For example, to update a representative cost from January of 1997 (ENR CCI value 5765), the cost from January of 1997 would be multiplied by the ratio of 6018 over 5765. The ENR CCI values are based on representative (steel, cement, and lumber) material and labor construction costs, averaged across 20 cities. The index measures the amount of money it would cost to purchase a theoretical quantity of services and goods in one year, as opposed to another. Monthly index values are reported from 1977 to the present and annual average values are reported back to 1908.

1.1 Pump Stations

The cost of a pump station depends upon a wide variety of conditions, including pump discharge, pumping head, pump type, site conditions, desired usage, and structural design. In constructing a preliminary estimate of the cost of a pump station, the intent is not to determine the pump type or details of the station structural design, but rather to estimate the cost of a general station capable of pumping the desired discharge at the necessary head conditions. Regional pump station project cost estimates and construction records were used to adjust published EPA historical pump station cost data. By using a comprehensive and reliable source of pump station cost data, recognizing the trend, and then adjusting that trend to similar projects in the region, a representative set of values for this region was determined. The cost table for this section, shown in Table 2, displays the costs for pump stations at a variety of horsepower requirements, based on peak discharge and design head. Higher horsepower requirements may require multiple pump stations.

Pump stations are generally [redacted] or [redacted], depending on the source of the water coming into the station. [redacted] normally [redacted]ch as a river or reservoir, and [redacted] are permitted. [redacted]tations normally act as [redacted]n a plant or pipeline and [redacted]s since the inlet pipe flow conditions are fairly constant. The total cost for the intake of a pump station has been estimated as an additional 20 percent of the pump station construction cost. While 10 percent is structural additions, the other 10 percent is trash rack screens and miscellaneous rack cleaning equipment.

TABLE 2 PUMP STATION COSTS

Pump Station Horsepower (HP)	Pump Station Construction Cost ($)
0	0
700	6,205,000
1000	7,632,000
2000	10,404,000
3000	12,026,000
4000	13,177,000
5000	14,069,000
6000	14,799,000
7000	15,415,000
8000	15,949,000
9000	16,420,000
10000	16,842,000
12000	17,571,000
15000	18,464,000
20000	19,614,000

[1] Values as of Second Quarter 1999.
[2] Add 20 percent for pumps stations with intake structures.
[3] Add 35 percent for pumps stations with standby power.

All electrical costs, with the exception of standby power, are included in the base pump station construction cost. Standby power, normally either a diesel generator or a dual power feed, is necessary to insure that the pump station can remain operational in the event of a power failure. Standby power is an optional feature which has been estimated as an additional 35 percent of the base pump station construction cost.

The costs of pump stations located in water treatment plants are accounted for in the water treatment plant cost table.

1.2 Pipelines

Pipeline capital costs are dependent upon a variety of factors, including pipe material used, trenching slopes and depths, fill material quality, frequency of valves/fittings, number of obstruction crossings, necessity of pavement removal and replacement, utility interference, traffic control, geologic conditions, and degree of urbanization. Due to the lack of significant quantities of rock in the primarily sandy clay soil of the region, only one soil type was analyzed. Table 3 shows the unit costs for pipe diameters from 12-inches to 144-inches, based on level of urban development.

TABLE 3 PIPELINE UNIT COSTS

Pipe Diameter (inches)	Rural Construction ($ / LF)	Urban Construction ($ / LF)
12	55	90
14	65	110
16	75	130
18	90	145
20	100	165
24	125	210
27	145	240
30	170	280
33	185	305
36	205	340
42	245	405
48	285	475
54	335	555
60	380	635
64	410	685
66	430	710
72	485	805
78	525	870
84	575	955
90	625	1,040
96	675	1,125
102	725	1,210
108	780	1,295
114	830	1,385
120	885	1,475
144	1,105	1,840

[1] Values as of Second Quarter 1999.

The unit costs are based on open cut construction methods, with the exception of special crossings. Special crossings at railroads, streets, and rivers will likely be accomplished by horizontal boring, also known as pipe jacking. Horizontal boring costs are shown in Table 4.

TABLE 4 PIPELINE CROSSING UNIT COSTS

Pipe Diameter (inches)	Total Cost ($ / LF)
4	560
6	565
8	580
10	610
12	600
16	680
18	745
20	730
24	845
30	940
36	1045
42	1170
48	1295
54	1430
60	1565
66	1650
72	1730
78	1795
84	1850
[1] Values as of Second Quarter 1999. [2] Costs based on Horizontal Boring (Jacking).	

1.3 Water Treatment Plants

Water treatment plant capital costs are shown in Table 5 for three alternative treatment methods. One process is used almost exclusively on groundwater sources. The other two processes use filtration, mostly for surface water sources, and the quality of the source water normally dictates which one is used.

Groundwater is commonly treated by chlorination only, because the process is relatively inexpensive compared to filtration and the treatment equipment is small enough that each groundwater well can normally have its own. The most common of the surface water treatment methods is conventional filtration treatment. When influent suspended solids concentrations are sufficiently low that they are completely removed by filtration and result in a reasonable backwash cycle on the filtration units, direct filtration can be used. The direct filtration plant is essentially the same as the conventional filtration plant, except the sedimentation process is deleted. Wastewater effluent is sometimes reclaimed for aquifer injection or non-potable use, but this process is discussed later in Section 1.11.

TABLE 5 WATER TREATMENT PLANT COSTS

Plant Capacity (MGD)	Groundwater Chlorination Plant Cost ($)	Direct Filtration Plant Cost ($)	Conventional Filtration Plant Cost ($)
1	385,000	2,862,000	3,578,000
10	2,246,000	16,682,000	20,852,000
50	7,000,000	52,000,000	65,000,000
75	10,500,000	78,000,000	97,500,000
100	14,000,000	104,000,000	130,000,000
150	21,000,000	156,000,000	195,000,000
200	28,000,000	208,000,000	260,000,000

[1] Values as of Second Quarter 1999.

As can be seen in Table 6, the choice of treatment methods is dictated by both the quality of the influent water source and the intended destination of the treated water. Surface waters treated by direct filtration and wastewater reclamation are not intended for conveyance to a public water distribution system. The reason for this is that surface water and wastewater effluent normally has a high suspended solids content and the treatment processes cannot remove enough of the suspended solids to produce a water quality necessary for public water supplies.

TABLE 6 WATER TREATMENT METHOD DESCRIPTIONS

Water Treatment Method	Source			Destination	
	Groundwater	Surface Water	Wastewater	Aquifer or Non-Potable Use	Public Water System Distribution
Groundwater Chlorination	●			●	●
Direct Filtration	●			●	●
Direct Filtration		●		●	
Conventional (Filtration)		●		●	●
Wastewater Reclamation			●	●	

1.4 Storage Tanks

Storage tanks are used in a variety of different water supply systems, including pump stations, distribution systems, and pipelines. Several factors influence the cost of storage tanks, including frequency of use, capacity, type of construction materials, location, architectural treatment, and corrosion resistance. Steel tanks are normally constructed in elevated or ground-level locations, while prestressed concrete tanks are normally constructed at or below grade. Concrete does not require cathodic protection or any type of protective exterior coating. Below grade tanks require no architectural treatment, but have higher excavation and backfill costs. The costs of storage tanks are shown in Table 7 are based on ground-level prestressed concrete construction for a range of capacities.

WATER STORAGE TANK COSTS

Storage Capacity (MG)	Cost ($)
0.01	161,998
0.05	192,277
0.10	250,864
0.5	494,717
1.0	741,476
2.0	1,105,507
4.0	1,662,686
6.0	2,226,462
7.5	2,691,516
9.0	3,065,107
10.0	3,302,218
15.0	4,709,555

[1] Values as of Second Quarter 1999.
[2] Costs based on ground level prestressed concrete construction.

1.5 Off-Channel Reservoirs

An off-channel reservoir is a reservoir that receives minimal or no natural inflow. Two methods are normally employed in the construction of off-channel reservoirs. A dam can be constructed along a minor tributary or a ring dike can be constructed. Since little or no natural inflow reaches the reservoir, water is normally supplied by pumping from a nearby river or other location. The cost of the off-channel reservoir is highly dependent on the height of the levees that are constructed and the area of land that is available for use. Land costs will be considerably higher for a shorter ring dike with a much larger circumference that can still hold the same capacity as a taller ring dike with a smaller circumference. Table 8 shows the cost of off-channel reservoirs for a range of capacities.

OFF-CHANNEL RESERVOIR COSTS

Storage Volume (ac-ft)	Ring Dike Cost ($)
500	965,000
1,000	1,393,000
2,500	2,313,000
5,000	4,590,000
7,500	5,733,000
10,000	6,733,000
12,500	7,642,000
15,000	10,788,000
17,500	11,732,000
20,000	15,728,000
22,000	16,542,000
25,000	17,705,000

[1] Values as of Second Quarter 1999.
[2] Values are based on ring dike construction.
[3] Values also used for cost of dams on minor tributaries.

1.6 Well Fields

The costs for public water supply wells are shown in Table 9, as estimated by LBG-Guyton Associates, Inc. The costs include well completion, pumps, and all other necessary facilities. Irrigation wells costs are assumed to amount to 55 percent of public water supply well costs for wells of equivalent depth and capacity.

PUBLIC SUPPLY WELL COSTS

Well Depth (feet)	Well Capacity (gpm)				
	200	400	700	1,000	1,500
Static Water Level Less Than 200 Feet Below Land Surface					
300	$ 150,000	$ 229,200	$ 250,800	-	-
500	$ 180,000	$ 260,400	$ 285,600	$ 404,400	-
700	$ 235,000	$ 282,000	$ 308,400	$ 430,800	$ 459,600
1,000	$ 270,000	$ 328,800	$ 355,200	$ 469,200	$ 498,000
1,500	$ 310,000	$ 340,200	$ 405,600	$ 520,200	$ 564,000
Static Water Levels Between 200 and 300 Feet Below Land Surface					
500	$ 160,000	$ 221,000	-	-	-
700	$ 190,000	$ 224,400	$ 315,800	$ 440,200	$ 470,600
1,000	$ 240,000	$ 335,400	$ 365,600	$ 485,500	$ 530,100
1,500	$ 320,000	$ 350,900	$ 415,600	$ 530,900	$ 600,500
Static Water Levels Between 300 and 400 Feet Below Land Surface					
500	$ 170,000	-	-	-	-
700	$ 210,000	$ 238,000	$ 350,000	$ 470,000	$ 500,000
1,000	$ 260,000	$ 414,400	$ 367,200	$ 510,000	$ 550,000
1,500	$ 330,000	$ 415,000	$ 564,000	$ 690,000	$ 750,000
Static Water Levels Between 400 and 500 Feet Below Land Surface					
1,000	$ 283,000	$ 400,800	$ 485,800	$ 596,400	-
1,500	$ 328,000	$ 434,400	$ 576,000	$ 767,000	-

[1] Values as of Second Quarter 1999.
[2] Costs based on underreamed, gravel-packed wells, with steel casing and stainless steel screens.
[3] Costs as estimated by LBG-Guyton Associates.
[4] Irrigation well costs assumed to be 55% of above public water supply well cost values.

1.7 Dams and Reservoirs

Dam and reservoir construction costs were estimated on an individual case basis due to the unique nature of each project. Most dams and reservoirs that are currently under consideration have been studied in detail in the past and the previous cost estimates normally include both construction cost and other project costs. In most cases, the cost estimates from these previous studies were used, after adjusting the costs with the ENR CCI to the Second Quarter of 1999.

1.8 Relocations

In some cases, projects required the use of lands that contain existing facilities or improvements. While relocation of existing utilities, roads, homes, businesses, and other facilities is oftentimes an option, outright purchase cost of the land must be allowed for in cases where it is not deemed acceptable to relocate. Relocation cost estimates are addressed on an individual project basis due to the variation in the cost of the land and facilities which require relocation.

1.9 Water Distribution System Improvements

A water distribution system is used to distribute water throughout the service area by means of pump stations, piping, valves, storage tanks, and a variety of other equipment and facilities. When a city or entity requires additional water, improvements to the water distribution system are normally necessary. The cost of the water distribution system improvements varies considerably, based on the extent of the existing and proposed facilities and the wide variety of facilities that make up a water distribution system. Costs are estimated on an individual basis using previous proposed water distribution facility studies and cost estimates.

1.10 Stilling Basins

Stilling basins are normally used in water distribution systems to decrease the water flow velocity and allow sediment to settle out prior to discharging into a canal, reservoir, or other body of water. Stilling basin costs are estimated based on a target detention time of two hours and includes all excavation and hauling costs necessary to construct the basin. Optional mechanical sedimentation basin dredging equipment is not included. Stilling basin construction costs, when applicable, are estimated as $2,800 per cfs of discharge.

1.11 Wastewater Reclamation Plants

Wastewater effluent can be treated by a variety of methods for aquifer or other non-potable uses. The reverse osmosis membrane treatment method, including denitrification, was used to estimate the wastewater reclamation plant costs that are shown in Table 10. Reclaimed wastewater should not be sent directly to a public water distribution system.

TABLE 10 WASTEWATER RECLAMATION PLANT COSTS

Plant Capacity (MGD)	Wastewater Reclamation Plant Cost ($)
1	5,048,000
10	25,301,000
50	51,500,000
75	77,250,000
100	103,000,000
150	154,500,000
200	206,000,000

[1] Values as of Second Quarter 1999.

[2] Based on Reverse Osmosis Membrane process, with Denitrification, from Trans-Texas Water Program, Southeast Area, Technical Memorandum entitled "Wastewater Reclamation", March 19, 1998.

2 OTHER PROJECT COSTS

2.1 Engineering, Financial and Legal Services, and Contingencies

Engineering, financial and legal services, and contingencies are estimated as a lump sum, according to TWDB guidelines, as 30 percent of the total construction cost for pipelines and 35 percent of the total construction cost for all other types of projects.

2.2 Land and Easements

Land related costs for a project are typically one of two types: land permanently purchased for construction of a facility, or easement costs. The amount and cost of land purchased for various types of projects is considered on an individual project basis, taking into consideration similar project experience. Easement costs, on the other hand, can vary considerably in a single project, based on the variety of site conditions that a pipeline may encounter along its path. Easements are generally acquired for pipeline projects and can normally be classified as temporary or permanent. Permanent easements are purchased for the land that the pipeline will remain in once it is completed, including a wide enough buffer zone to allow maintenance access and protect the pipeline from other parallel utilities. Temporary easements are "rented" to allow extra room for material and equipment staging, as well as other construction related activities.

Land related costs include legal services, sales commissions, and surveying. Ten percent of the total land and easement costs is added to account for all legal services, sales commisions, and surveying associated with the land related purchases. Land costs can vary considerably throughout the region, based on degree of urbanization and other economic factors. County appraisal district records, previous project estimates, and other land value sources are used to estimate the land related costs.

2.3 Environmental and Archaeology Studies, Permitting, and Mitigation

Costs for environmental studies, archaeological studies, permitting, and mitigation are estimated on an individual project basis, taking into consideration previous project estimates, the judgement of qualified professionals, and any other available information. In the case of reservoir projects, mitigation costs were generally equal to the land value of the acreage that would be inundated.

2.4 Interest During Construction

Interest during construction is calculated as the cost of the interest on the borrowed funds, less the return on the unspent portion of the borrowed funds that are invested during construction. Interest during construction is calculated, according to TWDB guidelines, as the total interest accrued by a 6 percent annual interest rate on the total borrowed funds at the end of the construction phase, less a 4 percent annual rate of return on investment of unspent funds.

3 ANNUAL COSTS

Annual costs are expenses which the owner of the project can expect once the project is completed. Each of these costs is described in detail in the following subsections.

3.1 Debt Service

Debt service is the total annual payment that is required to repay borrowed funds. Debt service was calculated according to TWDB Section 1.71 of Exhibit B, assuming an annual interest rate of 6 percent and a repayment period of 40 years for reservoir projects and 30 years for all other projects.

3.2 Operation and Maintenance

Operation and maintenance (O&M) costs include all labor and materials required to run the facility and and keep it operational, including periodic repair and/or replacement of facility equipment. In accordance with TWDB guidelines, O&M costs are calculated as 1 percent of the total estimated construction costs for pipelines, distribution facilities, tanks, and wells, 1.5 percent of the total estimated construction costs for dams and reservoirs, and 2.5 percent of the total estimated construction costs for intake structures and pump stations. Water treatment plant cost estimates are shown in Table 10 below.

TABLE 11 OPERATION AND MAINTENANCE COSTS FOR WATER TREATMENT PLANTS

Plant Capacity (MGD)	Groundwater Chlorination Plant Cost ($)	Direct Filtration Plant Cost ($)	Conventional (Filtration) Plant Cost ($)	Wastewater Reclamation Plant Cost ($)
1	146,000	156,000	195,000	211,700
10	1,460,000	1,560,000	1,950,000	2,117,000
50	7,300,000	7,800,000	9,750,000	10,585,000
75	10,950,000	11,700,000	14,625,000	15,877,500
100	14,600,000	15,600,000	19,500,000	21,170,000
150	21,900,000	23,400,000	29,250,000	31,755,000
200	29,200,000	31,200,000	39,000,000	42,340,000

[1] Values as of Second Quarter 1999.

3.3 Pumping Energy Costs

Power costs are calculated on an annual basis, using calculated horsepower input and a power purchase cost of $0.06 per kWh, per TWDB guidelines.

3.4 Purchase of Water

The purchase of water, if applicable to the management strategy being considered, is dependent on the source and type (raw or treated) of water being purchased. The cost is addressed on an individual project basis due to the wide variety of water types and sources.

4 PRESENTATION OF COST ESTIMATES

Each water management strategy is provided with a cost estimate that shows total construction costs, total project costs (the sum of construction costs and other project costs), and total annual project costs. The unit cost of each alternative per unit of water delivered (total project cost per acre-foot of water delivered) is also presented for further comparison. Each site specific alternative provides as much detail in the estimate as is necessary to accurately estimate the management strategy that is being considered. Once the detailed cost estimate is completed for each shortage, the values from the detailed estimates are included in the Table 11 summary table.

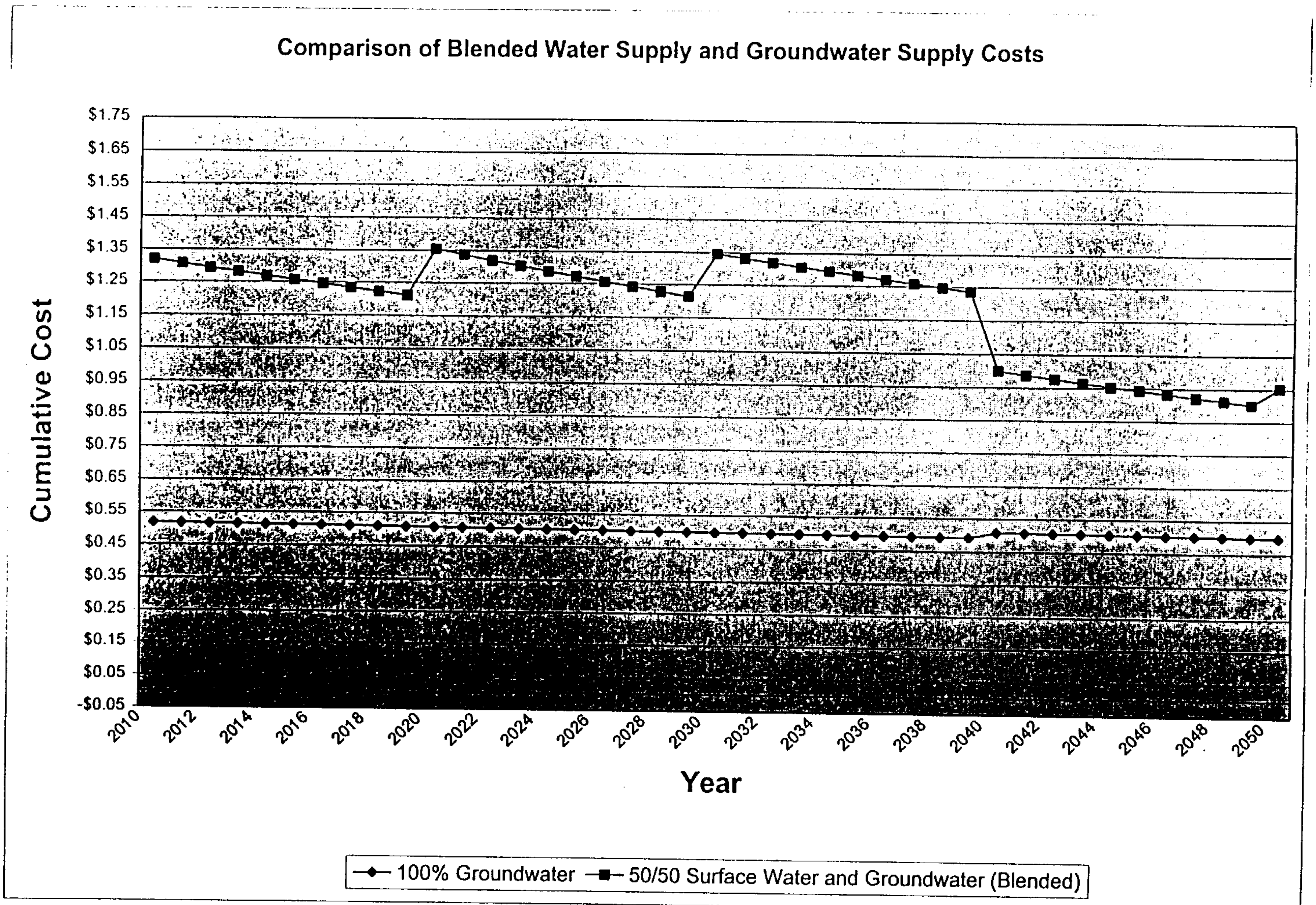
Appendix C

Cost Comparison of Groundwater and Blended Water Supplies

							100 % Groundwater Alternative					
Year	Total Demand (ac-Ft)	Total Demand (gallons)	BWA Contract (ac-Ft)	Total GW Demand (ac-Ft)	Total GW Demand (gallons)	BWA Contract Cost	GW O&M Cost	GW Rehab. Cost	New Well Cost	Total Annual GW Cost	Total Annual GW Cost	Cumulative GW Cost
2010	17962	5852536906	1815	16147	5261157634	$408,375	$2,157,075	$157,835		$2,723,284	$0.52	$2,723,284
2011	18180	5923632750	1815	16365	5332253478	$408,375	$2,186,224	$159,968		$2,754,567	$0.52	$5,477,851
2012	18398	5994728594	1815	16583	5403349322	$408,375	$2,215,373	$162,100		$2,785,849	$0.52	$8,263,700
2013	18617	6065824438	1815	16802	5474445166	$408,375	$2,244,523	$164,233		$2,817,131	$0.51	$11,080,830
2014	18835	6136920282	1815	17020	5545541010	$408,375	$2,273,672	$166,366		$2,848,413	$0.51	$13,929,244
2015	19053	6208016126	1815	17238	5616636854	$408,375	$2,302,821	$168,499		$2,879,695	$0.51	$16,808,939
2016	19271	6279111971	1815	17456	5687732699	$408,375	$2,331,970	$170,632		$2,910,977	$0.51	$19,719,916
2017	19489	6350207815	1815	17674	5758828543	$408,375	$2,361,120	$172,765		$2,942,260	$0.51	$22,662,176
2018	19708	6421303659	1815	17893	5829924387	$408,375	$2,390,269	$174,898		$2,973,542	$0.51	$25,635,717
2019	19926	6492399503	1815	18111	5901020231	$408,375	$2,419,418	$177,031		$3,004,824	$0.51	$28,640,541
2020	20144	6563495347	1815	18329	5972116075	$408,375	$2,448,568	$179,163		$3,036,106	$0.51	$31,676,647
2021	20463	6667532483	1815	18648	6076153211	$408,375	$2,491,223	$182,285		$3,081,882	$0.51	$34,758,530
2022	20783	6771569619	1815	18968	6180190347	$408,375	$2,533,878	$185,406		$3,127,659	$0.51	$37,886,189
2023	21102	6875606755	1815	19287	6284227483	$408,375	$2,576,533	$188,527		$3,173,435	$0.50	$41,059,624
2024	21421	6979643891	1815	19606	6388264619	$408,375	$2,619,188	$191,648		$3,219,211	$0.50	$44,278,835
2025	21741	7083681026	1815	19926	6492301754	$408,375	$2,661,844	$194,769		$3,264,988	$0.50	$47,543,823
2026	22060	7187718162	1815	20245	6596338890	$408,375	$2,704,499	$197,890		$3,310,764	$0.50	$50,854,587
2027	22379	7291755298	1815	20564	6700376026	$408,375	$2,747,154	$201,011		$3,356,540	$0.50	$54,211,127
2028	22698	7395792434	1815	20883	6804413162	$408,375	$2,789,809	$204,132		$3,402,317	$0.50	$57,613,444
2029	23018	7499829570	1815	21203	6908450298	$408,375	$2,832,465	$207,254		$3,448,093	$0.50	$61,061,537
2030	23337	7603866706	1815	21522	7012487434	$408,375	$2,875,120	$210,375		$3,493,869	$0.50	$64,555,407
2031	23620	7695945924	1815	21805	7104566652	$408,375	$2,912,872	$213,137		$3,534,384	$0.50	$68,089,791
2032	23902	7788025143	1815	22087	7196645871	$408,375	$2,950,625	$215,899		$3,574,899	$0.50	$71,664,690
2033	24185	7880104362	1815	22370	7288725090	$408,375	$2,988,377	$218,662		$3,615,414	$0.50	$75,280,104
2034	24467	7972183581	1815	22652	7380804309	$408,375	$3,026,130	$221,424		$3,655,929	$0.50	$78,936,033
2035	24750	8064262800	1815	22935	7472883528	$408,375	$3,063,882	$224,187		$3,696,444	$0.49	$82,632,477
2036	25033	8156342019	1815	23218	7564962747	$408,375	$3,101,635	$226,949		$3,736,959	$0.49	$86,369,436
2037	25315	8248421238	1815	23500	7657041966	$408,375	$3,139,387	$229,711		$3,777,473	$0.49	$90,146,909
2038	25598	8340500457	1815	23783	7749121185	$408,375	$3,177,140	$232,474		$3,817,988	$0.49	$93,964,897
2039	25880	8432579676	1815	24065	7841200404	$408,375	$3,214,892	$235,236		$3,858,503	$0.49	$97,823,401
2040	26163	8524658894	1815	24348	7933279622	$408,375	$3,252,645	$237,998	$135,870	$4,034,888	$0.51	$101,858,289
2041	26575	8658998109	1815	24760	8067618837	$408,375	$3,307,724	$242,029	$135,870	$4,093,997	$0.51	$105,952,286
2042	26988	8793337323	1815	25173	8201958051	$408,375	$3,362,803	$246,059	$135,870	$4,153,107	$0.51	$110,105,392
2043	27400	8927676537	1815	25585	8336297265	$408,375	$3,417,882	$250,089	$135,870	$4,212,216	$0.51	$114,317,608
2044	27812	9062015751	1815	25997	8470636479	$408,375	$3,472,961	$254,119	$135,870	$4,271,325	$0.50	$118,588,933
2045	28225	9196354966	1815	26410	8604975694	$408,375	$3,528,040	$258,149	$135,870	$4,330,434	$0.50	$122,919,368
2046	28637	9330694180	1815	26822	8739314908	$408,375	$3,583,119	$262,179	$135,870	$4,389,544	$0.50	$127,308,911
2047	29049	9465033394	1815	27234	8873654122	$408,375	$3,638,198	$266,210	$135,870	$4,448,653	$0.50	$131,757,564
2048	29461	9599372608	1815	27646	9007993336	$408,375	$3,693,277	$270,240	$135,870	$4,507,762	$0.50	$136,265,326
2049	29874	9733711823	1815	28059	9142332551	$408,375	$3,748,356	$274,270	$135,870	$4,566,871	$0.50	$140,832,197
2050	30286	9868051037	1815	28471	9276671765	$408,375	$3,803,435	$278,300	$135,870	$4,625,981	$0.50	$145,458,178

50/50 Surface Water and Groundwater (Blended) Alternative

Year	Total Demand (ac-Ft)	Total Demand (gallons)	Total SW Demand (ac-Ft)	Total SW Demand (gallons)	BWA Contract (ac-Ft)	BWA Contract Cost	Annual SW Cost 2010	Annual SW Cost 2020	Annual SW Cost 2030	Annual SW Cost 2040	Annual SW Cost 2050	Total SW Cost	GW O&M Cost	GW Rehab. Cost	Total GW Cost	Total Annual Blended Cost	Total Annual Blended Cost	Cumulative Blended Cost
2010	17962	5852536906	8981	2926268453	1815	$408,375	$6,436,685					$6,436,685	$1,199,770	$87,788	$1,287,558	$7,724,243	$1.32	$7,724,243
2011	18180	5923632750	9090	2961816375	1815	$408,375	$6,436,685					$6,436,685	$1,214,345	$88,854	$1,303,199	$7,739,884	$1.31	$15,464,127
2012	18398	5994728594	9199	2997364297	1815	$408,375	$6,436,685					$6,436,685	$1,228,919	$89,921	$1,318,840	$7,755,525	$1.29	$23,219,653
2013	18617	6065824438	9308	3032912219	1815	$408,375	$6,436,685					$6,436,685	$1,243,494	$90,987	$1,334,481	$7,771,166	$1.28	$30,990,819
2014	18835	6136920282	9417	3068460141	1815	$408,375	$6,436,685					$6,436,685	$1,258,069	$92,054	$1,350,122	$7,786,807	$1.27	$38,777,626
2015	19053	6208016126	9527	3104008063	1815	$408,375	$6,436,685					$6,436,685	$1,272,643	$93,120	$1,365,764	$7,802,449	$1.26	$46,580,075
2016	19271	6279111971	9636	3139555985	1815	$408,375	$6,436,685					$6,436,685	$1,287,218	$94,187	$1,381,405	$7,818,090	$1.25	$54,398,165
2017	19489	6350207815	9745	3175103907	1815	$408,375	$6,436,685					$6,436,685	$1,301,793	$95,253	$1,397,046	$7,833,731	$1.23	$62,231,895
2018	19708	6421303659	9854	3210651829	1815	$408,375	$6,436,685					$6,436,685	$1,316,367	$96,320	$1,412,687	$7,849,372	$1.22	$70,081,267
2019	19926	6492399503	9963	3246199752	1815	$408,375	$6,436,685					$6,436,685	$1,330,942	$97,386	$1,428,328	$7,865,013	$1.21	$77,946,280
2020	20144	6563495347	10072	3281747674	1815	$408,375		$7,449,828				$7,449,828	$1,345,517	$98,452	$1,443,969	$8,893,797	$1.36	$86,840,077
2021	20463	6667532483	10232	3333766242	1815	$408,375		$7,449,828				$7,449,828	$1,366,844	$100,013	$1,466,857	$8,916,685	$1.34	$95,756,762
2022	20783	6771569619	10391	3385784809	1815	$408,375		$7,449,828				$7,449,828	$1,388,172	$101,574	$1,489,745	$8,939,573	$1.32	$104,696,335
2023	21102	6875606755	10551	3437803377	1815	$408,375		$7,449,828				$7,449,828	$1,409,499	$103,134	$1,512,633	$8,962,461	$1.30	$113,658,797
2024	21421	6979643891	10711	3489821945	1815	$408,375		$7,449,828				$7,449,828	$1,430,827	$104,695	$1,535,522	$8,985,350	$1.29	$122,644,147
2025	21741	7083681026	10870	3541840513	1815	$408,375		$7,449,828				$7,449,828	$1,452,155	$106,255	$1,558,410	$9,008,238	$1.27	$131,652,384
2026	22060	7187718162	11030	3593859081	1815	$408,375		$7,449,828				$7,449,828	$1,473,482	$107,816	$1,581,298	$9,031,126	$1.26	$140,683,510
2027	22379	7291755298	11190	3645877649	1815	$408,375		$7,449,828				$7,449,828	$1,494,810	$109,376	$1,604,186	$9,054,014	$1.24	$149,737,525
2028	22698	7395792434	11349	3697896217	1815	$408,375		$7,449,828				$7,449,828	$1,516,137	$110,937	$1,627,074	$9,076,902	$1.23	$158,814,427
2029	23018	7499829570	11509	3749914785	1815	$408,375		$7,449,828				$7,449,828	$1,537,465	$112,497	$1,649,963	$9,099,791	$1.21	$167,914,217
2030	23337	7603866706	11669	3801933353	1815	$408,375			$8,563,800			$8,563,800	$1,558,793	$114,058	$1,672,851	$10,236,651	$1.35	$178,150,868
2031	23620	7695945924	11810	3847972962	1815	$408,375			$8,563,800			$8,563,800	$1,577,669	$115,439	$1,693,108	$10,256,908	$1.33	$188,407,776
2032	23902	7788025143	11951	3894012572	1815	$408,375			$8,563,800			$8,563,800	$1,596,545	$116,820	$1,713,366	$10,277,166	$1.32	$198,684,942
2033	24185	7880104362	12092	3940052181	1815	$408,375			$8,563,800			$8,563,800	$1,615,421	$118,202	$1,733,623	$10,297,423	$1.31	$208,982,365
2034	24467	7972183581	12234	3986091791	1815	$408,375			$8,563,800			$8,563,800	$1,634,298	$119,583	$1,753,880	$10,317,680	$1.29	$219,300,045
2035	24750	8064262800	12375	4032131400	1815	$408,375			$8,563,800			$8,563,800	$1,653,174	$120,964	$1,774,138	$10,337,938	$1.28	$229,637,983
2036	25033	8156342019	12516	4078171009	1815	$408,375			$8,563,800			$8,563,800	$1,672,050	$122,345	$1,794,395	$10,358,195	$1.27	$239,996,178
2037	25315	8248421238	12658	4124210619	1815	$408,375			$8,563,800			$8,563,800	$1,690,926	$123,726	$1,814,653	$10,378,453	$1.26	$250,374,631
2038	25598	8340500457	12799	4170250228	1815	$408,375			$8,563,800			$8,563,800	$1,709,803	$125,108	$1,834,910	$10,398,710	$1.25	$260,773,341
2039	25880	8432579676	12940	4216289838	1815	$408,375			$8,563,800			$8,563,800	$1,728,679	$126,489	$1,855,168	$10,418,968	$1.24	$271,192,308
2040	26163	8524658894	13082	4262329447	1815	$408,375				$6,646,116		$6,646,116	$1,747,555	$127,870	$1,875,425	$8,521,541	$1.00	$279,713,849
2041	26575	8658998109	13288	4329499054	1815	$408,375				$6,646,116		$6,646,116	$1,775,095	$129,885	$1,904,980	$8,551,096	$0.99	$288,264,945
2042	26988	8793337323	13494	4396668661	1815	$408,375				$6,646,116		$6,646,116	$1,802,634	$131,900	$1,934,534	$8,580,650	$0.98	$296,845,595
2043	27400	8927676537	13700	4463838269	1815	$408,375				$6,646,116		$6,646,116	$1,830,174	$133,915	$1,964,089	$8,610,205	$0.96	$305,455,800
2044	27812	9062015751	13906	4531007876	1815	$408,375				$6,646,116		$6,646,116	$1,857,713	$135,930	$1,993,643	$8,639,759	$0.95	$314,095,560
2045	28225	9196354966	14112	4598177483	1815	$408,375				$6,646,116		$6,646,116	$1,885,253	$137,945	$2,023,198	$8,669,314	$0.94	$322,764,874
2046	28637	9330694180	14318	4665347090	1815	$408,375				$6,646,116		$6,646,116	$1,912,792	$139,960	$2,052,753	$8,698,869	$0.93	$331,463,742
2047	29049	9465033394	14525	4732516697	1815	$408,375				$6,646,116		$6,646,116	$1,940,332	$141,976	$2,082,307	$8,728,423	$0.92	$340,192,166
2048	29461	9599372608	14731	4799686304	1815	$408,375				$6,646,116		$6,646,116	$1,967,871	$143,991	$2,111,862	$8,757,978	$0.91	$348,950,144
2049	29874	9733711823	14937	4866855911	1815	$408,375				$6,646,116		$6,646,116	$1,995,411	$146,006	$2,141,417	$8,787,533	$0.90	$357,737,676
2050	30286	9868051037	15143	4934025518	1815	$408,375					$7,225,642	$7,225,642	$2,022,950	$148,021	$2,170,971	$9,396,613	$0.95	$367,134,289



Comparison of Blended Water Supply and Groundwater Supply Costs
Cumulative Cost
$1.75
$1.65
$1.55
$1.45
$1.35
$1.25
$1.15
$1.05
$0.95
$0.85
$0.75
$0.65
$0.55
$0.45
$0.35
$0.25
$0.15
$0.05
-$0.05
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Year
100% Groundwater
50/50 Surface Water and Groundwater (Blended)

Appendix F
Treatment Process Capital and O & M Costs

CAPITAL COSTS FOR 25 MGD HIGH RATE CONVENTIONAL SYSTEM (2 PHASE)

Unit	Units	Quantity	Cost Estimate	Notes
Sitework	per acre	20	$3,500,000	
Yard Piping	per mgd	25	$2,125,000	
Low Lift Pumping	per mgd	27.5	$792,000	Includes VFDs
Mixing/Flocculation/Sedimentaton	per unit	3	$1,170,000	Superpulsators
Filters	per sf	3644	$5,467,000	Deep bed, GAC/sand, air scour
Transfer Pumping	per mgd	26.5	$780,000	Includes VFDs
PAC System	per sys	2	$250,000	Silo storage
Backwash Equalization Tank	per gal	257850	$232,000	Tank and recycle pumps
Backwash Clarification	per mgd	0.6	$106,000	Lamella settlers
Gravity thickeners/holding tanks	per mgd	0.4	$16,000	
Chemical Systems,Building, Tanks	ls per sys.	22	$5,335,000	Chlorine, caustic soda, ammonia, ferric,PEC,PEA, chlorine dioxide, flouride,orthophosphate,spare
Sludge Lagoons	per acre	5.07	$888,000	
Ground Storage Tanks	per gal	7,000,000	$2,800,000	
Subtotal			$23,461,000	
Electrical, Instrumentation, and Controls			$3,050,000	Allowance (13%)
Subtotal			$26,511,000	
Mobilization			$795,000	Allowance (3%)
Subtotal			$27,306,000	
Construction Management, Insurance, Bonds,Profit			$3,550,000	Allowance (13%)
Construction Cost Subtotal			$30,856,000	
Total Capital Cost			$30,860,000	Rounded
			$1.23	Per Gallon of Capacity

Notes:
1. 25 MGD Finished Water Capacity
2. 15 MGD First Phase

CAPITAL COSTS FOR 15 MGD INTIAL PHASE - HIGH RATE CONVENTIONAL SYSTEM

Unit	Unit Cost	Units	Quantity	Cost Estimate	Notes
Sitework	$175,000	per acre	20.0	$3,500,000	
Yard Piping	$85,000	per mgd	15.0	$1,275,000	
Low Lift Pumping	$40,000	per mgd	16.5	$660,000	Includes VFDs
Mixing/Flocculation/Sedimentaiton	$327,500	per unit	2.0	$655,000	Superpulsators
Filters	$1,500	per sf	2,733.0	$4,100,000	Deep bed, GAC/sand, air scour
Transfer Pumping	$40,000	per mgd	16.5	$660,000	Includes VFDs
PAC System	$125,000	per sys	2.0	$250,000	Silo storage
Backwash Equalization Tank	$0.90	per gal	257,850.0	$232,000	Tank and recycle pumps
Backwash Clarification	$175,000	per mgd	0.3	$53,000	Lamella settlers
Gravity thickeners/holding tanks	$40,000	per mgd	0.2	$8,000	
Chemical Systems,Building, Tanks	$350,000	ls per sys.	11.0	$3,850,000	Chlorine, caustic soda, ammonia, ferric,PEC,PEA, chlorine dioxide, flouride,orthophosphate,spare
Sludge Lagoons	$175,000	per acre	3.4	$592,000	
Ground Storage Tanks	$0.40	per gal	4,000,000	$1,600,000	
Subtotal				**$17,435,000**	
Electrical, Instrumentation, and Controls	13%			$2,267,000	Allowance (13%)
Subtotal				**$19,702,000**	
Mobilization	3%			$591,000	Allowance (3%)
Subtotal				**$20,293,000**	
Construction Management, Insurance, Bonds,Profit	13%			$2,638,000	Allowance (13%)
Construction Cost Subtotal				$22,931,000	
Total Capital Cost				$22,931,000	Rounded
				$1.53	Per Gallon of Capacity

Notes:

1. 25 MGD Finished Water Capacity
2. 15 MGD First Phase

OPERATING AND MAINTENACE COSTS FOR HIGH RATE CONVENTIONAL SYSTEM

15.0 MGD Finished Water Capacity

VARIABLE COSTS

Electrical Costs

Cost per kW-hr = **$0.06**

	No. of Units	Horsepower	% Utilization	Power Consumption, kW-hr	Cost per kgal produced
Low Lift Pumps	4	50	100%	3,581	$0.0143
Clarifier System	2	15	100%	537	$0.0021
Backwash pumps and blowers	1	400	5%	358	$0.0014
Transfer Pumps	4	50	100%	3,581	$0.0143
WW EQ Recycle Pum	2	30	75%	806	$0.0032
Sludge pumping and	4	30	75%	1,611	$0.0064
Miscellanous	1	100	100%	1,790	$0.0072
				Electrical Costs Subtotal	**$0.049**

Chemical Costs

		Cost ($/Ton-Dry Equivalent)	Dose (mg/l of dry equivalent)	Flow (mgd)	Cost per kgal produced
Ferric		$450	30	16.5	$0.062
Cationic Polymer		$1,000	5	16.5	$0.023
Anionic Polymer		$1,500	1	16.5	$0.003
Sodium Chlorite	(1.5 mg/l Chlorine dioxide dose)	$1,000	0.8	16.5	$0.004
Chlorine - ClO2	(1.5 mg/l Chlorine dioxide dose)	$400	0.8	16.5	$0.002
Chlorine - BW		$400	5	0.8	$0.000
Chlorine - Residual Disinfectant		$400	3	15.0	$0.005
Ammonia		$350	1.0	15.0	$0.001
PAC		$1,100	10.0	16.5	$0.050
Caustic Soda		$600	10.0	15.0	$0.025
Flouride		$1,500	0.6	15.0	$0.004
Corrosion Inhibitor, mg/L		$5,200	0.5	15.0	$0.011
				Chemical Costs Subtotal	**$0.190**

Sludge Disposal Costs

	Sludge Produced, cy wet sludge/YR	Dried Percent Solids	Handling/Disposal, $/cy	Cost per kgal produced
	4,920	**45%**	**$15.0**	**$0.013**

Raw Water Costs **(contained in raw water analysis)**

Variable Operating Costs, cost per kgal treated **$0.253**

FIXED COSTS

					Annual Cost
Maintenance			% of CC's 1.7%	Capital Costs $22,931,000	**$390,000**
GAC Replacement		**3499 cu ft/yr**	$ 100.00	per cu ft	**$350,000**

Labor		No. of Equivalent Full-Time	Avg. Salary $/Hr	Avg. Burdened Salary $/Hr	
	Total	12.5	$18.44	$27.66	**$718,000**
	Process Operators	6	$17.00	$25.50	$318,000
	Electrician, Instrument Tech	2	$22.50	$33.75	$140,000
	Maintenance	3	$18.00	$27.00	$168,000
	Administration	1	$13.00	$19.50	$41,000
	Superintendent	0.5	$33.00	$49.50	$51,000
	Burden Multiplier	1.5			
Admin					**$600,000**

Fixed Operating Costs, cost per year **$2,058,000**

Fixed Operating Costs, cost per 1000 gallons provided **$0.63**

CAPITAL COSTS FOR 10 MGD EXPANSION - HIGH RATE CONVENTIONAL SYSTEM

Unit	Unit Cost	Units	Quantity	Cost Estimate	Notes
Sitework	$175,000	per acre	0.0	$0	
Yard Piping	$85,000	per mgd	10.0	$850,000	
Low Lift Pumping	$12,000	per mgd	11.0	$132,000	Includes VFDs
Mixing/Flocculation/Sedimentaiton	$515,000	per unit	1.0	$515,000	Superpulsators
Filters	$1,500	per sf	911.0	$1,367,000	Deep bed, GAC/sand, air scour
Transfer Pumping	$12,000	per mgd	10.0	$120,000	Includes VFDs
PAC System	$125,000	per sys	0.0	$0	Silo storage
Backwash Equalization Tank	$0.90	per gal	0.0	$0	Tank and recycle pumps
Backwash Clarification	$175,000	per mgd	0.3	$53,000	Lamella settlers
Gravity thickeners/holding tanks	$40,000	per mgd	0.2	$8,000	
Chemical Systems,Building, Tanks	$135,000	ls per sys.	11.0	$1,485,000	Chlorine, caustic soda, ammonia, ferric,PEC,PEA, chlorine dioxide, flouride,orthophosphate,spare
Sludge Lagoons	$175,000	per acre	1.7	$296,000	
Ground Storage Tanks	$0.40	per gal	3,000,000	$1,200,000	
Subtotal				**$6,026,000**	
Electrical, Instrumentation, and Controls	13%			$783,000	Allowance
Subtotal				**$6,809,000**	
Mobilization	3%			$204,000	Allowance
Subtotal				**$7,013,000**	
Construction Management, Insurance, Bonds,Profit	13%			$912,000	Allowance
Construction Cost Subtotal				$7,925,000	
Total Capital Cost				$7,930,000	Rounded
				$0.32	Per Gallon of Capacity

Notes:
1. 25 MGD Finished Water Capacity
2. 10 MGD Expansion

OPERATING AND MAINTENACE COSTS FOR HIGH RATE CONVENTIONAL SYSTEM

25.0 MGD Finished Water Capacity

VARIABLE COSTS

Electrical Costs

Cost per kW-hr = **$0.06**

	No. of Units	Horsepower	% Utilization	Power Consumption, kW-hr	Cost per kgal produced
Low Lift Pumps	4	80	100%	5,729	$0.0138
Clarifier System	2	15	100%	537	$0.0013
Backwash pumps and blowers	1	400	5%	358	$0.0009
Transfer Pumps	4	80	100%	5,729	$0.0138
WW EQ Recycle Pumps	2	30	75%	806	$0.0019
Sludge pumping and mixing	4	30	75%	1,611	$0.0039
Miscellanous	1	100	100%	1,790	$0.0043
				Electrical Costs Subtotal	**$0.040**

Chemical Costs

		Cost ($/Ton-Dry Equivalent)	Dose (mg/l of dry equivalent)	Flow (mgd)	Cost per kgal produced
Ferric		$450	30	27.5	$0.062
Cationic Polymer		$1,000	5	27.5	$0.023
Anionic Polymer		$1,500	1	27.5	$0.003
Sodium Chlorite	(1.5 mg/l Chlorine dioxide dose)	$1,000	0.8	27.5	$0.004
Chlorine - ClO2	(1.5 mg/l Chlorine dioxide dose)	$400	0.8	27.5	$0.002
Chlorine - BW		$400	5	1.3	$0.000
Chlorine - Residual Disinfectant		$400	3	25.0	$0.005
Ammonia		$350	1.0	25.0	$0.001
PAC		$1,100	10.0	27.5	$0.050
Caustic Soda		$600	10.0	25.0	$0.025
Flouride		$1,500	0.6	25.0	$0.004
Corrosion Inhibitor, mg/L		$5,200	0.5	25.0	$0.011
				Chemical Costs Subtotal	**$0.190**

Sludge Disposal Costs

Sludge Produced, cy wet sludge/YR	Dried Percent Solids	Handling/Disposal, $/cy	Cost per kgal produced
8,200	**45%**	**$15.0**	**$0.013**

Raw Water Costs **(contained in raw water analysis)**

Variable Operating Costs, cost per kgal treated **$0.244**

FIXED COSTS

Maintenance — % of CC's: **1.7%**; Capital Costs: $30,860,000 — **$525,000**

GAC Replacement — 5832 **cu ft/yr** $ 100.00 per cu ft — **$583,000**

Labor

	No. of Equivalent Full-Time	Avg. Salary $/Hr	Avg. Burdened Salary $/Hr	
Total	13	$19.00	$28.50	**$770,000**
Process Operators	6	$17.00	$25.50	$318,000
Electrician, Instrument Tech	2	$22.50	$33.75	$140,000
Maintenance	3	$18.00	$27.00	$168,000
Administration	1	$13.00	$19.50	$41,000
Superintendent	1	$33.00	$49.50	$103,000

Burden Multiplier 1.5

Admin — **$600,000**

Fixed Operating Costs, cost per year **$2,478,000**

Fixed Operating Costs, cost per 1000 gallons of capacity **$0.70**

Appendix G
TWDB Region H Cost Estimation Schedules

PUBLIC SUPPLY WELL COSTS

Well Depth (feet)	Well Capacity (gpm) 200	400	700	1,000	1,500
Static Water Level Less Than 200 Feet Below Land Surface					
300	$ 150,000	$ 229,200	$ 250,800	-	-
500	$ 180,000	$ 260,400	$ 285,600	$ 404,400	-
700	$ 235,000	$ 282,000	$ 308,400	$ 430,800	$ 459,600
1,000	$ 270,000	$ 328,800	$ 355,200	$ 469,200	$ 498,000
1,500	$ 310,000	$ 340,200	$ 405,600	$ 520,200	$ 564,000
Static Water Levels Between 200 and 300 Feet Below Land Surface					
500	$ 160,000	$ 221,000	-	-	-
700	$ 190,000	$ 224,400	$ 315,800	$ 440,200	$ 470,600
1,000	$ 240,000	$ 335,400	$ 365,600	$ 485,500	$ 530,100
1,500	$ 320,000	$ 350,900	$ 415,600	$ 530,900	$ 600,500
Static Water Levels Between 300 and 400 Feet Below Land Surface					
500	$ 170,000	-	-	-	-
700	$ 210,000	$ 238,000	$ 350,000	$ 470,000	$ 500,000
1,000	$ 260,000	$ 414,400	$ 367,200	$ 510,000	$ 550,000
1,500	$ 330,000	$ 415,000	$ 564,000	$ 690,000	$ 750,000
Static Water Levels Between 400 and 500 Feet Below Land Surface					
1,000	$ 283,000	$ 400,800	$ 485,800	$ 596,400	-
1,500	$ 328,000	$ 434,400	$ 576,000	$ 767,000	-

[1] Values as of Second Quarter 1999.

[2] Costs based on underreamed, gravel-packed wells, with steel casing and stainless steel screens.

[3] Costs as estimated by LBG-Guyton Associates.

[4] Irrigation well costs assumed to be 55% of above public water supply well cost values.

OFF-CHANNEL RESERVOIR COSTS

Storage Volume (ac-ft)	Ring Dike Cost ($)
500	965,000
1,000	1,393,000
2,500	2,313,000
5,000	4,590,000
7,500	5,733,000
10,000	6,733,000
12,500	7,642,000
15,000	10,788,000
17,500	11,732,000
20,000	15,728,000
22,000	16,542,000
25,000	17,705,000

[1] Values as of Second Quarter 1999.
[2] Values are based on ring dike construction.
[3] Values also used for cost of dams on minor tributaries.

WATER STORAGE TANK COSTS

Storage Capacity (MG)	Cost ($)
0.01	161,998
0.05	192,277
0.10	250,864
0.5	494,717
1.0	741,476
2.0	1,105,507
4.0	1,662,686
6.0	2,226,462
7.5	2,691,516
9.0	3,065,107
10.0	3,302,218
15.0	4,709,555

[1] Values as of Second Quarter 1999.
[2] Costs based on ground level prestressed concrete construction.

Appendix H
Modified Region H Raw Water Alternative Costs

CAPITAL AND O&M COSTS
Alternative 1: 16.5 MGD untreated water to be purchase water from the GCWA.

Phase 1: 16.5 MGD (2010)

CAPITAL COSTS					
ITEMS	Unit Cost	Units	Quantity	Units	Updated Cost
RAW WATER SUPPLY					
Pump Stations			0		$ -
Piping			0		$ -
TOTAL Construction					**$ -**
LAND ACQUISITION			0		$ -
ENVIRONMENTAL & ARCHEOLOGICAL STUDIES AND MITIGATION			0		$ -
Total Capital					**$ -**

ANNUAL O&M COSTS					
Purchase of Raw Water	29.32	$/AF	18482.06	AF	$ 542,000
TOTAL O&M COST					**$ 542,000**

CAPITAL AND O&M COSTS
Alternative 1: 27.5 MGD untreated water to be purchase water from the GCWA.

Phase 2: 11 MGD (2030 Expansion)

CAPITAL COSTS					
ITEMS	Unit Cost	Units	Quantity	Units	Updated Cost
RAW WATER SUPPLY					
Pump Stations			0		$ -
Piping			0		$ -
TOTAL Construction					**$ -**
LAND ACQUISITION			0		$ -
ENVIRONMENTAL & ARCHEOLOGICAL STUDIES AND MITIGATIOI			0		$ -
Total Capital					**$ -**

ANNUAL O&M COSTS					
Purchase of Raw Water	29.32	$/AF	30803.44	AF	$ 903,000
TOTAL O&M COST					**$ 903,000**

CAPITAL AND O&M COSTS
Alternative 2: 16.5 MGD untreated water to be purchase water from the BRA to Site A

Phase 1: 16.5 MGD (2010)

CAPITAL COSTS							
ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost	
RAW WATER SUPPLY							
Pump Stations							
Raw water Pump Station	330 HP	3,207,000	$	1	LS	$	3,207,000
Intake Structure	20% of Pump Station	641,400	$	1	LS	$	641,000
Power Connection		125	$/Hp	330	HP	$	41,000
Standby Power	35% of Pump Station	1,122,450	$	1	LS	$	1,122,000
Total						***$***	***5,011,000***
Piping							
Open Cut Trenches							
Pipe @ 42" in rural areas		210	$/ft	30000	LF	$	6,300,000
Total						***$***	***6,300,000***
Total Construction						**$**	**11,311,000**
LAND ACQUISITION							
Right of Way Pipeline in rural areas		8,000	$/a	41	acres	$	328,000
Right of Way Pipeline in urban areas		10,748	$/a	0	acres	$	-
Pump Station Site acquisition		2,000	$/a	4	acres	$	8,000
ENVIRONMENTAL & ARCHEOLOGICAL STUDIES AND MITIGATION							
Pipeline		25,000	$/mile	5.7	miles	$	142,500
Other		48,000	$			$	48,000
TOTAL CONSTRUCTION COST						**$**	**11,837,500**

ANNUAL O&M COSTS							
Pipeline O&M	0.25 %	6,300,000	$			$	16,000
Intake Pump Stations O&M	3 %	5,011,000	$			$	150,000
Pump Pressure	40 psi						
Pump Efficiency	0.8						
Pumping Energy Costs		0.06	$/kW-	5983.159	kW-hr	$	131,000
Purchase of Raw Water		45	$/AF	18482.06	AF	$	832,000
TOTAL O&M COST						**$**	**1,129,000**

CAPITAL AND O&M COSTS
Alternative 2: 27.5 MGD untreated water to be purchase water from the BRA to Site A

Phase 2: 11 MGD (2030 Expansion)

CAPITAL COSTS							
ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost	
RAW WATER SUPPLY							
Pump Stations							
Raw water Pump Station	220 HP	1,589,000	$	1	LS	$	1,589,000
Intake Structure	20% of Pump Station	317,800	$	1	LS	$	318,000
Power Connection		125	$/Hp	220	HP	$	28,000
Standby Power	35% of Pump Station	556,150	$	1	LS	$	556,000
Total							***2,491,000***
Total Construction							**2,491,000**

ANNUAL O&M COSTS							
Pipeline O&M	0.25 %	20,370,000	$			$	51,000
Intake Pump Stations O&M	3 %	9,710,000	$			$	291,000
Pump Pressure	40 psi						
Pump Efficiency	0.8						
Pumping Energy Costs		0.06	$/kW-	9971.931	kW-hr	$	218,000
Purchase of Raw Water		45	$/AF	30803.44	AF	$	1,386,000
TOTAL O&M COST							**1,946,000**

CAPITAL AND O&M COSTS
Alternative 2: 16.5 MGD untreated water to be purchase water from the BRA to Site E

Phase 1: 16.5 MGD (2010)

CAPITAL COSTS							
ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost	
RAW WATER SUPPLY							
Pump Stations							
Raw water Pump Station	470 HP	4,619,000	$	1	LS	$	4,619,000
Intake Structure	20% of Pump Station	923,800	$	1	LS	$	924,000
Power Connection		125	$/Hp	470	HP	$	59,000
Standby Power	35% of Pump Station	1,616,650	$	1	LS	$	1,617,000
Total						***$***	***7,219,000***
Piping							
Open Cut Trenches							
Pipe @ 42" in rural areas		210	$/ft	97000	LF	$	20,370,000
Total						***$***	***20,370,000***
Total Construction						**$**	**27,589,000**
LAND ACQUISITION							
Right of Way Pipeline in rural areas		8,000	$/a	134	acres	$	1,072,000
Right of Way Pipeline in urban areas		10,748	$/a	0	acres	$	-
Pump Station Site acquisition		2,000	$/a	4	acres	$	8,000
ENVIRONMENTAL & ARCHEOLOGICAL STUDIES AND MITIGATION							
Pipeline		25,000	$/mile	18	miles	$	450,000
Other		48,000	$			$	48,000
TOTAL CONSTRUCTION COST						**$**	**29,167,000**

ANNUAL O&M COSTS							
Pipeline O&M	0.25 %	20,370,000	$			$	51,000
Intake Pump Stations O&M	3 %	7,219,000	$			$	217,000
Pump Pressure	56 psi						
Pump Efficiency	0.8						
Pumping Energy Costs		0.06	$/kW-	8376.422	kW-hr	$	183,000
Purchase of Raw Water		45	$/AF	18482.06	AF	$	832,000
TOTAL O&M COST						**$**	**1,283,000**

CAPITAL AND O&M COSTS
Alternative 2: 27.5 MGD untreated water to be purchase water from the BRA to Site E

Phase 2: 11 MGD (2030 Expansion)

CAPITAL COSTS						
ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost
RAW WATER SUPPLY						
Pump Stations						
Raw water Pump Station	310 HP	2,958,000	$	1	LS	$ 2,958,000
Intake Structure	20% of Pump Station	591,600	$	1	LS	$ 592,000
Power Connection		125	$/Hp	310	HP	$ 39,000
Standby Power	35% of Pump Station	1,035,300	$	1	LS	$ 1,035,000
Total						***4,624,000***
Total Construction						**4,624,000**

ANNUAL O&M COSTS						
Pipeline O&M	0.25 %	20,370,000	$			$ 51,000
Intake Pump Stations O&M	3 %	11,843,000	$			$ 355,000
Pump Pressure	56 psi					
Pump Efficiency	0.8					
Pumping Energy Costs		0.06	$/kW-	13960.7	kW-hr	$ 306,000
Purchase of Raw Water		45	$/AF	30803.44	AF	$ 1,386,000
TOTAL O&M COST						**2,098,000**

CAPITAL AND O&M COSTS
Alternative 3: 16.5 MGD untreated water to be purchase water from the CBWC

Phase 1: 16.5 MGD (2010)

CAPITAL COSTS							
ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost	
RAW WATER SUPPLY							
Pump Stations							
Raw water Pump Station	250 HP	2,099,000	$	1	LS	$	2,099,000
Intake Structure	20% of Pump Station	419,800	$	1	LS	$	420,000
Power Connection		125	$/Hp	250	HP	$	31,000
Standby Power	35% of Pump Station	734,650	$	1	LS	$	735,000
Total						***$***	***3,285,000***
Piping							
Open Cut Trenches							
Pipe @ 30" in rural areas		120	$/feet	11600	LF	$	1,392,000
Total Construction						**$**	**4,677,000**
LAND ACQUISITION							
Right of Way Pipeline in rural areas		8,000	$/a	16	acres	$	128,000
Right of Way Pipeline in urban areas		10,748	$/a	0	acres	$	-
Pump Station Site acquisition		2,000	$/a	4	acres	$	8,000
ENVIRONMENTAL & ARCHEOLOGICAL STUDIES AND MITIGATION							
Pipeline		25,000	$/mile	2	miles	$	50,000
Other		48,000	$			$	48,000
Purchase Water Rights		200	$/AF	30794	AF	$	6,159,000
TOTAL CAPITAL COST						**$**	**11,070,000**
ANNUAL O&M COSTS							
Pipeline O&M	1 %	1,392,000	$			$	14,000
Intake Pump Stations O&M	2.5 %	3,285,000	$			$	82,000
Pump Pressure	30 psi						
Pump Efficiency	0.8						
Pumping Energy Costs		0.06	$/kW-hr	4487.369	kW-hr	$	98,000
Existing CBWC Energy Costs (10 psi)		0.06	$/kW-hr	1495.7897	kW-hr	$	33,000
TOTAL O&M COST						**$**	**227,000**

CAPITAL AND O&M COSTS
Alternative 3: 27.5 MGD untreated water to be purchase water from the CBWC

Phase 1: 11 MGD (2030 Expansion)

ITEMS		Unit Cost	Units	Quantity	Units	Updated Cost	
CAPITAL COSTS							
RAW WATER SUPPLY							
Pump Stations							
Raw water Pump Station	170 HP	560,000	$	1	LS	$	560,000
Intake Structure	20% of Pump Station	112,000	$	1	LS	$	112,000
Power Connection		125	$/Hp	170	HP	$	21,000
Standby Power	35% of Pump Station	196,000	$	1	LS	$	196,000
Total						***$***	***889,000***
Total Construction						**$**	**889,000**
TOTAL CAPITAL COST						**$**	**889,000**
ANNUAL O&M COSTS							
Pipeline O&M	1 %	1,392,000	$			$	14,000
Intake Pump Stations O&M	3 %	4,174,000	$			$	125,000
Pump Pressure	30 psi						
Pump Efficiency	0.8						
Pumping Energy Costs		0.06	$/kW-hr	7478.9484	kW-hr	$	164,000
Existing CBWC Energy Costs (10 psi)		0.0598	$/kW-hr	2492.9828	kW-hr	$	54,000
TOTAL O&M COST						**$**	**357,000**

Appendix I
Raw Water Capital and O&M Costs

Capital and O&M Costs

Alternative 1: Raw Water Purchase from GCWA

ITEMS		COST (M$, YR 2000)	
		16.5 MGD Initial Phase	11 MGD Expansion
Raw Water Pumping Station			
	Property	$ -	$ -
	Pump Station	$ -	$ -
Raw Water Pipeline			
	Pipelines	$ -	$ -
	Easements	$ -	$ -
Subtotal		**$ -**	**$ -**
Engineering Contingency (10%)		$ -	$ -
Construction Contingency (5%)		$ -	$ -
Cost Contingency (20%)		$ -	$ -
Total Construction		**$ -**	**$ -**
Environmental Studies		$ -	$ -
Water Rights Purchase		$ -	$ -
Engineering (15%)		$ -	$ -
Construction Administration (5%)		$ -	$ -
MBCPG Administration (3%)		$ -	$ -
Total Capital Cost		**$ -**	**$ -**

Annual O&M Costs

ITEMS		COST (M$, YR 2000)	
		2010-2030 (16.5 MGD)	2030-2050 (27.5 MGD)
	Raw Water Pumping	$ -	$ -
	Raw Water Pipelines	$ -	$ -
	Cost of Raw Water	$ 542,000	$ 903,000
Total Annual O&M Cost		**$ 542,000**	**$ 903,000**
Present Worth (Yr 2000 $)		**$15,276,000**	

Capital and O&M Costs

Alternative 2: Raw Water Purchase through CBWC

ITEMS	COST (M$, YR 2000) 16.5 MGD Initial Phase	11 MGD Expansion
Raw Water Pumping Station		
Property	$ 8,000	$ -
Pump Station	$ 3,285,000	$ 889,000
Raw Water Pipeline		
Pipelines	$ 1,392,000	$ -
Easements	$ 128,000	$ -
Subtotal	**$ 4,813,000**	**$ 889,000**
Engineering Contingency (10%)	$ 480,000	$ 90,000
Construction Contingency (5%)	$ 240,000	$ 40,000
Cost Contingency (20%)	$ 960,000	$ 180,000
Total Construction	**$ 6,493,000**	**$ 1,199,000**
Environmental Studies	$ 98,000	$ -
Water Rights Purchase	$ 6,159,000	$ -
Engineering (15%)	$ 970,000	$ 180,000
Construction Administration (5%)	$ 320,000	$ 60,000
MCBPG Administration (3%)	$ 190,000	$ 40,000
Total Capital Cost	**$ 14,230,000**	**$ 1,479,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000) 2010-2030 (16.5 MGD)	2030-2050 (27.5 MGD)
Raw Water Pumping	$ 131,000	$ 218,000
Maintenance	$ 96,000	$ 139,000
Cost of Raw Water	$ -	$ -
Total Annual O&M Cost	**$ 227,000**	**$ 357,000**
Present Worth (Yr 2000 $)	**$17,873,000**	

Capital and O&M Costs

Alternative 3A: Raw Water Purchase through BRA to Site A in Manvel

ITEMS	COST (M$, YR 2000)	
	16.5 MGD Initial Phase	11 MGD Expansion
Raw Water Pumping Station		
Property	$ 8,000	$ -
Pump Station	$ 5,011,000	$ 2,491,000
Raw Water Pipeline		
Pipelines	$ 6,300,000	$ -
Easements	$ 328,000	$ -
Subtotal	**$ 11,647,000**	**$ 2,491,000**
Engineering Contingency (10%)	$ 1,160,000	$ 250,000
Construction Contingency (5%)	$ 580,000	$ 120,000
Cost Contingency (20%)	$ 2,330,000	$ 500,000
Total Construction	**$ 15,717,000**	**$ 3,361,000**
Environmental Studies	$ 190,500	$ -
Water Rights Purchase	$ -	$ -
Engineering (15%)	$ 2,360,000	$ 500,000
Construction Administration (5%)	$ 790,000	$ 170,000
MCBPG Administration (3%)	$ 470,000	$ 100,000
Total Capital Cost	**$ 19,527,500**	**$ 4,131,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (16.5 MGD)	2030-2050 (27.5 MGD)
Raw Water Pumping	$ 131,000	$ 218,000
Maintenance	$ 166,000	$ 342,000
Cost of Raw Water	$ 832,000	$ 1,386,000
Total Annual O&M Cost	**$ 1,129,000**	**$ 1,946,000**
Present Worth (Yr 2000 $)	**$49,113,000**	

Capital and O&M Costs

Alternative 3B: Raw Water Purchase through BRA to Site E in Alvin

ITEMS	COST (M$, YR 2000)	
	16.5 MGD Initial Phase	11 MGD Expansion
Raw Water Pumping Station		
Property	$ 8,000	$ -
Pump Station	$ 7,219,000	$ 4,624,000
Raw Water Pipeline		
Pipelines	$ 20,370,000	$ -
Easements	$ 1,072,000	$ -
Subtotal	**$ 28,669,000**	**$ 4,624,000**
Engineering Contingency (10%)	$ 2,870,000	$ 460,000
Construction Contingency (5%)	$ 1,430,000	$ 230,000
Cost Contingency (20%)	$ 5,730,000	$ 920,000
Total Construction	**$ 38,699,000**	**$ 6,234,000**
Environmental Studies	$ 498,000	$ -
Water Rights Purchase	$ -	$ -
Engineering (15%)	$ 5,800,000	$ 940,000
Construction Administration (5%)	$ 1,930,000	$ 310,000
MCBPG Administration (3%)	$ 1,160,000	$ 190,000
Total Capital Cost	**$ 48,087,000**	**$ 7,674,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (16.5 MGD)	2030-2050 (27.5 MGD)
Raw Water Pumping	$ 183,000	$ 306,000
Maintenance	$ 268,000	$ 406,000
Cost of Raw Water	$ 832,000	$ 1,386,000
Total Annual O&M Cost	**$ 1,283,000**	**$ 2,098,000**
Present Worth (Yr 2000 $)	**$75,979,000**	

Annual O&M Costs		
Alternative 4: Raw Water Delivery to GCWA FT Bend, Harris County WTP		
ITEMS	COST (M$, YR 2000)	
	16.5 MGD Initial Phase	11 MGD Expansion
Cost of Water ($0.07 per 1000 gal)	$ 422,000	$ 703,000
Total Annual O&M Cost	**$ 422,000**	**$ 703,000**
Present Worth (Yr 2000 $)	**$11,893,000**	

Appendix J
Finished Water Transmission and O&M Costs

Capital and O&M Costs			
Alternative 1A: Manvel Site Delivering Water At Pressure			
ITEMS		**COST (M$, YR 2000)**	
		15 MGD Initial Phase	**10 MGD Expansion**
Water Treatment Plant			
	Property	$ 700,000	$ -
	Plant	$ 22,931,000	$ 7,930,000
	Additional Site Work (Flood Plain)	$ 60,000	$ -
Finished Water Transmission			
	High Service Pump Station	$ 840,000	$ 560,000
	Booster Pump Station and Ground Storage	$ 1,848,000	$ 1,232,000
	Pipelines	$ 19,820,000	$ -
	Easements	$ 760,000	$ -
Subtotal		**$ 46,959,000**	**$ 9,722,000**
Engineering Contingency (10%)		$ 4,700,000	$ 970,000
Construction Contingency (5%)		$ 2,350,000	$ 490,000
Cost Contingency (20%)		$ 9,390,000	$ 1,940,000
Total Construction		**$ 63,399,000**	**$ 13,122,000**
Engineering (15%)		$ 9,510,000	$ 1,970,000
Construction Administration (5%)		$ 3,170,000	$ 660,000
MBCPG Administration (3%)		$ 1,900,000	$ 390,000
Total Capital Cost		**$ 77,979,000**	**$ 16,142,000**
Annual O&M Costs			
ITEMS		**COST (M$, YR 2000)**	
		2010-2030 (15 MGD)	**2030-2050 (25 MGD)**
	Plant	$ 3,443,000	$ 4,702,000
	Finished Water Pumping and Pipelines	$ 370,000	$ 560,000
Total Annual O&M Cost		**$ 3,813,000**	**$ 5,262,000**
Present Worth (Yr 2000 $)		**$159,841,000**	

Capital and O&M Costs		
Alternative 1B: Manvel Site Delivering Water To GSTs		
ITEMS	COST (M$, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant		
Property	$ 700,000	$ -
Plant	$ 22,931,000	$ 7,930,000
Additional Site Work (Flood Plain)	$ 60,000	$ -
Finished Water Transmission		
High Service Pump Station	$ 840,000	$ 560,000
Booster Pump Station and Ground Storage	$ 3,924,000	$ 2,616,000
Pipelines	$ 18,530,000	$ -
Easements	$ 760,000	$ -
Subtotal	**$ 47,745,000**	**$ 11,106,000**
Engineering Contingency (10%)	$ 4,770,000	$ 1,110,000
Construction Contingency (5%)	$ 2,390,000	$ 560,000
Cost Contingency (20%)	$ 9,550,000	$ 2,220,000
Total Construction	**$ 64,455,000**	**$ 14,996,000**
Engineering (15%)	$ 9,670,000	$ 2,250,000
Construction Administration (5%)	$ 3,220,000	$ 750,000
MBCPG Administration (3%)	$ 1,930,000	$ 450,000
Total Capital Cost	**$ 79,275,000**	**$ 18,446,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (15 MGD)	2030-2050 (25 MGD)
Plant	$ 3,443,000	$ 4,702,000
Finished Water Pumping and Pipelines	$ 460,000	$ 690,000
Total Annual O&M Cost	**$ 3,903,000**	**$ 5,392,000**
Present Worth (Yr 2000 $)	**$163,748,000**	

Capital and O&M Costs

Alternative 2A: Alvin Site Delivering Water At Pressure

ITEMS	COST (M$, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant		
Property	$ -	$ -
Plant	$ 22,931,000	$ 7,930,000
Additional Site Work	$ -	$ -
Finished Water Transmission		
High Service Pump Station	$ 840,000	$ 560,000
Booster Pump Station and Ground Storage	$ 1,848,000	$ 1,232,000
Pipelines	$ 26,520,000	$ -
Easements	$ 820,000	$ -
Subtotal	**$ 52,959,000**	**$ 9,722,000**
Engineering Contingency (10%)	$ 5,300,000	$ 970,000
Construction Contingency (5%)	$ 2,650,000	$ 490,000
Cost Contingency (20%)	$ 10,590,000	$ 1,940,000
Total Construction	**$ 71,499,000**	**$ 13,122,000**
Engineering (15%)	$ 10,720,000	$ 1,970,000
Construction Administration (5%)	$ 3,570,000	$ 660,000
MBCPG Administration (3%)	$ 2,140,000	$ 390,000
Total Capital Cost	**$ 87,929,000**	**$ 16,142,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (15 MGD)	2030-2050 (25 MGD)
Plant	$ 3,443,000	$ 4,702,000
Finished Water Pumping and Pipelines	$ 410,000	$ 600,000
Total Annual O&M Cost	**$ 3,853,000**	**$ 5,302,000**
Present Worth (Yr 2000 $)	**$168,571,000**	

Capital and O&M Costs

Alternative 2B: Alvin Site Delivering Water To GSTs

ITEMS	COST (M$, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant		
Property	$ -	$ -
Plant	$ 22,931,000	$ 7,930,000
Additional Site Work	$ -	$ -
Finished Water Transmission		
High Service Pump Station	$ 840,000	$ 560,000
Booster Pump Station and Ground Storage	$ 3,924,000	$ 2,616,000
Pipelines	$ 23,610,000	$ -
Easements	$ 820,000	$ -
Subtotal	**$ 52,125,000**	**$ 11,106,000**
Engineering Contingency (10%)	$ 5,210,000	$ 1,110,000
Construction Contingency (5%)	$ 2,610,000	$ 560,000
Cost Contingency (20%)	$ 10,430,000	$ 2,220,000
Total Construction	**$ 70,375,000**	**$ 14,996,000**
Engineering (15%)	$ 10,560,000	$ 2,250,000
Construction Administration (5%)	$ 3,520,000	$ 750,000
MBCPG Administration (3%)	$ 2,110,000	$ 450,000
Total Capital Cost	**$ 86,565,000**	**$ 18,446,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (15 MGD)	2030-2050 (25 MGD)
Plant	$ 3,443,000	$ 4,702,000
Finished Water Pumping and Pipelines	$ 490,000	$ 720,000
Total Annual O&M Cost	**$ 3,933,000**	**$ 5,422,000**
Present Worth (Yr 2000 $)	**$170,158,000**	

Capital and O&M Costs

Alternative 3A: GCWA Fort Bend County Regional WTP Delivering Water At Pressure

ITEMS	COST (M$, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant		
Property	$ -	$ -
Plant	$ 13,950,000	$ 7,100,000
Additional Site Work	$ -	$ -
Finished Water Transmission		
High Service Pump Station	$ 840,000	$ 560,000
Booster Pump Station and Ground Storage	$ 1,848,000	$ 1,232,000
Pipelines	$ 37,050,000	$ -
Easements	$ 1,750,000	$ -
Subtotal	**$ 55,438,000**	**$ 8,892,000**
Engineering Contingency (10%)	$ 5,540,000	$ 890,000
Construction Contingency (5%)	$ 2,770,000	$ 440,000
Cost Contingency (20%)	$ 11,090,000	$ 1,780,000
Total Construction	**$ 74,838,000**	**$ 12,002,000**
Engineering (15%)	$ 11,230,000	$ 1,800,000
Construction Administration (5%)	$ 3,740,000	$ 600,000
MBCPG Administration (3%)	$ 2,250,000	$ 360,000
Total Capital Cost	**$ 92,058,000**	**$ 14,762,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (15 MGD)	2030-2050 (25 MGD)
Plant	$ 2,464,000	$ 4,015,000
Finished Water Pumping and Pipelines	$ 410,000	$ 600,000
Total Annual O&M Cost	**$ 2,874,000**	**$ 4,615,000**
Present Worth (Yr 2000 $)	**$154,472,000**	

Capital and O&M Costs

Alternative 3B: GCWA Fort Bend County Regional WTP Delivering Water to GSTs

ITEMS		COST (M$, YR 2000)	
		15 MGD Initial Phase	10 MGD Expansion
Water Treatment Plant			
	Property	$ -	$ -
	Plant	$ 13,950,000	$ 7,100,000
	Additional Site Work	$ -	$ -
Finished Water Transmission			
	High Service Pump Station	$ 840,000	$ 560,000
	Booster Pump Station and Ground Storage	$ 3,924,000	$ 2,616,000
	Pipelines	$ 35,870,000	$ -
	Easements	$ 1,750,000	$ -
Subtotal		**$ 56,334,000**	**$ 10,276,000**
Engineering Contingency (10%)		$ 5,630,000	$ 1,030,000
Construction Contingency (5%)		$ 2,820,000	$ 510,000
Cost Contingency (20%)		$ 11,270,000	$ 2,060,000
Total Construction		**$ 76,054,000**	**$ 13,876,000**
Engineering (15%)		$ 11,410,000	$ 2,080,000
Construction Administration (5%)		$ 3,800,000	$ 690,000
MBCPG Administration (3%)		$ 2,280,000	$ 420,000
Total Capital Cost		**$ 93,544,000**	**$ 17,066,000**

Annual O&M Costs

ITEMS		COST (M$, YR 2000)	
		2010-2030 (15 MGD)	2030-2050 (25 MGD)
	Plant	$ 2,464,000	$ 4,015,000
	Finished Water Pumping and Pipelines	$ 550,000	$ 810,000
Total Annual O&M Cost		**$ 3,014,000**	**$ 4,825,000**
Present Worth (Yr 2000 $)		**$159,874,000**	

Capital and O&M Costs

Null Alternative: All Groundwater Well Option

ITEMS	COST (M$, YR 2000)	
	15 MGD Initial Phase	10 MGD Expansion
Wells		
GST	$ 5,659,000	$ 2,767,000
Well	$ 4,623,000	$ 3,658,000
Booster Pump Station	$ 577,000	$ 433,000
Total	**$ 10,859,000**	**$ 6,858,000**
Engineering Contingency (10%)	$ 1,090,000	$ 690,000
Construction Contingency (5%)	$ 540,000	$ 340,000
Cost Contingency (20%)	$ 2,170,000	$ 1,370,000
Total Construction	**$ 14,659,000**	**$ 9,258,000**
Engineering (15%)	$ 2,200,000	$ 1,390,000
Construction Administration (5%)	$ 730,000	$ 460,000
MBCPG Administration (3%)	$ 440,000	$ 280,000
Total Capital Cost	**$ 18,029,000**	**$ 11,388,000**

Annual O&M Costs

ITEMS	COST (M$, YR 2000)	
	2010-2030 (15 MGD)	2030-2050 (25 MGD)
Electricity	$ 1,063,700	$ 1,864,000
Maintenance	$ 170,300	$ 279,000
Total Annual O&M Cost	**$ 1,234,000**	**$ 2,143,000**
Present Worth (Yr 2000 $)	**$52,273,000**	

Appendix K
Water Well Alternative Costs

Phase 1 Water Well Construction and O&M Costs

Participating Utility	Capacity Increase (MGD)	Construction Cost	O&M Cost
Alvin	2.26	$475,000	$173,100
Angleton	1.34	$411,000	$104,400
Brookside Village	0.31	$192,000	$27,100
Danbury	0.27	$189,000	$24,300
Hillcrest	0.05	-	-
Iowa Colony	0.14	$183,000	$15,100
Manvel	2.26	$717,000	$176,900
Pearland	7.81	$2,456,000	$610,700
Total	**14.44**	**$4,623,000**	**$1,131,600**

Phase 2 Water Well Construction and O&M Costs

Participating Utility	Capacity Increase (MGD)	Construction Cost	O&M Cost
Angleton	1.11	$344,000	$191,200
Brookside Village	0.26	$188,000	$50,600
Danbury	0.21	$185,000	$44,200
Hillcrest	0.02	-	-
Iowa Colony	0.10	$182,000	$27,500
Manvel	1.51	$465,000	$294,700
Pearland	5.85	$1,839,000	$1,068,200
Total	**9.06**	**$3,203,000**	**$1,676,400**

Phase 1 Ground Storage Tank Cost

Participating Utility	GST Volume (MG)	Construction Cost	Maintenance Cost
Alvin	2.55	$1,266,000	$3,200
Angleton	0.07	$217,000	$500
Brookside Vill.	0.26	$345,000	$900
Danbury	0.24	$331,000	$800
Hillcrest	0.02	$177,000	$400
Iowa Colony	0.10	$238,000	$600
Manvel	1.95	$1,092,000	$2,700
Pearland	5.18	$1,993,000	$5,000
Total	10.37	$5,659,000	$14,100

Phase 2 Ground Storage Tank Cost

Participating Utility	GST Volume (MG)	Construction Cost	Maintenance Cost
Alvin	2.09	$1,135,100	$6,000
Angleton	-	-	$500
Brookside Vill.	-	-	$900
Danbury	-	-	$800
Hillcrest	-	-	$400
Iowa Colony	-	-	$600
Manvel	-	-	$2,700
Pearland	3.91	$1,631,800	$9,100
Total	6	$2,766,900	$21,000

Phase 1 Booster Pump Station Cost

Participating Utility	Well Capacity Addition (MGD)	Well Capacity Addition (GPM)	Pump Station Construction Cost	Station Operating Capacity (GPM)	Power (kw-hr)	Annual Operating Cost ($)	Annual Maintenance Cost ($)
Alvin	2.31	1604.17	$92,000	1604.17	518.06	$11,300	$2,800
Angleton	1.34	930.56	$54,000	930.56	300.52	$6,600	$1,600
Brookside Villag	0.31	215.28	$12,000	215.28	69.52	$1,500	$400
Danbury	0.27	187.50	$11,000	187.50	60.55	$1,300	$300
Hillcrest	*	*	*	*	*	*	*
Iowa Colony	0.14	97.22	$6,000	97.22	31.40	$700	$200
Manvel	2.26	1569.44	$90,000	1569.44	506.84	$11,100	$2,700
Pearland	7.81	5423.61	$312,000	5423.61	1751.52	$38,400	$9,400
Total	**14.44**	**10027.78**	**$577,000**			**$70,900**	**$17,400**

* - included in Alvin

Phase 2 Booster Pump Station Cost

Participating Utility	Well Capacity Addition (MGD)	Well Capacity Addition (GPM)	Pump Station Construction Cost	Station Operating Capacity (GPM)	Power (kw-hr)	Annual Operating Cost ($)	Annual Maintenance Cost ($)
Alvin	1.82	1263.89	$73,000	2868.06	926.22	$20,300	$5,000
Angleton	1.11	770.83	$44,000	1701.39	549.45	$12,000	$2,900
Brookside Villag	0.26	180.56	$10,000	395.83	127.83	$2,800	$700
Danbury	0.21	145.83	$8,000	333.33	107.65	$2,400	$600
Hillcrest	*	*	*	*	*	*	*
Iowa Colony	0.10	69.44	$4,000	166.67	53.82	$1,200	$300
Manvel	1.51	1048.61	$60,000	2618.06	845.48	$18,500	$4,500
Pearland	5.85	4062.50	$234,000	9486.11	3063.48	$67,100	$16,400
Total	**10.86**	**7541.67**	**$433,000**			**$124,300**	**$30,400**

* - included in Alvin

Appendix L
Progress Meetings

Mid Brazoria County Water Planning Group
TWBD Facility Plan Study

Kickoff Meeting Agenda

Date: January 29, 2001
Time: 7:00 PM
Place: City of Alvin City Hall

Agenda:

1) Introduction of Attendees
2) General Overview of Project
   A) Project Scope
   B) Project Schedule
3) Review of Requested Information.
   A) Background Information on the MBCPG member including: City Area, ETJ size, year 2000 population, year 2000 water demand
   B) Maps of the existing water distribution system (electronic maps if at all possible)
   C) Maps of Groundwater wells (electronic maps if at all possible)
   D) Population and Water Demand projections for the year 2010, 2020, 2030, 2040, and 2050
   E) Existing groundwater water quality records
   F) MBCPG member data on existing raw water quantity (including contracts), quality, demand, distribution capacity, and storage capacity.
   G) Description of existing water distribution systems, including water sources, number of wells, length of water distribution mains, number of customers, number and size of ground and elevated storage tanks
   H) MBCPG Member Water Conservation Plans
   I) Existing MBCPG well installation costs (size, depth), and existing operations and maintenance.
   J) Potential regional water treatment plant sites (approximately 40 acres)
   K) USGS maps of Mid-Brazoria County

4) Proposed Report Outline
5) Time and Location of Next Progress Meetings
6) Discuss the status of formation of the Fresh Water Supply District.

CITY OF ALVIN
Mid-Brazoria County Planning Group Facility Plan Study

Progress Meeting Agenda

Date: February 26, 2001
Time: 7:00 PM
Place: City of Alvin City Hall

Agenda:

1) Introductions and Schedule Update
2) Present Water Demand Projections
   a) Region H Projections
   b) Participating Utilities Projections from Surveys.
3) Briscoe Property Presentation
4) Alternative Water Treatment Plant Site Locations
   a) Review Sites
   b) Review Siting Criteria
   c) Discuss Pros and Cons of Each Site
5) Discuss Water Plant Capacity
   a) Percentage of Demand to be met through regional facility
6) Open Discussion

Mid Brazoria County Planning Group Facility Plan Progress Meeting

Montgomery Watson
February 26, 2000

AGENDA

- Introductions
- Progress Report
- Water Demand Projections
- Discuss Water Plant Capacity
- Briscoe Property Presentation
- Alternative Water Treatment Plant Site Locations
- Open Discussion

Work Completed Last Month

- Reviewed Region H Data
- Started Water Conservation Plan
- Reviewed FWSD Feasibility
- Completed Population and Water Demand Projections
- Identified Alternate Water Plant Locations

Schedule Impacts

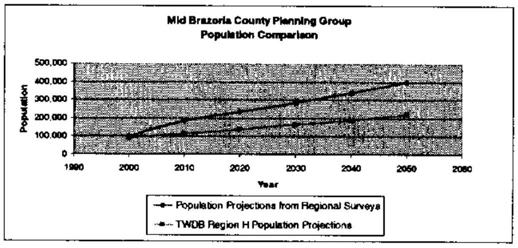
- Currently On Schedule
- Next Step is to:
  - Review / Screen Alternative Site Selections
  - Review Water Demand Allocation
  - Identify Participating Utility Take Points

Mid Brazoria County Planning Group Population and Water Demand Projections

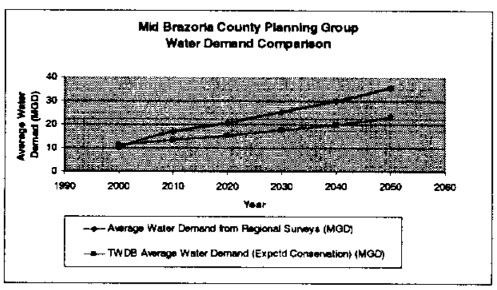
Water Demand Source Information

- TWDB / Region H Planning Group
- Participating Utilities Surveys

Population Projections

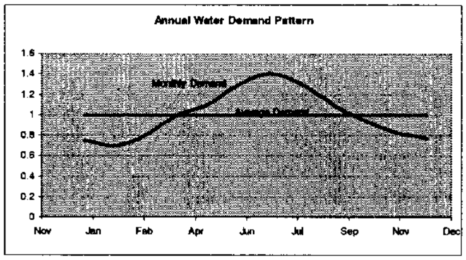


Water Demand Projections



Regional Plant Capacity

How Is Plant Capacity Determined



Meet Demand with Combination of Surface Water And Groundwater

Water Plant Capacity Development Constraints

- Existing Surface Water Contracts
- Blending
- Use of Existing Infrastructure

Surface Water Plant Capacity Options

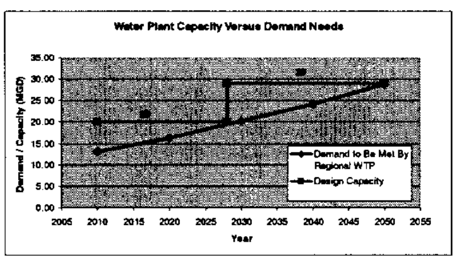
1) Meet Average and Peak Demand with Regional Surface Water Plant

2) Meet Percentage of Average Demand, Use Groundwater to meet Peak Demands

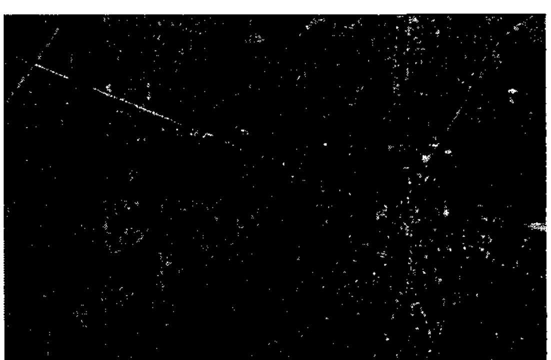
Water Plant Capacity Recommendations

- Smaller Community (< 1 MGD Demand)
  - Construct Facilities to meet 100% Demand Including peak day demand
- Larger Community (> 1 MGD Demand)
  - Construct Facilities to meet 80% Average Demand (minus existing contracts)
  - Use Groundwater To Supplement For Peak Flow

Plant Capacity



Alternate WTP Locations



Site A - Manvel

Location: State Hwy 6 and Iowa Lane
in Manvel, Texas

53 acres

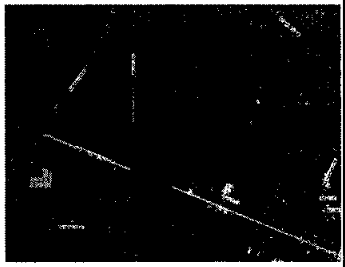
Asking Price: $700,000

Raw Water Source: Brazos River through
GCWA Canal

Adjacent to Hwy 6

Adjacent to Power and Utilities

Sludge Disposal: off-site



Site B - Pearland / Alvin

Location: CR 144 and CR 285
in Alvin ETJ

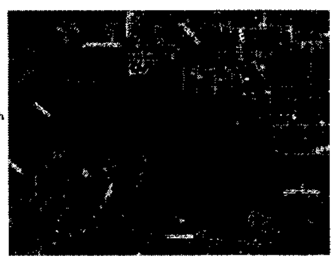
120 acres

Appraisal Value: $300,000

Raw Water Source: Brazos River through
GCWA American Canal

Not Adjacent to Power and Utilities

Sludge Disposal: on-site



Site C - Alvin Landfill

Location Adjacent to City of Alvin Landfill,
off Saladino Road

643 acres

Asking Price: $****

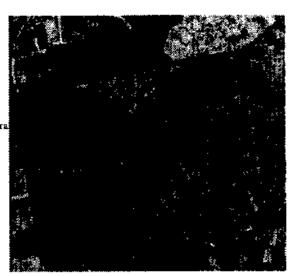
Raw Water Source: Brazos River through
GCWA Canal and Briscoe Property Canal Latera

Available Space for Raw Water Reservoir

Sludge Disposal. on-site

Not adjacent to Utilities or Power

Not adjacent to Major Thoroughfare



Site D - Alvin Landfill

Location: off Parker Davis and West Road near Alvin, Texas

919 acres

Asking Price: $****

Raw Water Source: Brazos River through GCWA Canal

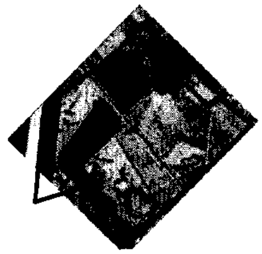
Available Space for Raw Water Reservoir

Sludge Disposal: on-site

Not adjacent to Utilities

Overhead Power Available

Not adjacent to Major Thoroughfare



Site E - Alvin

Location: Briscoe Canal and Highway 35 in Alvin, Texas

278 acres

Asking Price: $****

Raw Water Source: Brazos River through GCWA Canal

Available Space for Raw Water Reservoir

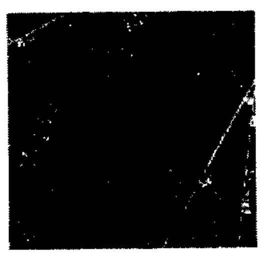
Sludge Disposal: on-site

Not adjacent to Utilities

Overhead Power Available

Adjacent to Hwy 35

Adjacent to Power and Utilities



Action Items

- Evaluate Alternative WTP Sites
- Set Design Plant Capacity of
  - 20 MGD by YR 2010
  - 29 MGD by YR 2030
  - Supplement With Groundwater For Peak Demand
- Take Points

CITY OF ALVIN
Mid-Brazoria County Planning Group Facility Plan Study

Progress Meeting Agenda

Date: April 12, 2001
Time: 7:00 PM
Place: City of Alvin City Hall

Agenda:

1) Introductions and Schedule Update
2) Surface Water Resource Information
3) Review Water Plant Capacity
4) Review Alternative Water Treatment Plant Site Locations
5) Take Points and Pipeline Corridor Analysis Discussion
6) Review Model Construction Scenarios
   a) At Pressure
   b) Fill Ground Storage Tank
   c) Other
7) Open Discussion

April Progress Meeting

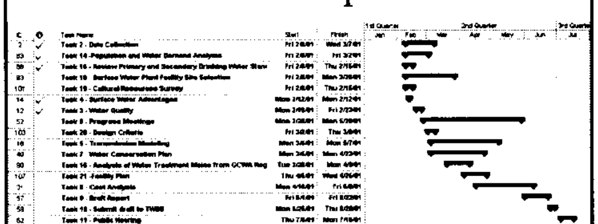
Regional Water Supply Facility Plan for Mid-Brazoria County

April 12, 2001

AGENDA

- Schedule Update
- Review of Surface Water options for the Mid-Brazoria County Planning Group
- Review of alternate Surface Water Treatment Plant Sites
- Review of selected SWTP Capacity
- Review of Transmission Main System Analysis

Schedule Update



Surface Water Options for the Mid-Brazoria County Planning Group

TWDB/Region H Planning Group Projects Water Shortage in Mid-Brazoria Planning Area

- Pearland
- Angleton
- Alvin
- No other shortages Projected

Region H has Projected Water Needs for Mid-Brazoria Planning Area

- 50% Groundwater
- 50% Surface Water
- Sustainable yield of Groundwater will not support 100% of area needs through 2050.

Region H Projected Surface Water Need Pearland by 2050 = 5544 ac*ft/yr or 5MGD

City of Pearland Currently has:

- 5,559 ac*ft/yr raw water option contract with GCWA.
- No infrastructure to use contract water

Region H addresses shortage through extension of GCWA contract

Region H Projected Surface Water Need for Angleton by 2050 = 2,992 ac*ft/yr or 2.7MGD

City of Angleton currently has:

- 1,815 ac*ft/yr treated water contract with BWA
- Contract expires 2040

Region H addresses shortage through extension of BWA contract

Region H Projected Surface Water Need for Alvin by 2050 = 2,967 ac*ft/yr or 2.7MGD

City of Alvin has:

- Groundwater Infrastructure
- No Surface Water Contracts

Region H Addresses shortage through new contract with GCWA

Everybody else in Mid-Brazoria County Planning Group continues with groundwater according to Region H.

Water Issues faced by the Mid-Brazoria Planning Group

Water supply issues for the Mid-Brazoria Planning Group

- No Groundwater Protection District
- Cost of various supply choices
- Reliability of supply sources

Texas water law identifies ownership and allocation of water

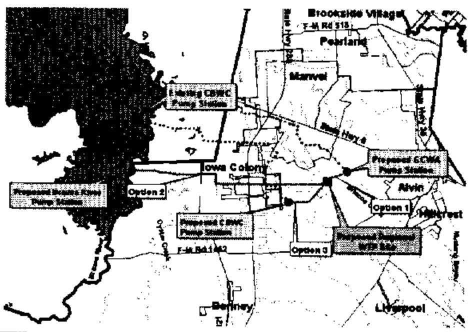
- Groundwater - belongs to person who can capture it
- Surface Water - State owned and allocated

Surface water owned by State is identified by law

- Every River
- Every Natural Stream
- Lakes
- Storm Water and Flood water in Water shed
- Every water right bay and river on Gulf of Mexico
- Nobody can appropriate water without a permit

Water source alternatives identified by Region H

Region H water source alternatives



Region H identifies water source alternatives

Region H Option 1: Raw water contract with GCWA

- Build Alvin Regional WTP
- Withdraw raw water from Briscoe Canal
- Estimated Capital Cost: $7 Million
- Estimated Average O&M Cost: $.144/kgal

Region H identifies water source alternatives

Region H Option 2: Raw water contract with BRA

- Water sources
  - BRA has 75,000 ac*ft/yr potentially available
  - Little River Reservoir
  - Allens Creek Reservoir
- Build Alvin Regional WTP
- Construct Raw Water conveyance pipeline & PS
- Alternately contract use of GCWA Canal
- Estimated Capital Cost: $35 Million
- Estimated Average O&M Cost: $.29/kgal

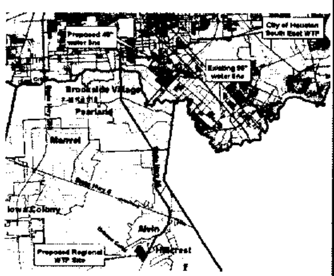
Region H identifies water source alternatives

Region H Option 3: Water Rights Contract from CBWC

- Purchase/Finance water rights
- Build Alvin Regional WTP
- Purchase CBWC canal for conveyance
- Estimated Capital Cost: *$12 Million**
- Estimated Average O&M Cost: $.10/kgal
- *N. Harris County Paid $650 an AF or $100 Million for these water rights*

City of Houston is another water source alternative

- COH will sell treated water
  - SEWTP
  - No WTP to build
  - Build transmission main from SEWTP Mains to central repumping facility near Alvin



Freeport Desal Plant is Another Water Source Alternative

- Poseidon Resources to estimate cost for City of Alvin

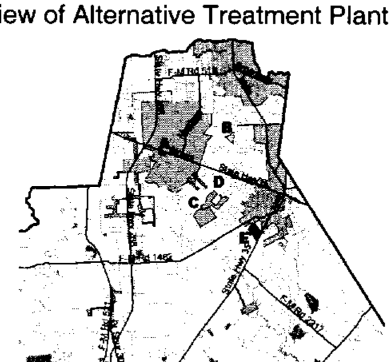
Water Source Recommendations for Mid-Brazoria Planning Group

- Implement groundwater protection district
- Plan to maintain groundwater production at current withdraw, use surface water for growth
- Review water contract opportunities with GCWA, BRA, CBWC, COH & DOW

The feasibility study will proceed in accordance with Region H's most economically attractive alternative

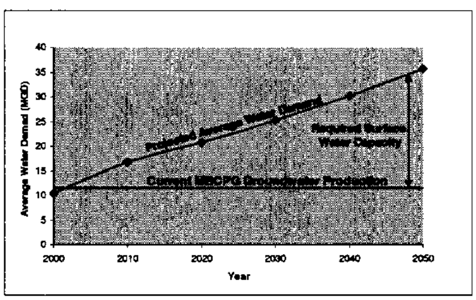
REVIEW OF SURFACE WATER TREATMENT PLANT SITE SELECTION

Review of Alternative Treatment Plant Sites



REVIEW OF SURFACE WATER TREATMENT PLANT CAPACITY

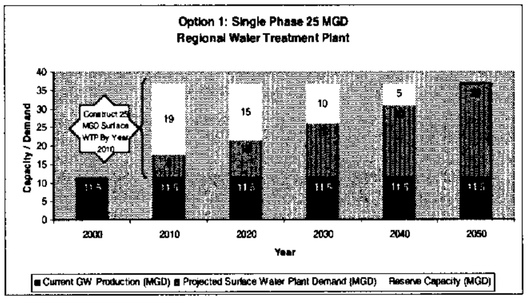
Mid-Brazoria County Planning Group
Water Demand



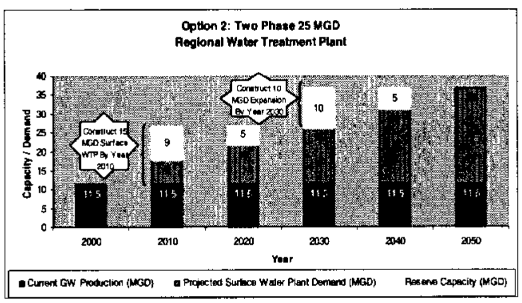
Surface Water Treatment Plant Options

- One phase construction
- Two phase construction

Proposed Water Treatment Plant Capacity

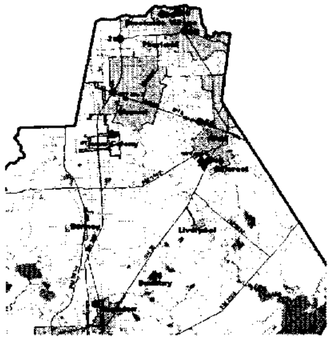


Proposed Water Treatment Plant Capacity



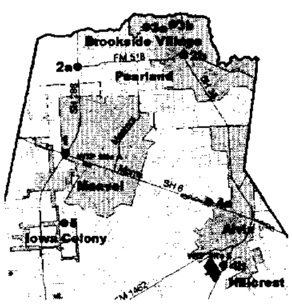
TRANSMISSION SYSTEM ANALYSIS

Take Points for Participating Utilities



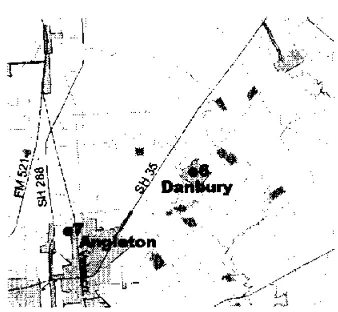
Take Points for Participating Utilities (Northern Half)

- **Manvel**:
  - TP 1: Intersection of SH288 and SH6
- **Pearland**:
  - TP 2a: Intersection of SH288 and FM518.
  - TP 2b: Intersection of FM518 and SH35
- **Brookside Village**:
  - TP 3a: Intersection of Garden Road and Brookside Road
  - TP 3b: Intersection of Cemetary Road and Mykawa Road
- **Alvin**:
  - TP 4a: Intersection of SH 6 and Heights-Manvel Road
  - TP 4b: Intersection of SH 35 and CR 171
- **Iowa Colony**:
  - TP 5: Near CR 64 and Chocolate Bayou



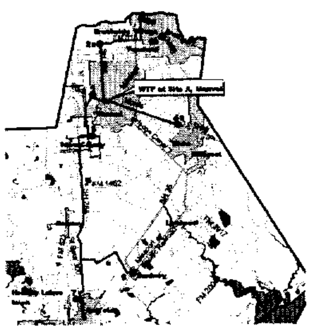
Take Points for Participating Utilities (Southern Half)

- **Danbury**:
  - TP 6: Intersection of CR 365 and St Spur 28
- **Angleton**:
  - TP 7: On West Henderson Road, to the west of Velasco Road

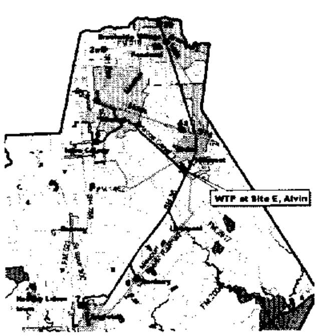


TRANSMISSION MAIN OPTIONS

Alternative Pipeline Corridors from Treatment Plant in Manvel site



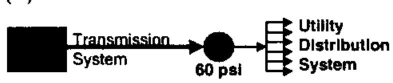
Alternative Pipeline Corridors from Treatment Plant in Alvin site



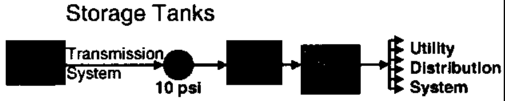
TRANSMISSION MAIN SYSTEM OPERATION ALTERNATIVES

Transmission Main System Alternatives

(A) Water Transmission "at Pressure"



(B) Water Transmission to Ground Storage Tanks



Analysis of Distribution System Alternatives

Options	ADVANTAGES	DISADVANTAGES
Transmission main system "at Pressure"	• No individual Utility Booster Pump Stations required • No individual Utility ground storage tanks required	• Larger diameter pipelines • Larger WTP Pump Station • One Pressure Plane
Transmission main system with "ground storage tanks"	• Larger diameter transmission mains	• Construction of individual ground storage tank and booster pump station at each Utility required

Recommendation: Transmission main with ground storage tanks, as this scenario has lower expected life cycle cost

Mid Brazoria County Water Planning Group
TWBD Facility Plan Study

Progress Meeting Agenda

Date: June 14, 2001
Time: 12:00 P.M.
Place: City of Alvin Library

Agenda:

1) Introduction of Attendees
2) MBCPG – Project Definition
3) MBCPG – Facility Plan Progress
   A) Water Treatment Plant Capacity
   B) Screened alternative WTP Sites
   C) Alternative Site evaluation
   D) Hydraulic modeling of finished water system
   E) Capital and O&M Cost Estimates for Alternatives
   F) Resource Management Plan
   G) Water Conservation Plan
4) Open Discussion.

Mid-Brazoria County Regional Planning Group

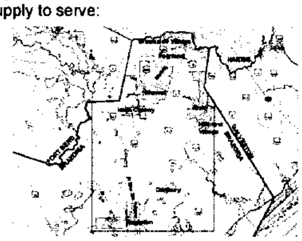
June Progress Meeting

Agenda

- MBCPG Project Mission
- Work Completed
- Review of Alternatives
- What's Next

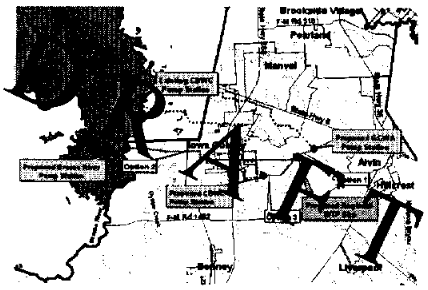
The MBCPG Project Definition

- Study Feasibility of Regional WTP to Provide Safe, Economical, and Reliable Water Supply to serve:
  - Alvin
  - Angleton
  - Brookside Village
  - Danbury
  - Hillcrest Village
  - Iowa Colony
  - Manvel
  - Pearland



- Develop Regional Surface WTP Facility Plan
- Develop Cost Estimate for Facility Plan

TWDB Governs Raw Water Source Development

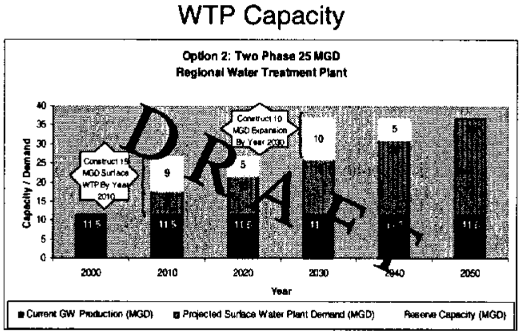


- MCBPG can identify other sources, but Facility Plan must be coordinated with Region H Regional Water Plan

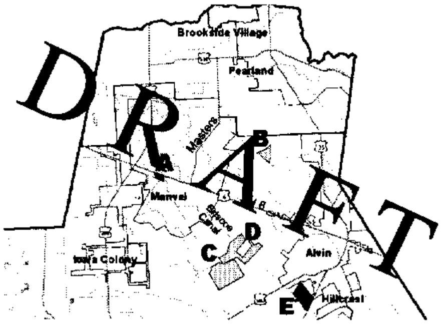
MCBPG Facility Plan Progress

- MCBPG Decisions to Date
  - Water Treatment Plant Capacity
  - Screened Alternative WTP Sites to Site A and Site E
- Work Completed Since Last Meeting
  - Alternative WTP Site Evaluation
  - Hydraulic Modeling of Finished Water System
  - Capital and O&M Cost Estimates for Alternatives
  - Resource Management Plan
  - Water Conservation Plan

Review of MCBPG Decisions - WTP Capacity



Review of MCBPG Decisions - Screened WTP Sites



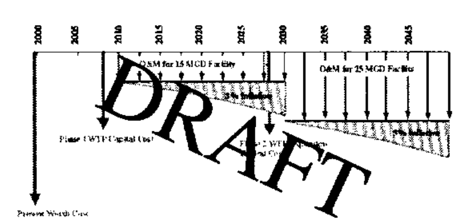
Work Completed This Period: WTP Location Evaluation

Intangibles
- Public Acceptance
- Expandability
- Reliability
- Environmental Impacts
- Permitting

Tangibles
- Raw Water Conveyance
- WTP
- Finished Water Conveyance

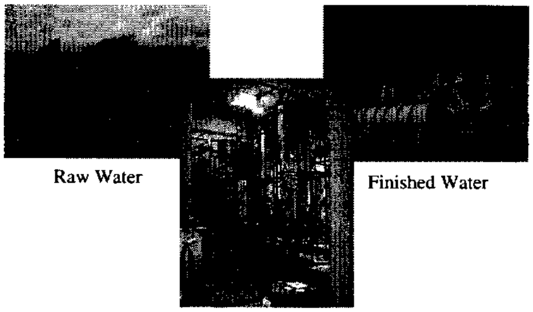
WTP Location Evaluation: Economic Evaluation

- Compare present worth cost to construct and operate the necessary facilities



- Includes Administration, Engineering, and Contingency

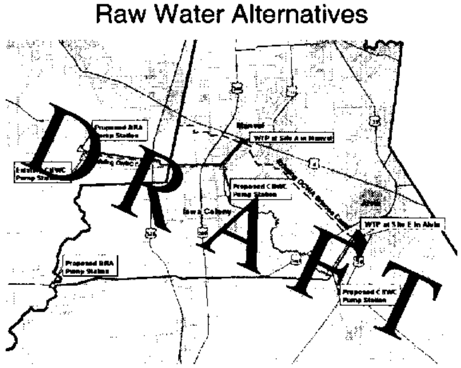
Economic Breakdown



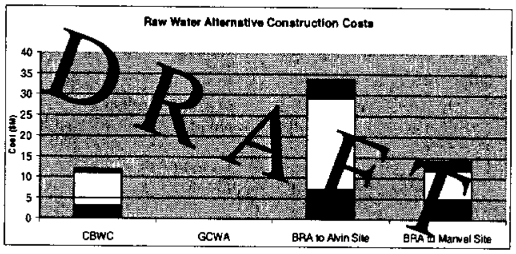
Raw Water Conveyance

- Separate Raw Water Conveyance Analysis
  - No firm contract for raw water
  - Variability in raw water cost from each entity
  - Gives MBCPG information from which to negotiate for necessary raw water
- Updated Capital and O&M costs from Region H to reflect screened locations of alternative WTP sites
- Raw Water Demand 10% Higher Than Required WTP Production to account for losses through plant

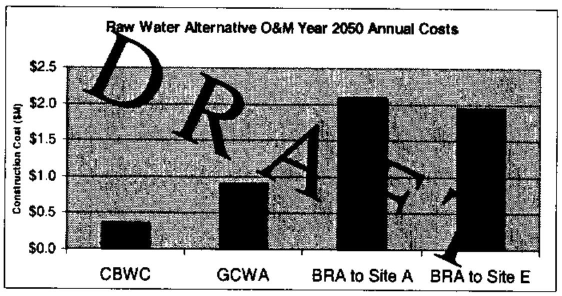
Raw Water Alternatives



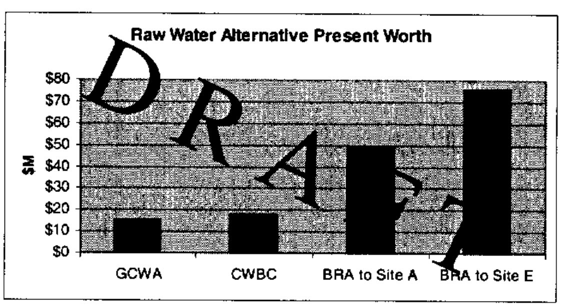
Raw Water Facilities Construction Costs



Raw Water Facilities O&M Cost

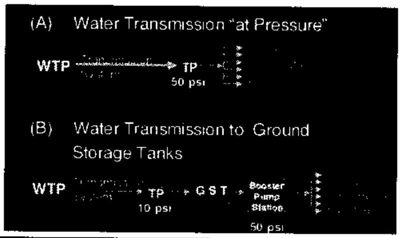


Raw Water Present Worth



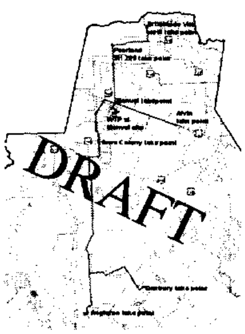
WTP Alternative Economics

- Water Treatment and Finished Water Transmission Costs
- Two Alternatives for Finished Water

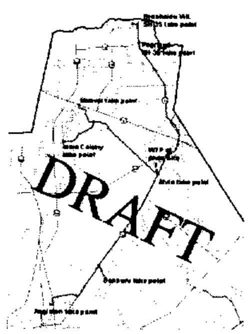


WTP Site Alternatives

Manvel



Alvin



Treatment and Transmission Costs

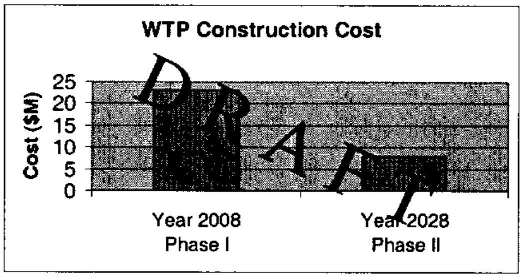

Site Development


Water Treatment

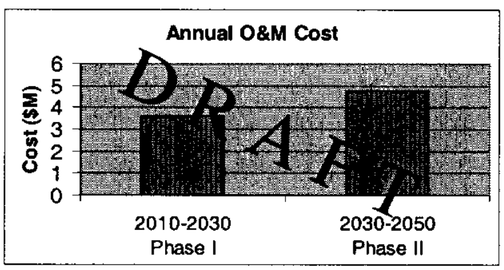

Transmission


Distribution

25 MGD High Rate Conventional WTP <u>Construction</u> Costs

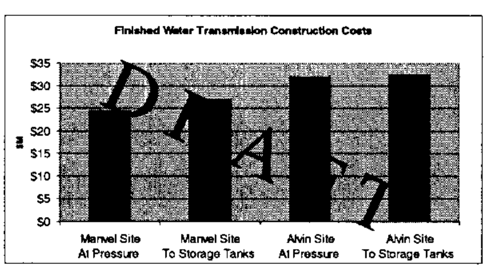


25 MGD High Rate Conventional WTP O&M Costs

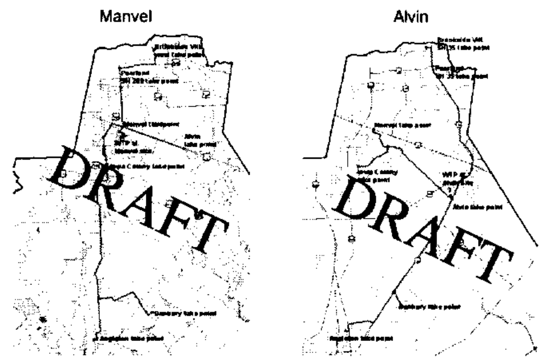


*Not including cost of raw water

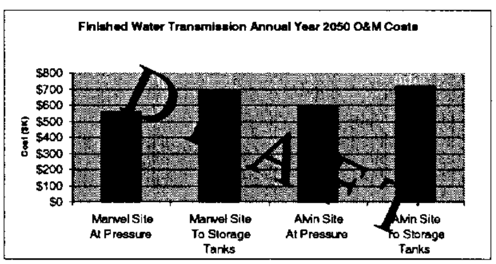
Finished Water Transmission Costs



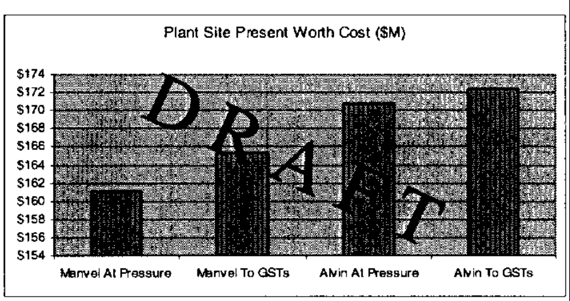
WTP Site Alternatives



Finished Water Transmission Costs



Present Worth



Resource Management Alternatives

- Four General Alternatives to Manage Regional Water Authority
  - Contract with Existing Authority
  - Create New Authority Under Existing Water Code Rules and Regulations
  - Create New Authority by Legislative Action
  - Establish a Non Profit Water Corporation

Recommendations

- Develop facility plan for 25 MGD plant at the Manvel site (MW)
- Negotiate for raw water contract or purchase
- Establish communication with other regional participants for cost savings of larger Regional Water Plant
- Brazoria County Groundwater Protection District Confirmation
- Create Regional Water Supply District

What's next

- Schedule:
  - Draft Report : June 30, 2001
  - On target to meet this deadline
  - Comments of Draft Report due back July 30, 2001
- Working on:
  - Compiling Report
  - Comparing alternative to larger Regional WTP alternative
  - Detailed Facility Plan
  - Financing
- Outstanding Items:
  - Dow Chemical Cost Proposal
  - Briscoe Properties Cost Proposal

Contract with Existing Regional Authority

Advantages

- Existing Authority with power to implement and finance necessary improvements
- No requirement for creation of another regional authority
- Leverage Administration Costs Across Larger Area
- Experience in O&M of Regional Water Treatment and Distribution Systems

Disadvantages

- No Protection of Groundwater Sources
- No Representation on Board

Create New Authority Under Existing Water Code Rules and Regulations

Advantages

- No additional rules required to establish authority
- Authority can be created with a petition, approval of county commissioners and voters of new District

Disadvantages

- Require approval of voters
- Perception of Taxing Agency

Create New Authority by Legislative Action

Advantages

- Authority creation does not require petition or voter approval
- Rules and governing provisions can be customized
- Can establish power to regulate groundwater protection and potable water treatment and distribution

Disadvantages

- Legislature may not pass bill creating new district

Establish a Non Profit Water Corporation

Advantages

- Creation through application to Texas Secretary of State
- Can design, build, and operate water treatment and distribution facilities

Disadvantages

- No Taxing Authority
- No Authority to Regulate Groundwater Withdrawal

Mid Brazoria County Water Planning Group
TWBD Facility Plan Study

Progress Meeting Agenda

Date: July 19, 2001
Time: 7:00 P.M.
Place: City of Alvin, City Hall

Agenda:

1) Introduction of Attendees
2) Project Approach
3) Water Demand Needs
4) Water Treatment Plant Site Location
5) Raw Water Source Alternatives
6) Planning Group Recommendations
7) Open Discussion

Regional Water Facility Provides a Reliable and Feasible Water Supply Alternatives

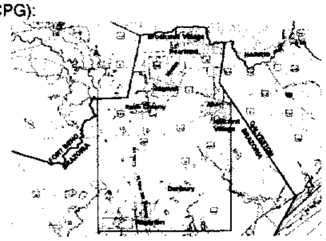
ALVIN, TEXAS
JULY 2001

Presentation Topics

- Project Approach
- Water Demand Needs
- WTP Site Selection
- Raw Water Source Alternatives
- Planning Group Recommendations

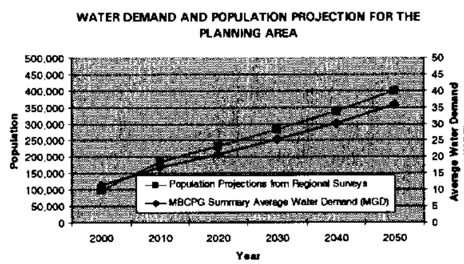
Approach

- Study Feasibility of Regional WTP to Provide Safe, Economical, and Reliable Water Supply to serve Mid-Brazoria County Planning Group (MBCPG):
  - Alvin
  - Angleton
  - Brookside Village
  - Danbury
  - Hillcrest Village
  - Iowa Colony
  - Manvel
  - Pearland

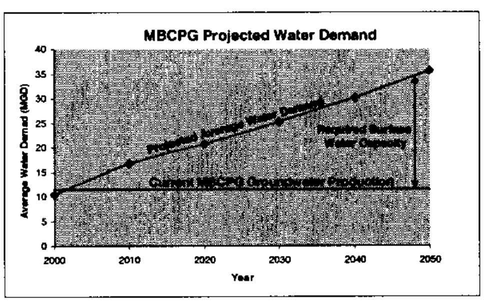


- Develop Regional Surface WTP Facility Plan
- Develop Cost Estimate for Facility Plan

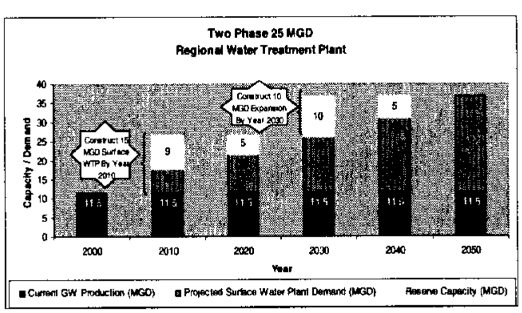
Mid Brazoria County Planning Group Population and Water Demand Projections



Mid Brazoria County Planning Group Water Demand



Proposed Water Treatment Plant Capacity

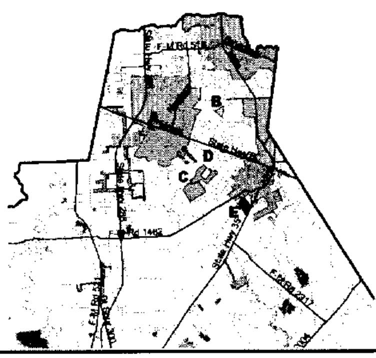


SURFACE WATER TREATMENT PLANT SITE SELECTION

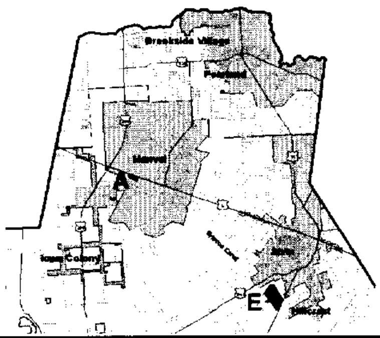
ALTERNATIVE PLANT SITE SELECTION PROCESS

- Met with MBCPG to review engineering requirements for a site
  - Size of Property
  - Proximity to Water Demand
  - Proximity to Raw Water Source
  - Proximity to Highways and Utilities
  - Site Surface Features

Review of Alternative Treatment Plant Sites



Screened Sites



EVALUATION OF SCREENED ALTERNATIVE WTP SITES

Treatment and Transmission Alternatives Evaluation Criteria

- Non-Economic Factors
  - Impact of Project on Intangibles
- Economic Lifecycle Cost to:
  - Construct Necessary Facilities
  - Operate and Maintain Facilities Until Year 2050

Non-Economic Criteria
Site Selection Summary

MBCPG noted no discernable difference between the Manvel and Alvin Site

Economics

- Capital Cost to Construct Facilities
- Annual O&M Cost to Produce and Deliver Potable Water

Treatment and Transmission Costs


Site Development


Water Treatment


Transmission

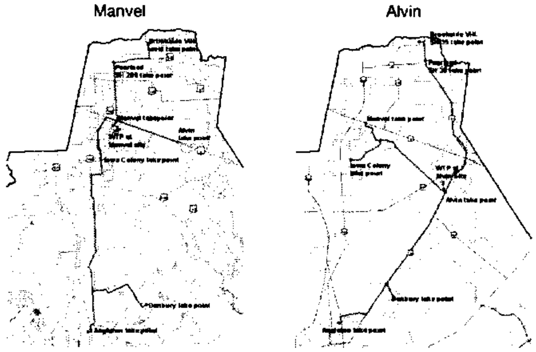

Distribution

FINISHED WATER TRANSMISSION

WTP Site Alternatives

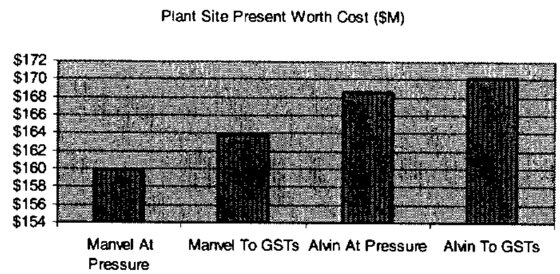
Manvel

Alvin

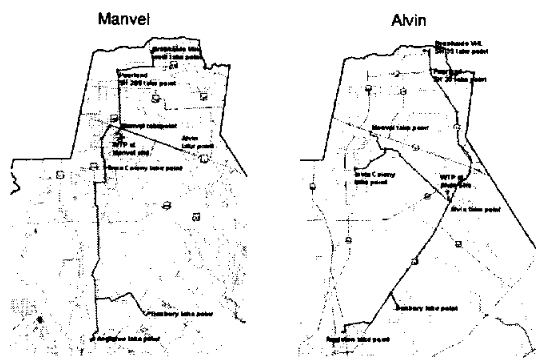


ECONOMIC COMPARISON

Surface Water Treatment and Transmission Present Worth Cost

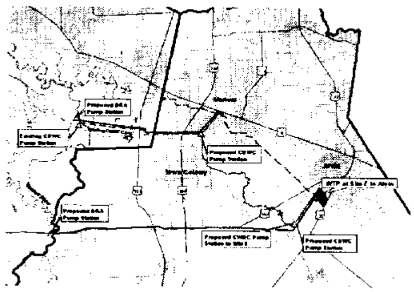


Contributing Factor To Cost Savings of Manvel Site



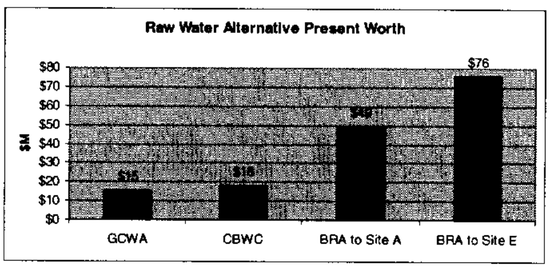
RAW WATER SUPPLY ECONOMICS

TWDB Governs Raw Water Source Development



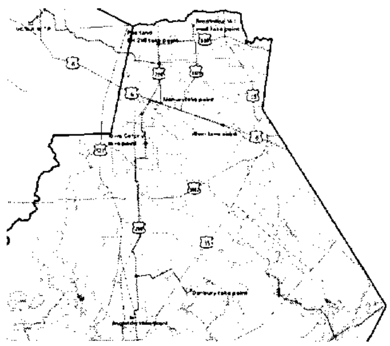
- MCBPG can identify other sources, but Facility Plan must be coordinated with Region H Regional Water Plan

Raw Water Facilities Present Worth Cost

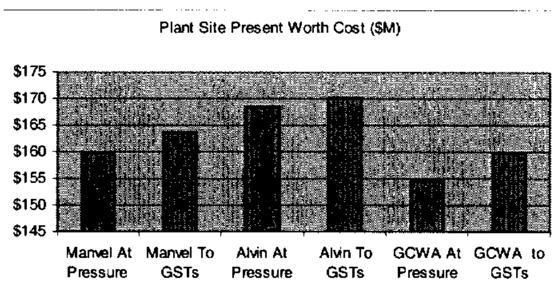


COMPARISION TO PROPOSED GCWA REGIONAL SURFACE WATER TREATMENT PLAN

Finished Water Transmission from GCWA WTP Site



Total Present Worth Cost



Recommendations

- Create Regional Water Supply District
  - Incorporation in Larger Regional Water Plant
    - Capitalize on cost savings associated with economy of scale
    - Initiate communication with agencies in Fort Bend, Harris, and Brazoria County for this larger regional water plant
  - Local Regional Water Plant
    - Construct a 25 MGD WTP at the Manvel site
    - Negotiate for raw water contract or purchase from CBWC, GCWA, or third party

NOTICE OF PUBLIC HEARING

The City of Alvin invites you to a public meeting on the feasibility of a Mid-Brazoria County Regional Water Plant. This water plant would serve the residents of Manvel, Brookside Village, Pearland, Alvin, Hillcrest Village, Danbury, Angleton, and Iowa Colony.

Meeting Location: City of Alvin City Hall
216 W. Sealy
Alvin, TX 77511

Meeting Time: September 24, 2001 - 7:00 PM

Meeting Agenda:

1) Mid-Brazoria County Planning Group Project Review
2) Report Overview
3) TWDB Comments Review
4) Regional Water Supplier round table
5) Comments

If you have any questions or comments on the agenda, please feel free to contact Chris Canonico, at Montgomery Watson (713)-403-1600.

Appendix M
Correspondence with State Regulatory Authorities

MONTGOMERY WATSON

TEN YEARS IN HOUSTON

April 23, 2001

Bill Martin
Department of Antiquities Protection
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711

Subject: Mid-Brazoria County Planning Group (MBCPG) Regional Surface Water Plant.

Dear Mr. Martin,

Montgomery Watson would like to request a cultural resources assessment of the proposed transmission pipelines from the MBCPG Regional Water Plant to be located in Mid-Brazoria County. This cultural assessment is requested as part of a study to determine the feasibility of locating a new regional water plant in the Mid-Brazoria County area. The results from this cultural resources assessment will be used to minimize impact on the cultural resources of Texas.

The attachments show the proposed site locations and proposed pipeline routes. Construction of each pipeline will require a strip of land approximately 20 feet in width along the entire length of the proposed pipelines. The majority of the proposed pipelines are aligned within existing TXDOT easements and construction of these pipelines will occur in areas that have been previously disturbed.

If you have any questions or need additional information, please feel free to call me. If the results of the cultural resources assessment shows any areas where construction is not feasible, please let me know as soon as possible as the final feasibility study will be issued in early June.

Sincerely,

Sushrut Joshi.

Attachments:
1. Figure 1-Alternate Water Treatment Plant Sites.
2. Figure 2-Detailed map of Water Treatment Plant Site 1.
3. Figure 3-Detailed map of Water Treatment Plant Site 2.
4. Figure 4-Alternate Pipeline alignments.

cc: Chris Canonico,
Montgomery Watson

5100 Westheimer, Suite 580
Houston, Texas
77056-5507

Tel: 713 403 1600
Fax: 713 850 7901

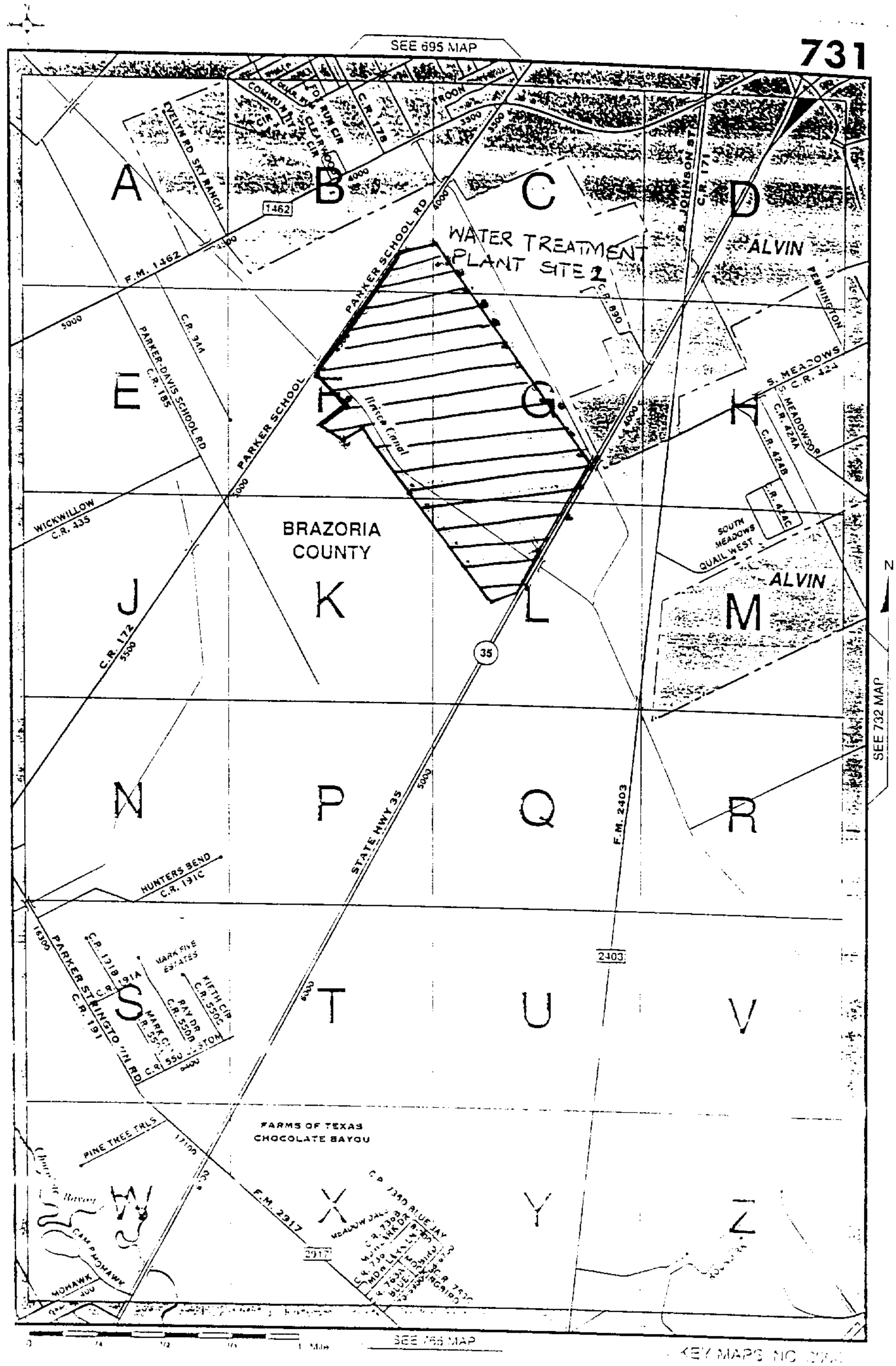


Figure 3-Detailed map of Water Treatment Plant Site 2

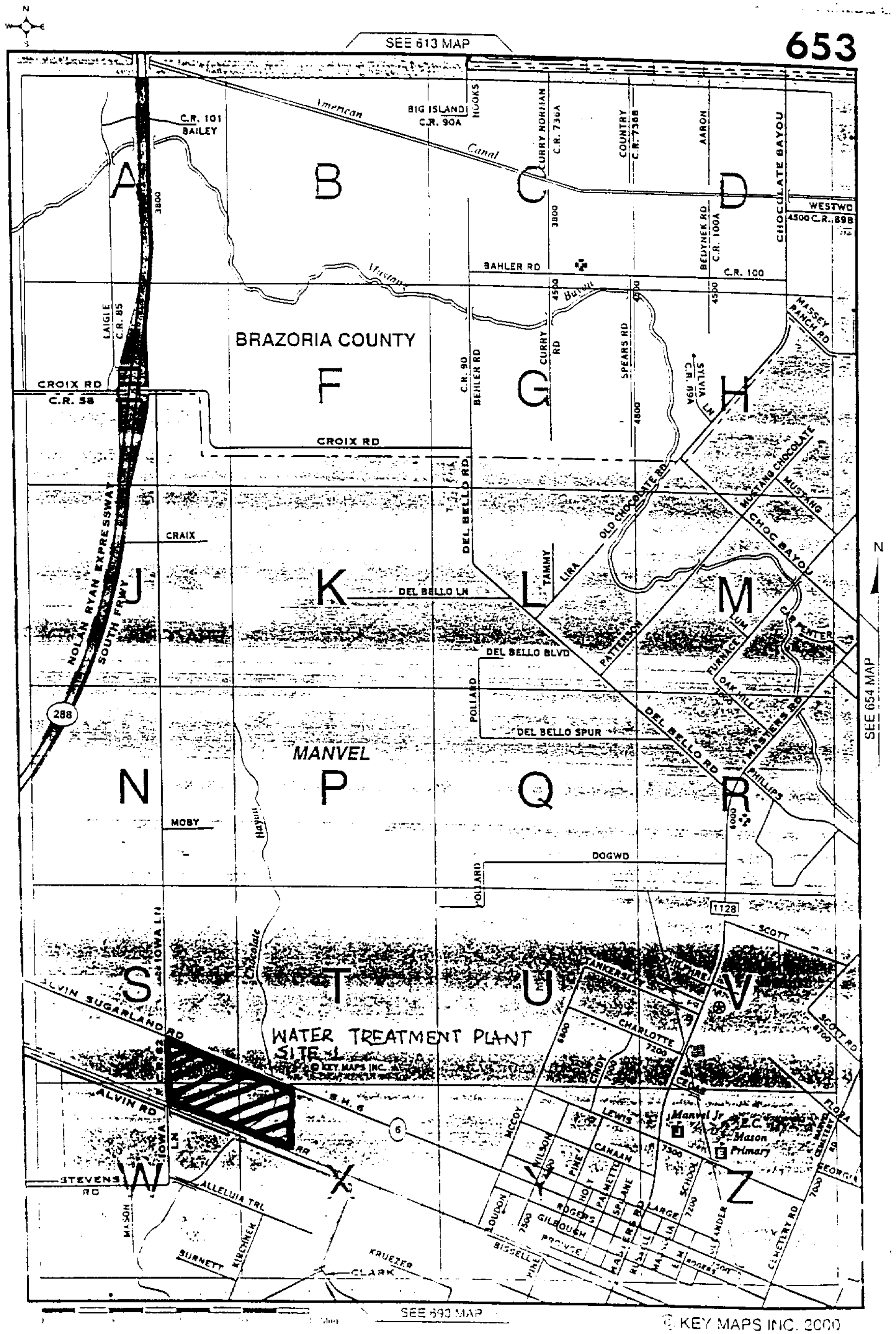


Figure 2-Detailed map of Water Treatment Plant Site 1

Figure 1- Alternate Water Treatment Plant Sites

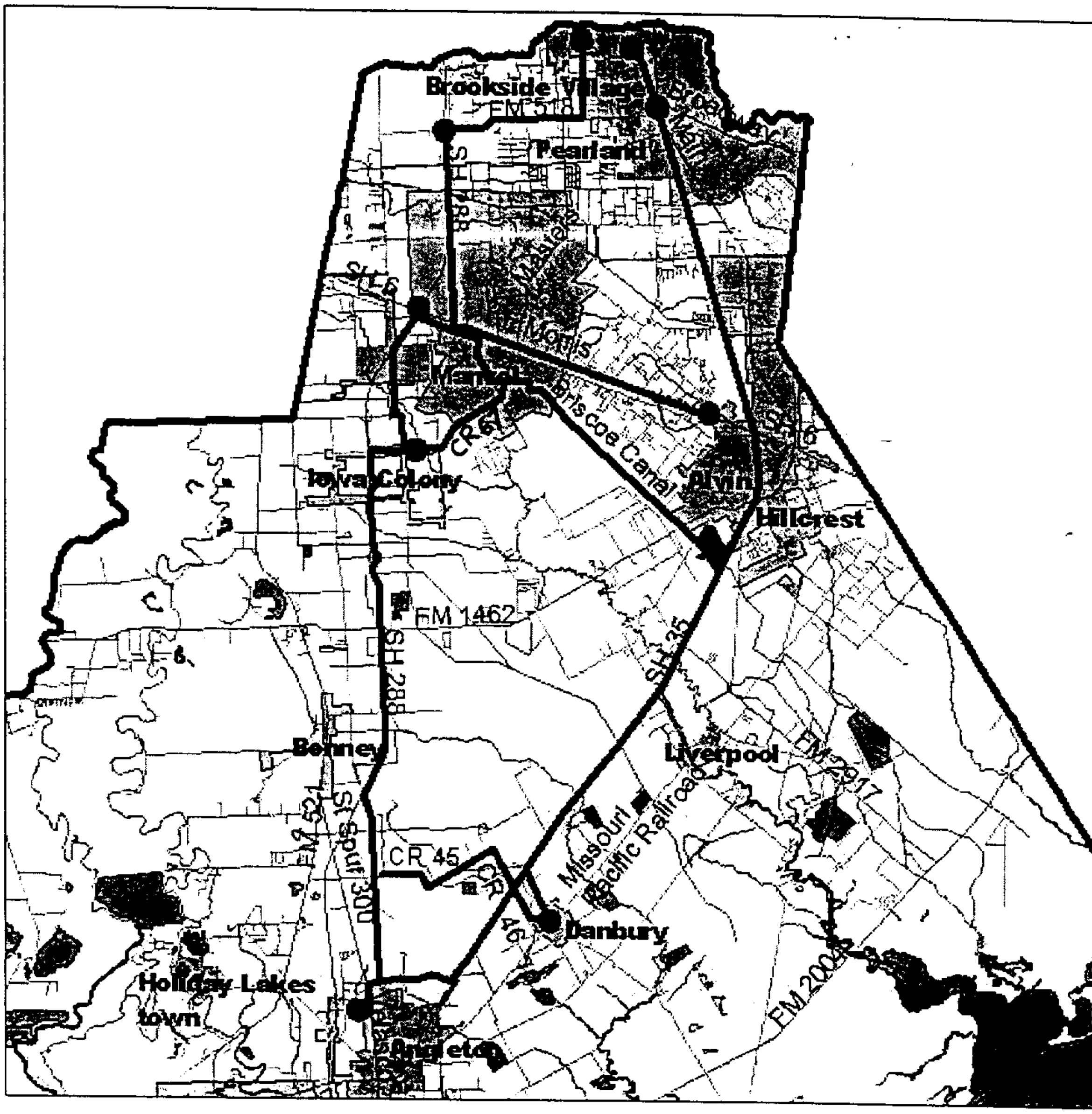


Figure 4- Alternate Pipeline alignments

TEXAS HISTORICAL COMMISSION

The State Agency for Historic Preservation

RICK PERRY, GOVERNOR
JOHN L. NAU, III, CHAIRMAN
F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

May 10, 2001

Sushrut Joshi
Montgomery Watson
5100 Westheimer, Suite 580
Houston, TX 77056-5507

Re: Project review under Section 106 of the National Historic Preservation Act of 1966
and the Antiquities Code of Texas
Mid-Brazoria County Regional Water Plant
(TWDB)

Dear Mr. Joshi:

Thank you for your correspondence describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission. As the state agency responsible for administering the Antiquities Code of Texas, these comments also provide recommendations on compliance with state and federal antiquities laws and regulations.

The review staff, led by Ed Baker, has completed its review. While we know of no cultural resources within the areas outlined on your maps, the areas submitted have not been professionally surveyed for cultural resources. Proposed plant site #1 may have a slightly greater chance to contain buried archeological material due to the presence of Chocolate Bayou, but either location could contain cultural resources. Previously disturbed roadways in the area are not likely to contain cultural resources. Exceptions may occur within broad rights-of-way or in areas where easements are expanded into previously undisturbed areas.

You may wish to engage a cultural resources consultant to conduct further records review and reconnaissance of the plant and pipeline alternatives. We would then be happy to review any recommendations they have for further work. Alternately, you may wish to re-submit the project for further review after preferred plant and pipeline locations are identified. In this case, please provide 7.5-minute topographic maps with proposed project elements outlined and described in detail.

We look forward to further consultation with your office and hope to maintain a partnership that will foster effective historic preservation. Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Ed Baker at 512/463-5866.**

Sincerely,

William A. Martin

for
F. Lawerence Oaks, State Historic Preservation Officer
FLO/elb

enclosure: *Council of Texas Archeologists Archeological Contractors List*

Texas Department of Transportation

P.O. BOX 1386 • HOUSTON, TEXAS 77251-1386 • (713) 802-5000

June 13, 2001

CONTACT: DOM

Preliminary Permit Review
Proposed Pipeline Corridor
SH 288 Within the limits of Pearland and Angleton

Mr. Sushrut Joshi
Montgomery Watson
5100 Westheimer, Suite 580
Houston, Texas 77056

Dear Mr. Joshi:

We have reviewed both of your requests dated April 18, 2001, and April 26, 2001, for access on SH 288 right-of-way for the proposed water pipelines serving the City of Brookside and the City of Angleton. The current Texas Department of Transportation Utility Accommodation Policy stipulates that new utilities will not be installed longitudinally within control of access lines of any freeway. We have verified that the existing control of access boundaries will not allow any utilities to be placed in the areas you identified along SH 288 for the proposed Pearland corridor and will require an alternate route. Our right-of-way maps verify that the majority of limits along SH 288 indicated in your proposal for the Angleton corridor are within a controlled access area although there are certain areas that are accessible within the limits you requested. Attached is a map showing where access is denied, indicated by a heavy blue line, and where it is allowed, indicated by the X's marked along SH 288.

If you should have any questions, please contact Ms. Alexine Stittiams-Ward, P.E., Maintenance Support Engineer (713) 802-5554.

Sincerely,

for Alexine Stittiams-Ward, P.E.

Michael W. Alford, P.E.
Director of Maintenance
Houston District

FHS:pm
Attachments
cc: Mr. Larry Heckathorn, P.E.
Ms. Alexine Stittiams-Ward, P.E.

MONTGOMERY WATSON

5100 Westheimer, Suite 580
Houston, TX 77056
713/403-1653
713/850-7901 (fax)

To:	Michael Alford, P. E.	From:	Sushrut Joshi
Company:	Director of Maintenance, Texas Department of Tansportation	Subject:	Preliminary Report for Right-of-Way along SH 288
Fax:	713-802-5550	No. of pages: 8 (including cover page)	
Phone:	713-802-5554	Reference:	
Date:	4/18/01		

Dear Mr. Alford,

Please find attached a request for preliminary report for right-of-way along SH 288, for a water transmission pipeline form the city of Manvel to the city of Angleton.

A project summary and map of the region with the the proposed pipeline along SH 288 is attached for your perusal.

Thank You,

Sushrut Joshi.

TEXAS DEPARTMENT OF TRANSPORTATION
HOUSTON DISTRICT MAINTENANCE
APR 18 2001

Att: ASW
Pls handle

If you do not receive all pages, or if there are any problems with this transmission, please call 713-403-1653

MONTGOMERY WATSON

TEN YEARS IN HOUSTON

April 18, 2001

Michael Alford, P.E.
Director of Maintenance
Texas Department of Transportation
P.O. Box 1386
Houston, Texas 77251-1386

Subject: Right-of-way along State Highway 288 for a proposed water transmission pipeline.

Dear Mr. Alford,

Montgomery Watson would like to request a preliminary report for availability of right-of-way along State Highway 288 for a proposed water transmission pipeline. The water pipeline will be owned and operated by governmental agencies charged with providing residents in the Mid-Brazoria County with potable water. Your preliminary report will help us determine if it is feasible to have 20" water pipeline routed along SH 288. We would like to know if there are any regulatory or any of your concerns for use of the right-of-way.

The proposed finished water transmission pipeline will start from a proposed water treatment plant located in the City of Manvel, along State Highway 6, and run south along the east side of the SH 288 corridor to the City of Angleton.

Please let me know if any further information is necessary. If you have any questions or need additional information, please feel free to call me. I understand that this review requires time, but since the project is advancing, we would greatly appreciate if you can respond by the 1st of May.

Sincerely,

Sushrut Joshi

Attachments:

1. Photocopy of road map of Brazoria County.
2. Detailed map of major roads in the Mid-Brazoria County region.
3. Detailed map showing the proposed pipeline corridor along State Highway 288.

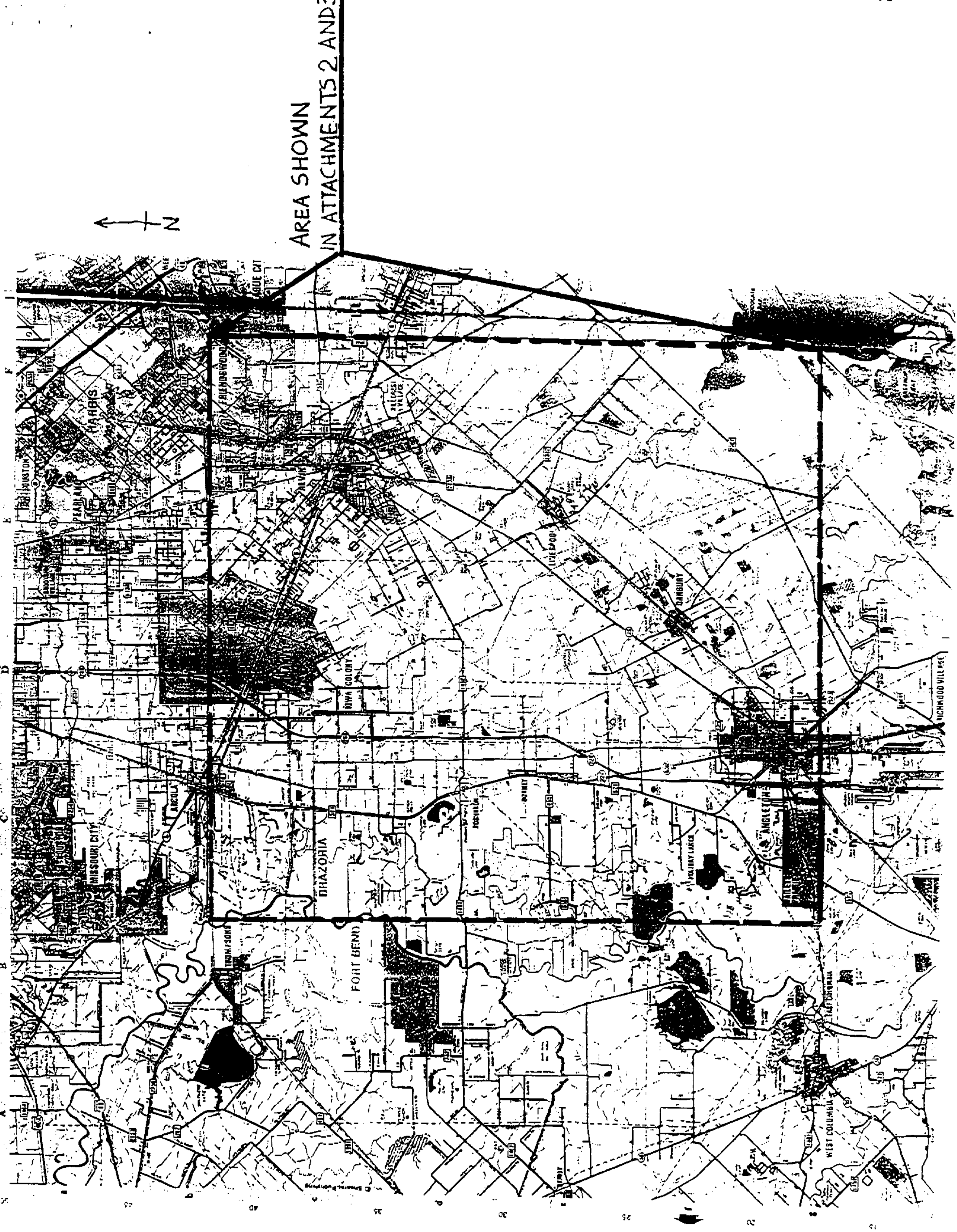
CC: Chris Canonico

5100 Westheimer, Suite 580
Houston, Texas
77056-5507

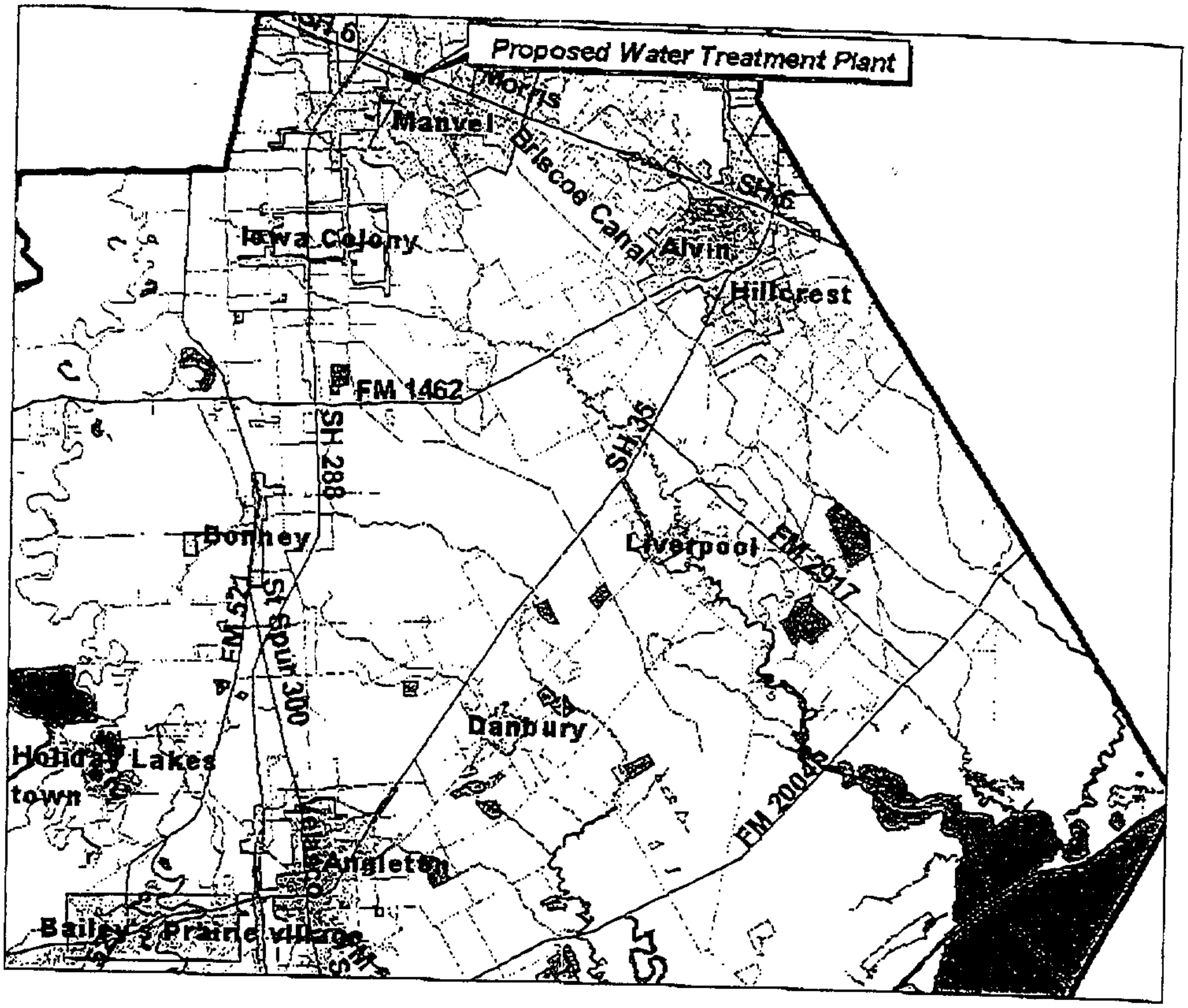
Tel: 713 403 1600
Fax: 713 850 7901

Serving the World's Environmental Needs

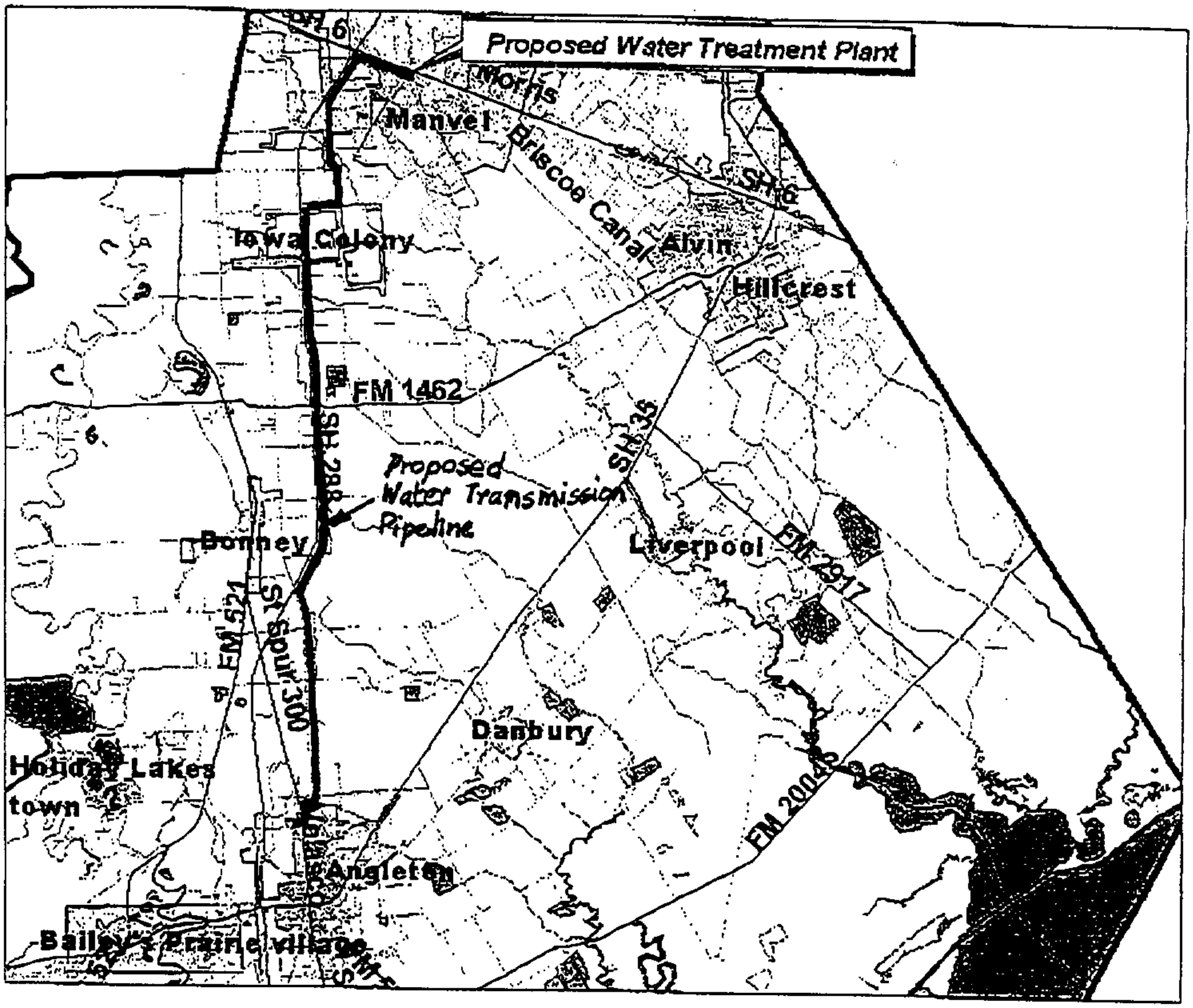
Attachment 1: Photocopy of road map of Brazoria County


AREA SHOWN
IN ATTACHMENTS 2 AND 3
N
FRIENDSWOOD
PEARLAND
HARRIS
ALVIN
LIVERPOOL
DANBURY
IOWA COLONY
ARCOLA
MISSOURI CITY
BRAZORIA
FORT BEND
THOMPSONS
ROSHARON
ANGLETON
HOLIDAY LAKES
RICHWOOD VILLAGE
WEST COLUMBIA
GALVESTON

Attachment 2: Detailed map of major roads in the Mid-Brazoria County region.


Proposed Water Treatment Plant
Morris
Manvel
Briscoe Canal
SH 6
Alvin
Hillcrest
Iowa Colony
FM 1462
SH 288
SH 35
Liverpool
FM 2917
Bonney
FM 521
St Spur 300
Danbury
Holiday Lakes town
Angleton
FM 2004
Bailey's Prairie village

Attachment 3: Map showing the proposed pipeline corridor for finished water transmission.


Proposed Water Treatment Plant
SH 6
Morris
Manvel
Briscoe Canal
SH 6
Alvin
Iowa Colony
Hillcrest
FM 1462
SH 288
Proposed Water Transmission Pipeline
SH 35
Bonney
Liverpool
FM 2917
FM 521
SH Spur 300
Danbury
Holiday Lakes town
FM 2004
Angleton
Bailey's Prairie village

MONTGOMERY WATSON

5100 Westheimer, Suite 580
Houston, TX 77056
713/403-1653
713/850-7901 (fax)

To:	Frankie	From:	Sushrut Joshi
Company:	Texas Department of Transportation	Subject:	Key Maps for Right-of-Way along SH 288
Fax:	713-802-5550	No. of pages:	~~8~~ 7 (including cover page)
Phone:	713-802-5554	Reference:	
Date:	4/26/01		

Frankie,

As per our phone conversation, please find attached detailed key maps of the probable finished water pipeline serving the cities of Angleton and Brookside Village.

Here are the details of the pipeline routes:

Pipeline Corridor serving the City of Brookside Village:

The pipeline runs West along Hwy 6, and then North-North East along SH 288 upto the intersection of SH 288 and FM 518. At the intersection, it runs East along FM 518, and then North along Suburban Garden Road, to the "water take point" for the City.
Please refer to Figures 1, 2, and 3 for the routing of this pipeline.

All controlled access on SH 288 + ROW FM 518 to CR 94 as part of SH 288

Pipeline Corridor serving the City of Angleton:

The pipeline runs West along Hwy 6, and then South along SH 288 for a short distance. It then veers off SH 288 to run south along CR 48 for approximately 1.75 miles, then east along CR 56 for approximately 0.2 miles, south along CR 65 for 1mile, and then West along CR 64 for approximately 1 mile to join SH 288.
Along 288, the pipeline runs South upto Spur 300. Then it runs South-South East along Business SH 288 till the intersection of Henderson Road. On Henderson Road, the pipeline turns West to the "water take point" for the City.
Please refer to Figures 4, 5, and 6 for the routing of this pipeline.

If you have any more questions, please feel free to call me.

Sincerely,

Sushrut Joshi.

If you do not receive all pages, or if there are any problems with this transmission, please call 713-403-1653

1

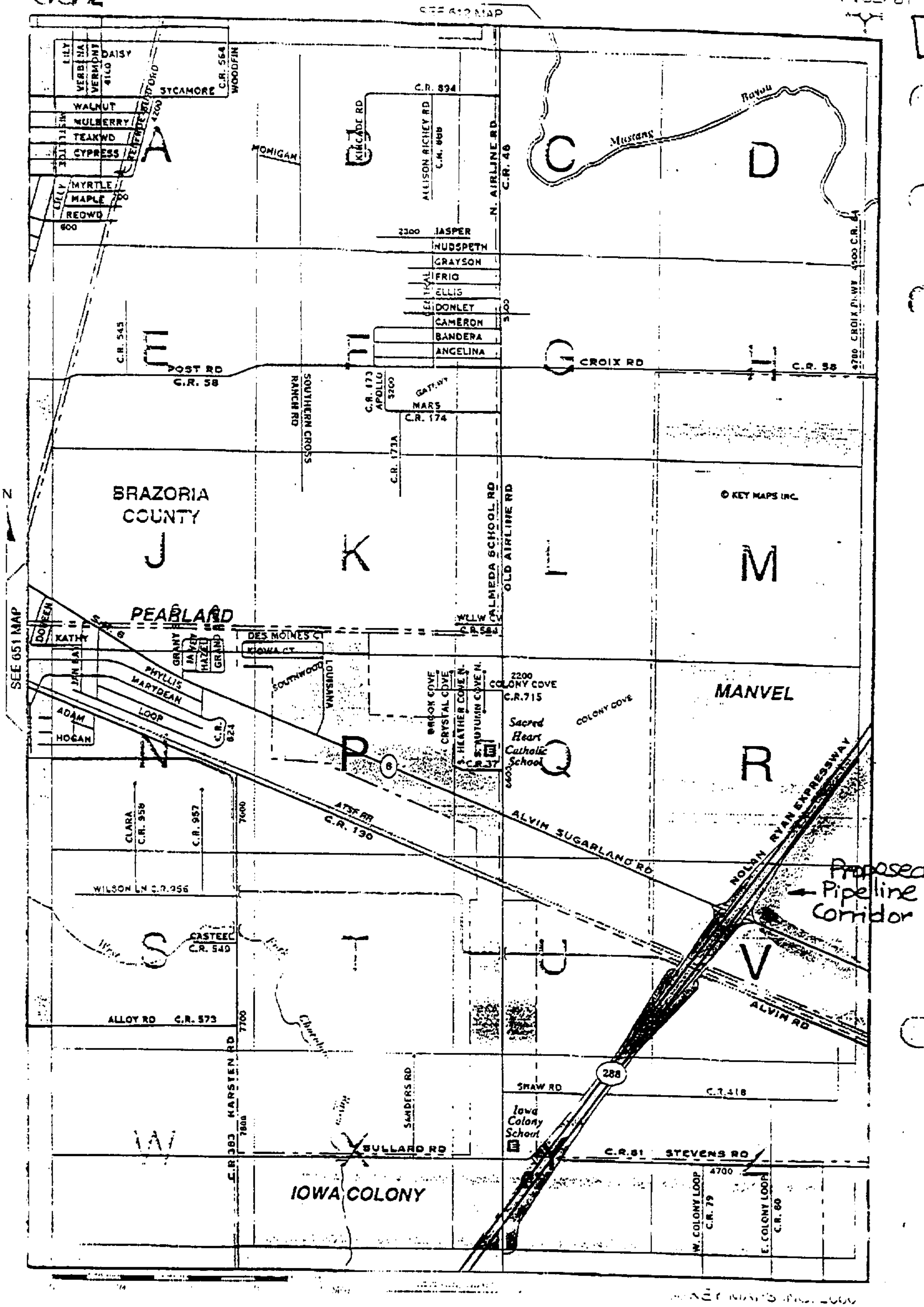

BRAZORIA COUNTY
PEARLAND
MANVEL
IOWA COLONY
Mustang Bayou
POST RD
C.R. 58
CROIX RD
N. AIRLINE RD
C.R. 48
OLD AIRLINE RD
ALMEDA SCHOOL RD
SOUTHERN CROSS RANCH RD
ALVIN SUGARLAND RD
ATSF RR
C.R. 130
NOLAN RYAN EXPRESSWAY
ALVIN RD
288
WILSON LN C.R. 956
CASTEEL C.R. 549
ALLOY RD C.R. 573
KARSTEN RD
C.R. 383
SANDERS RD
BULLARD RD
SHAW RD
C.R. 418
C.R. 61
STEVENS RD
W. COLONY LOOP C.R. 79
E. COLONY LOOP C.R. 60
CROIX PKWY C.R. 64
COLONY COVE C.R. 715
Sacred Heart Catholic School
Iowa Colony School
SEE 651 MAP
© KEY MAPS INC.
Proposed Pipeline Corridor
A
C
D
E
G
H
J
K
L
M
N
P
Q
R
S
T
U
V
W
X

Figure 1

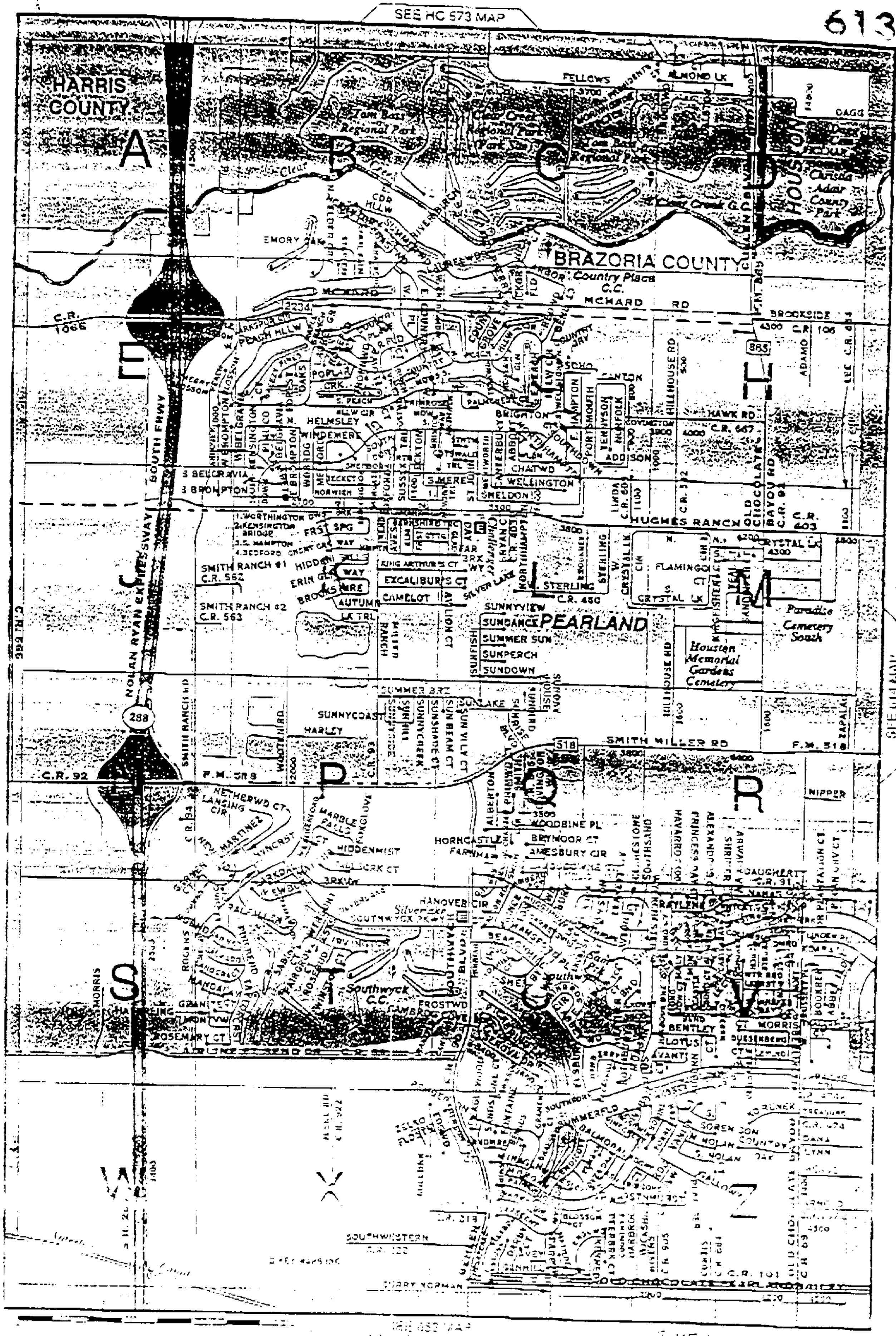
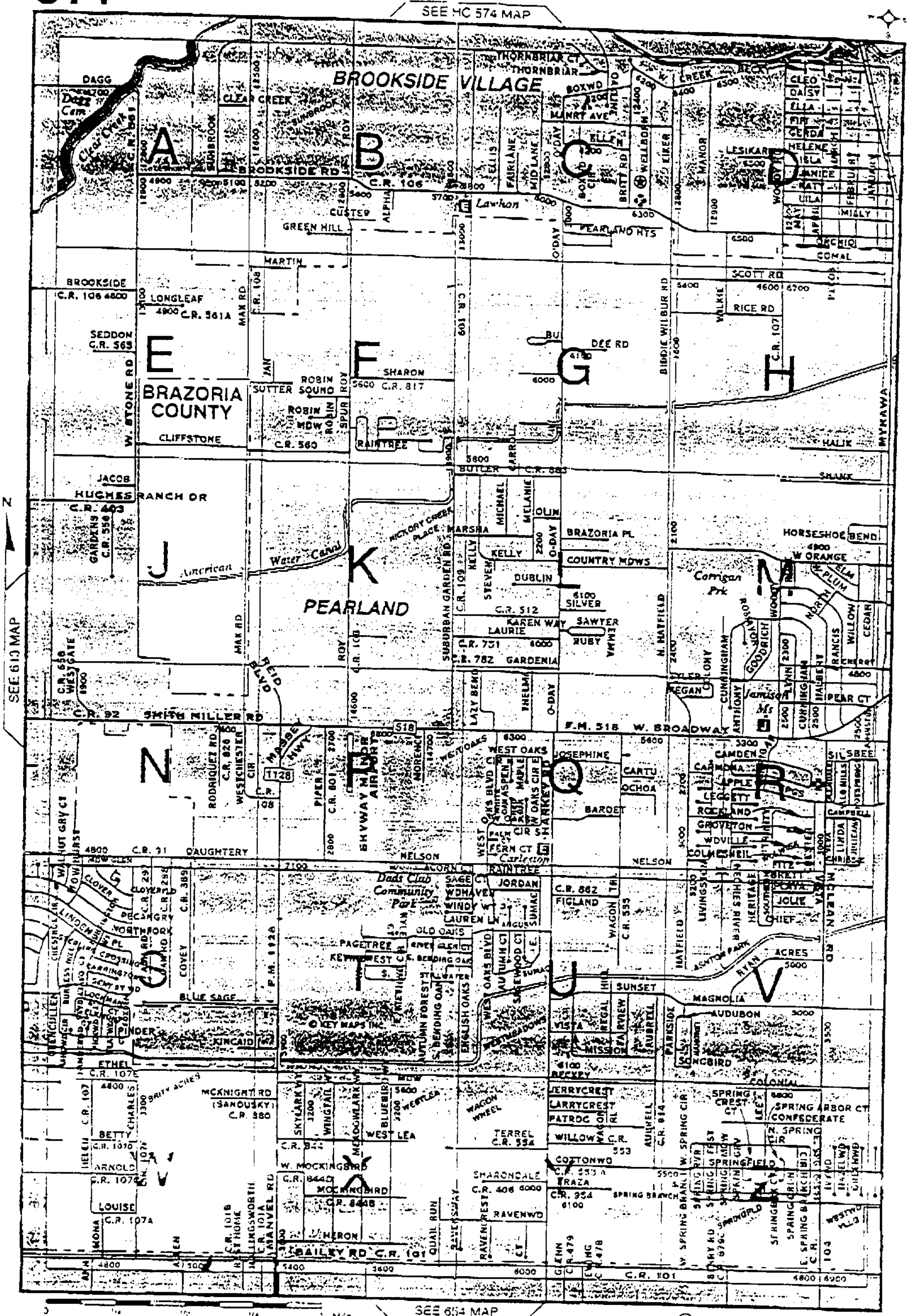


Figure 2

© KEY MAPS INC 2000



© KEY MAPS INC. 2000

Figure 3

4

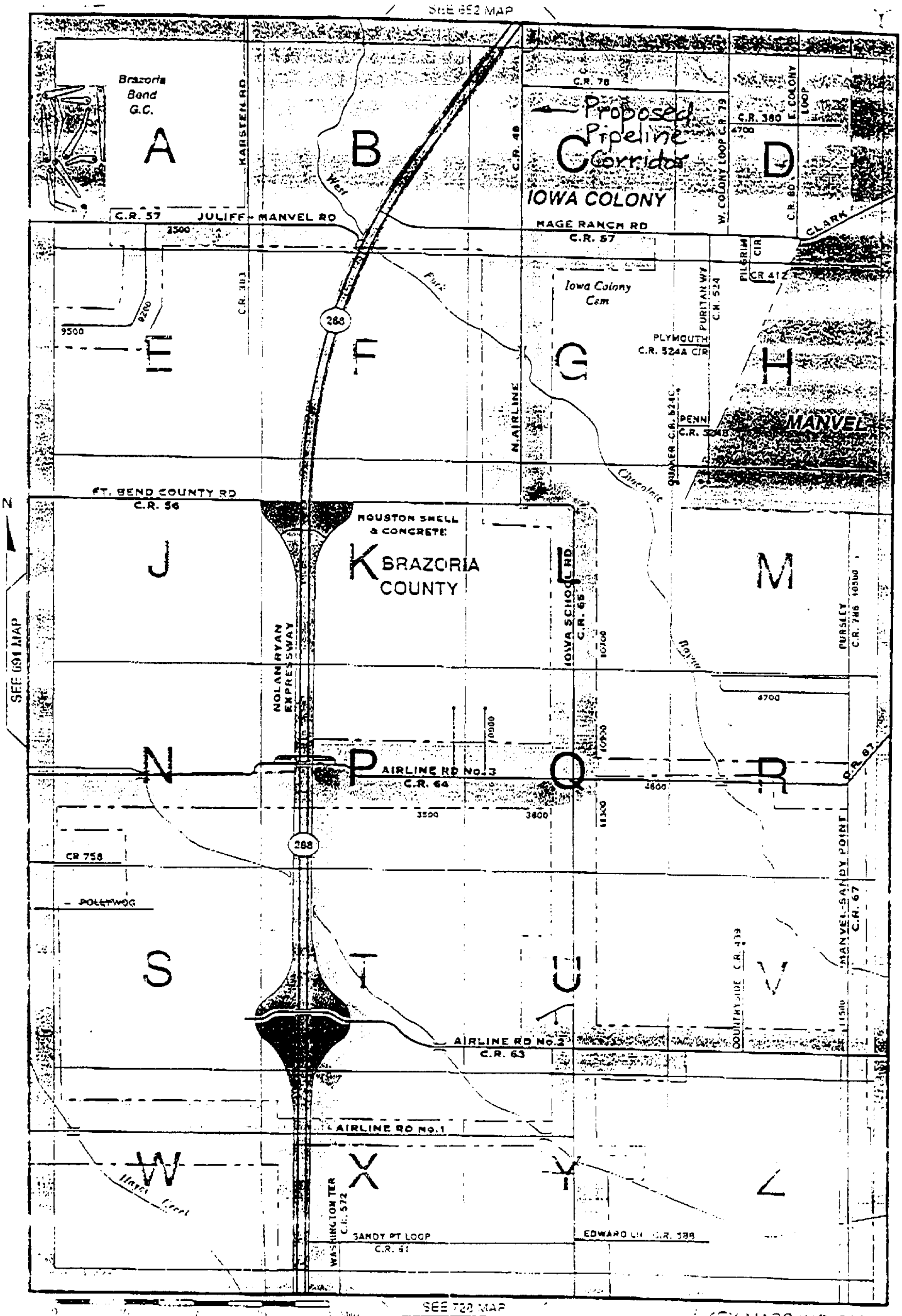

SEE 652 MAP
Brazoria Bend G.C.
A
B
C
D
Proposed Pipeline Corridor
IOWA COLONY
KARSTEN RD
C.R. 48
C.R. 78
C.R. 380
E. COLONY LOOP
W. COLONY LOOP C.R. 79
C.R. 80
C.R. 57
JULIFF-MANVEL RD
HAGE RANCH RD
C.R. 67
CLARK
PILGRIM CIR
CR 412
Iowa Colony Cem
PURITAN WY C.R. 524
PLYMOUTH C.R. 524A CIR
288
E
F
G
H
N. AIRLINE
QUAKER C.R. 524C
PENN C.R. 524B
MANVEL
FT. BEND COUNTY RD C.R. 56
HOUSTON SHELL & CONCRETE
J
K
BRAZORIA COUNTY
L
M
IOWA SCHOOL RD C.R. 65
PURSLEY C.R. 786
NOLAN RYAN EXPRESSWAY
SEE 691 MAP
N
P
Q
R
AIRLINE RD No. 3 C.R. 64
CR 758
POLLEYWOG
S
T
U
V
COUNTRYSIDE C.R. 439
MANVEL-SANDY POINT C.R. 67
AIRLINE RD No. 2 C.R. 63
AIRLINE RD No. 1
W
X
Y
Z
WASHINGTON TER C.R. 572
SANDY PT LOOP C.R. 61
EDWARD LN C.R. 588
SEE 728 MAP
KEY MAPS INC. 2000

Figure 4

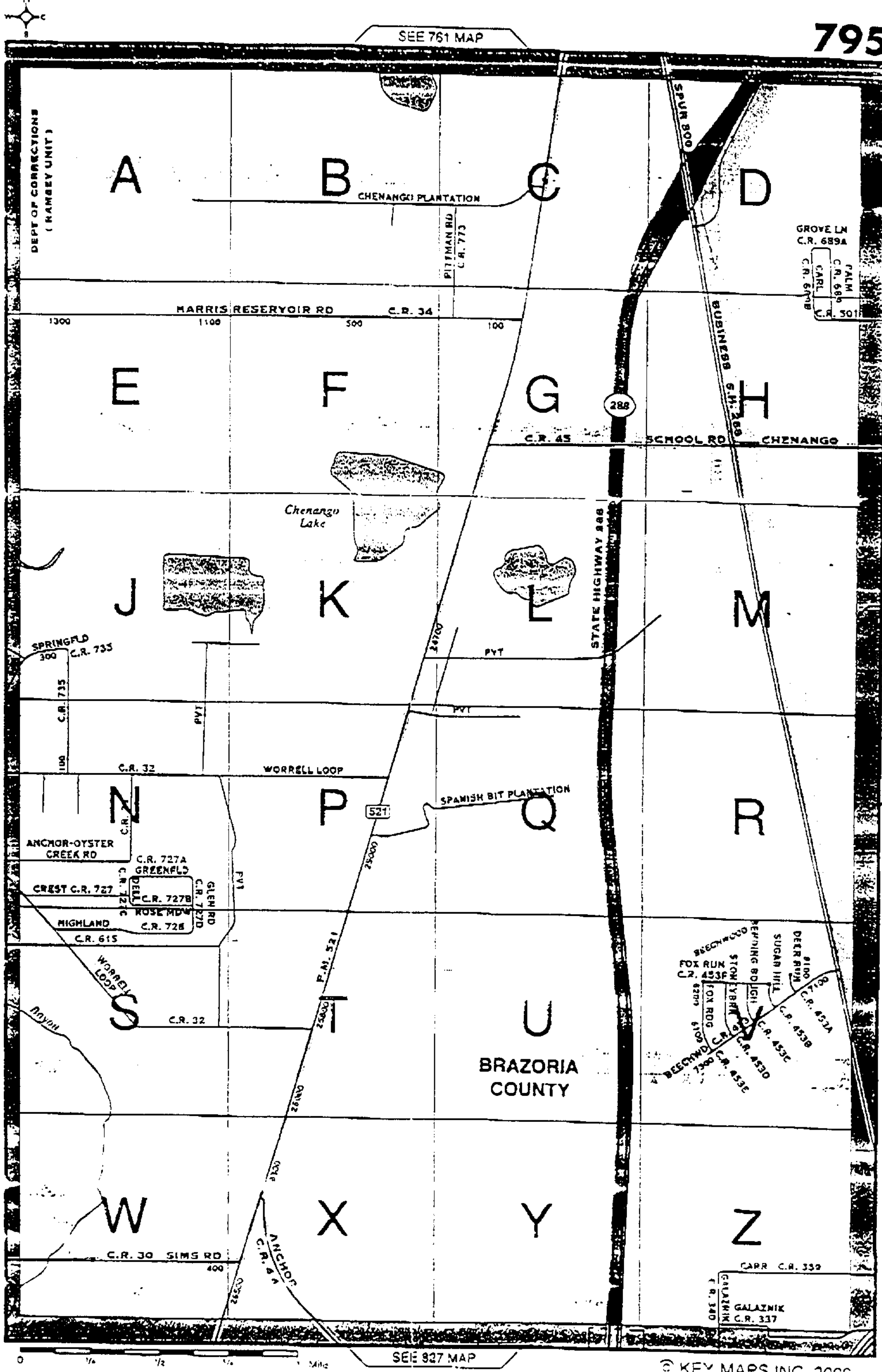

795
SEE 761 MAP
SEE 796 MAP
SEE 827 MAP
DEPT OF CORRECTIONS (RAMSEY UNIT)
CHENANGO PLANTATION
PITTMAN RD C.R. 773
SPUR 800
GROVE LN C.R. 689A
MARRIS RESERVOIR RD
C.R. 34
BUSINESS S.H. 288
288
C.R. 45
SCHOOL RD
CHENANGO
Chenango Lake
STATE HIGHWAY 288
SPRINGFLD C.R. 735
PVT
C.R. 735
C.R. 32
WORRELL LOOP
SPANISH BIT PLANTATION
521
ANCHOR-OYSTER CREEK RD
C.R. 727A
GREENFLD
CREST C.R. 727
C.R. 727B
ROSE MDW
GLEN RD
HIGHLAND
C.R. 728
C.R. 615
WORRELL LOOP
Bayou
F.M. 521
FOX RUN C.R. 453F
BEECHWOOD
SUGAR HILL
DEER RUN
C.R. 453A
C.R. 453B
C.R. 453C
C.R. 453D
C.R. 453E
BRAZORIA COUNTY
C.R. 30 SIMS RD
ANCHOR C.R. 44
CARR C.R. 339
GALAZNIK C.R. 337
A B C D E F G H J K L M N P Q R S T U W X Y Z
© KEY MAPS INC. 2000

Figure 5

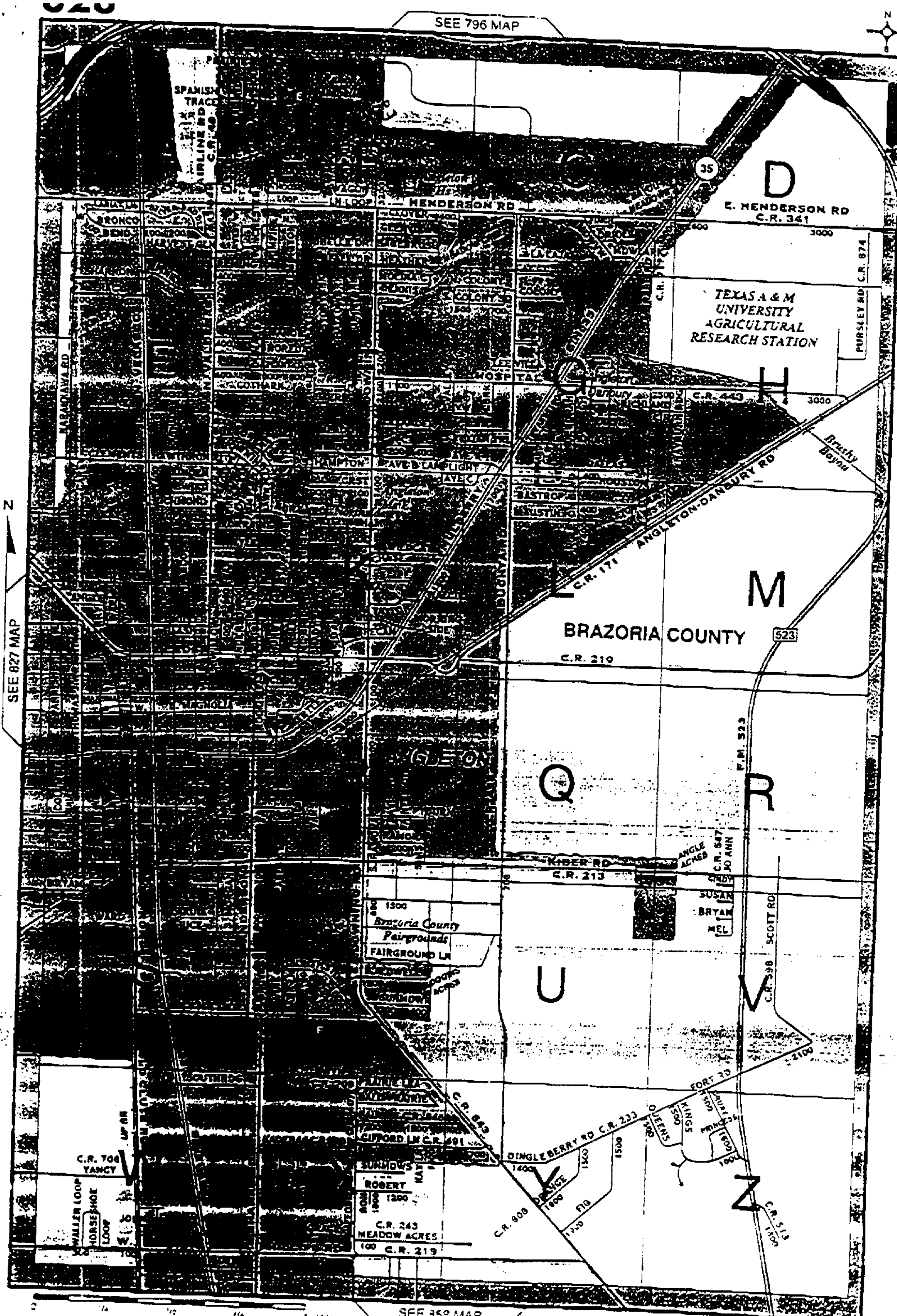
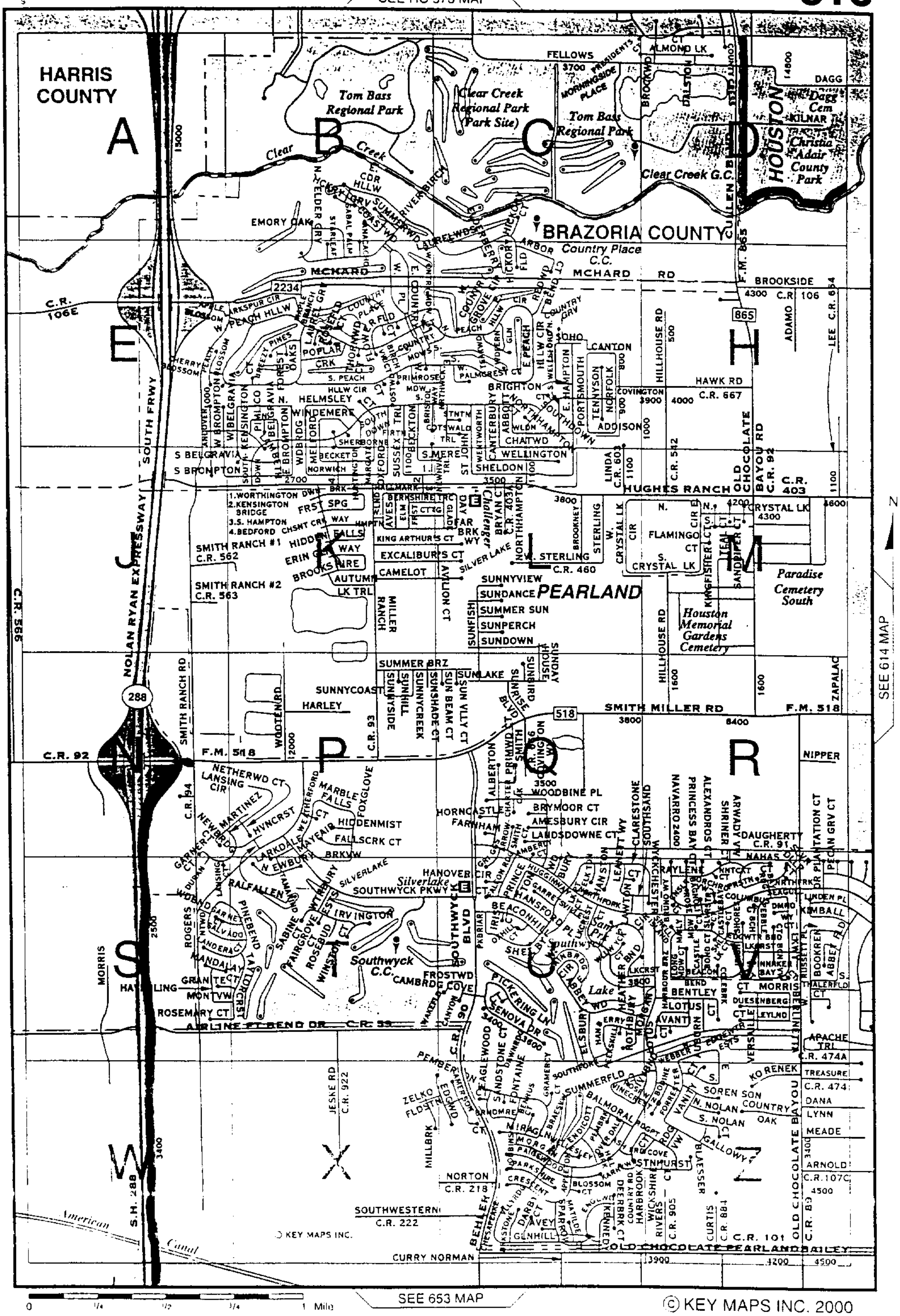

SEE 796 MAP
SEE 827 MAP
SEE 858 MAP
SPANISH TRACE
AIRLINE RD
HENDERSON RD
E. HENDERSON RD
C.R. 341
35
D
TEXAS A & M UNIVERSITY AGRICULTURAL RESEARCH STATION
PURSLEY RD
C.R. 874
G
H
C.R. 443
Danbury
HAMPTON
LAMPLIGHT
BASTROP
Brushy Bayou
ANGLETON-DANBURY RD
C.R. 171
L
M
BRAZORIA COUNTY
523
C.R. 219
F.M. 523
Q
R
KIBER RD
C.R. 213
ANGLE ACRES
C.R. 547
SUSAN
BRYAN
MEL
SCOTT RD
Brazoria County Fairgrounds
FAIRGROUND LN
U
V
C.R. 598
FORT RD
DINGLEBERRY RD C.R. 233
QUEENS
KINGS
PRINCESS
C.R. 843
GIFFORD LN
C.R. 704
YANCY
WALKER LOOP
HORSESHOE LOOP
ROBERT
C.R. 243
MEADOW ACRES
C.R. 219
C.R. 808
FIG
W
X
Y
Z
C.R. 513
N
1 MILE
© KEY MAPS INC. 2000

Figure 6.

SEE HC 573 MAP



SEE 653 MAP

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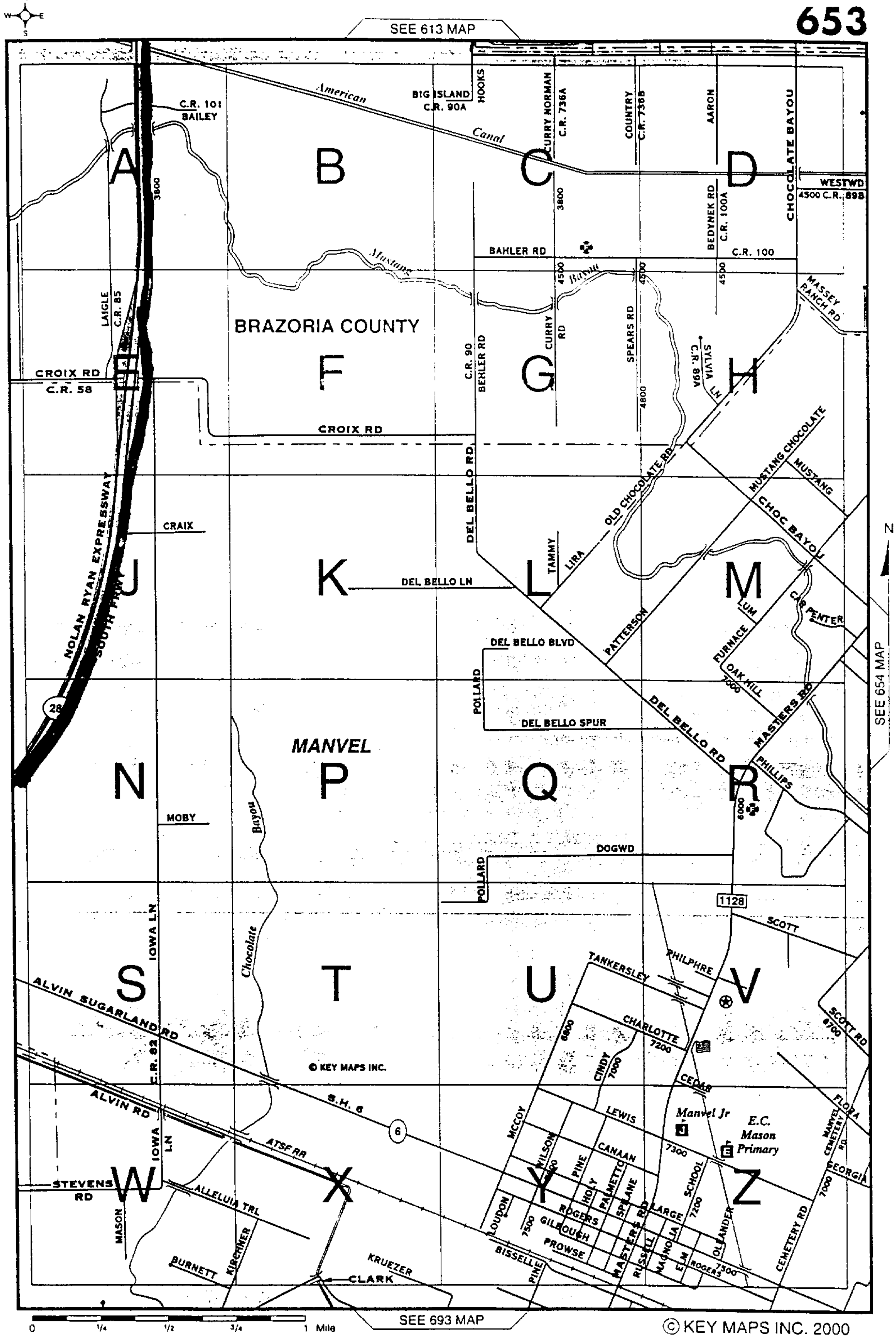

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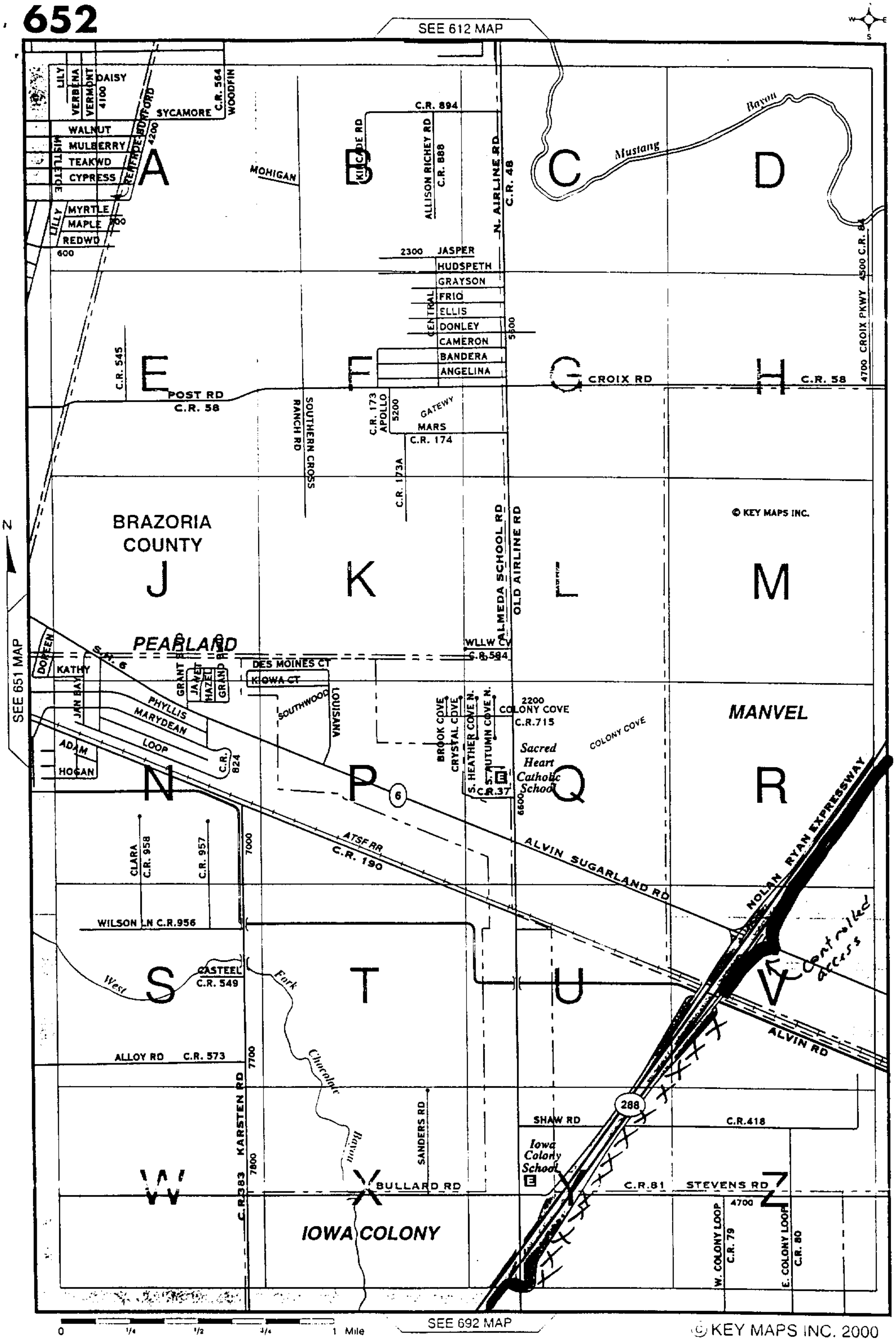
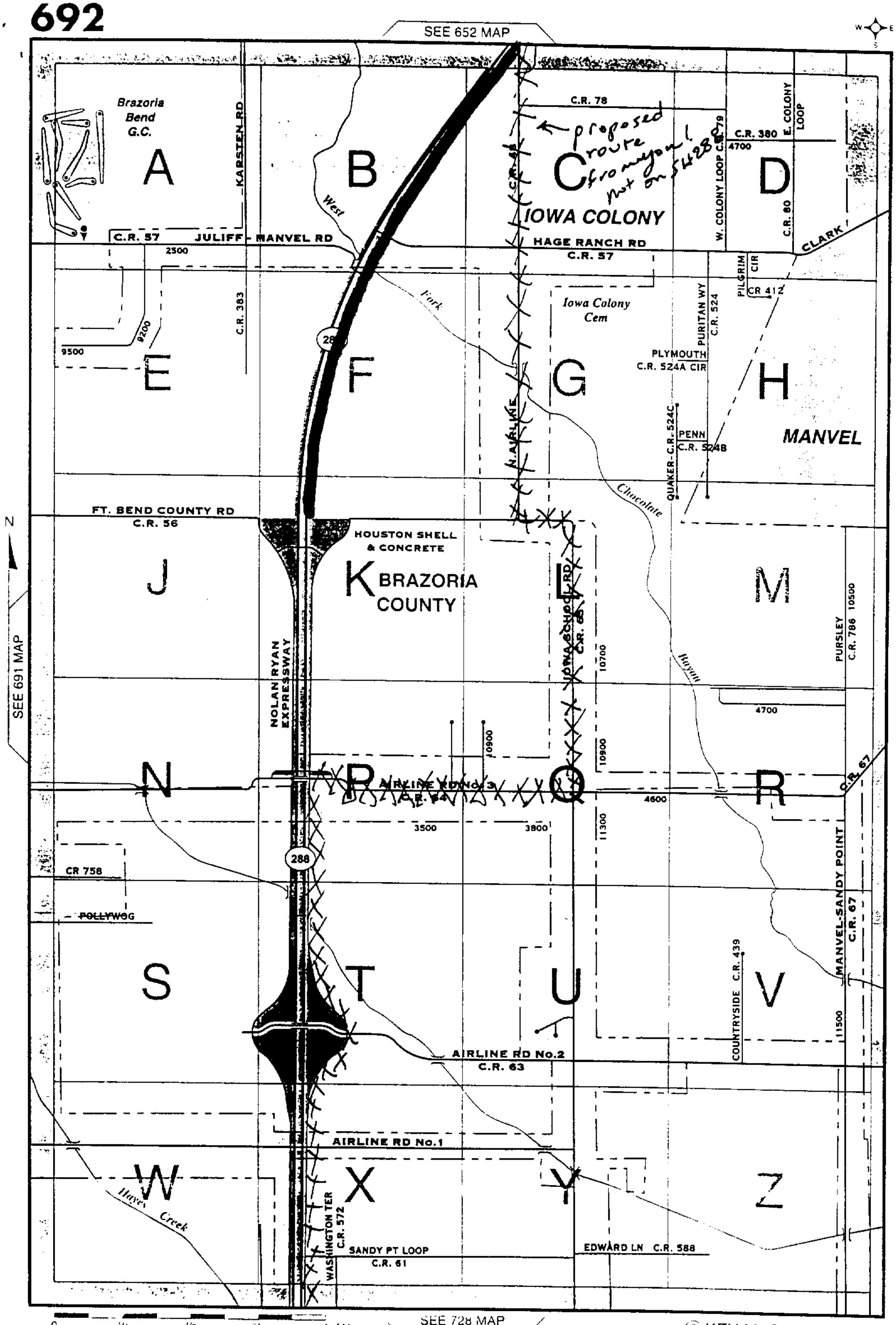

SEE 612 MAP
SEE 651 MAP
SEE 692 MAP
A B C D E F G H J K L M N P Q R S T U V W X Y Z
BRAZORIA COUNTY
PEARLAND
MANVEL
IOWA COLONY
© KEY MAPS INC.
LILY
VERBENA
VERMONT
4100
DAISY
SYCAMORE
C.R. 564
WOODFIN
BUFORD
4200
RENFROE
WALNUT
MULBERRY
TEAKWD
CYPRESS
MISTLETOE
MYRTLE
MAPLE
REDWD
600
MOHIGAN
KINCADE RD
C.R. 894
ALLISON RICHEY RD
C.R. 888
N. AIRLINE RD
C.R. 48
Mustang Bayou
2300
JASPER
HUDSPETH
GRAYSON
FRIO
ELLIS
DONLEY
CAMERON
BANDERA
ANGELINA
CENTRAL
5500
CROIX RD
C.R. 58
4700
CROIX PKWY
4500
C.R. 545
POST RD
C.R. 58
SOUTHERN CROSS RANCH RD
C.R. 173
APOLLO
5200
GATEWY
MARS
C.R. 174
C.R. 173A
ALMEDA SCHOOL RD
OLD AIRLINE RD
WLLW CV
C.R. 584
S.H. 6
DOREEN
KATHY
JAN BAY
GRANT
JANET
HAZEL
GRAND
DES MOINES CT
KIOWA CT
SOUTHWOOD
LOUISANA
PHYLLIS
MARYDEAN
LOOP
ADAM
HOGAN
C.R. 824
BROOK COVE
CRYSTAL COVE
S. HEATHER COVE N.
S. AUTUMN COVE N.
2200
COLONY COVE
C.R.715
COLONY COVE
C.R.37
6600
Sacred Heart Catholic School
6
ATSF RR
C.R. 190
ALVIN SUGARLAND RD
NOLAN RYAN EXPRESSWAY
CLARA
C.R. 958
C.R. 957
7000
WILSON LN C.R.956
CASTEEL
C.R. 549
West Fork Chocolate Bayou
ALLOY RD
C.R. 573
7700
KARSTEN RD
C.R.383
7800
SANDERS RD
BULLARD RD
288
SHAW RD
C.R.418
Iowa Colony School
C.R.81
STEVENS RD
4700
W. COLONY LOOP
C.R. 79
E. COLONY LOOP
C.R. 80
ALVIN RD
Controlled access
0 1/4 1/2 3/4 1 Mile
© KEY MAPS INC. 2000



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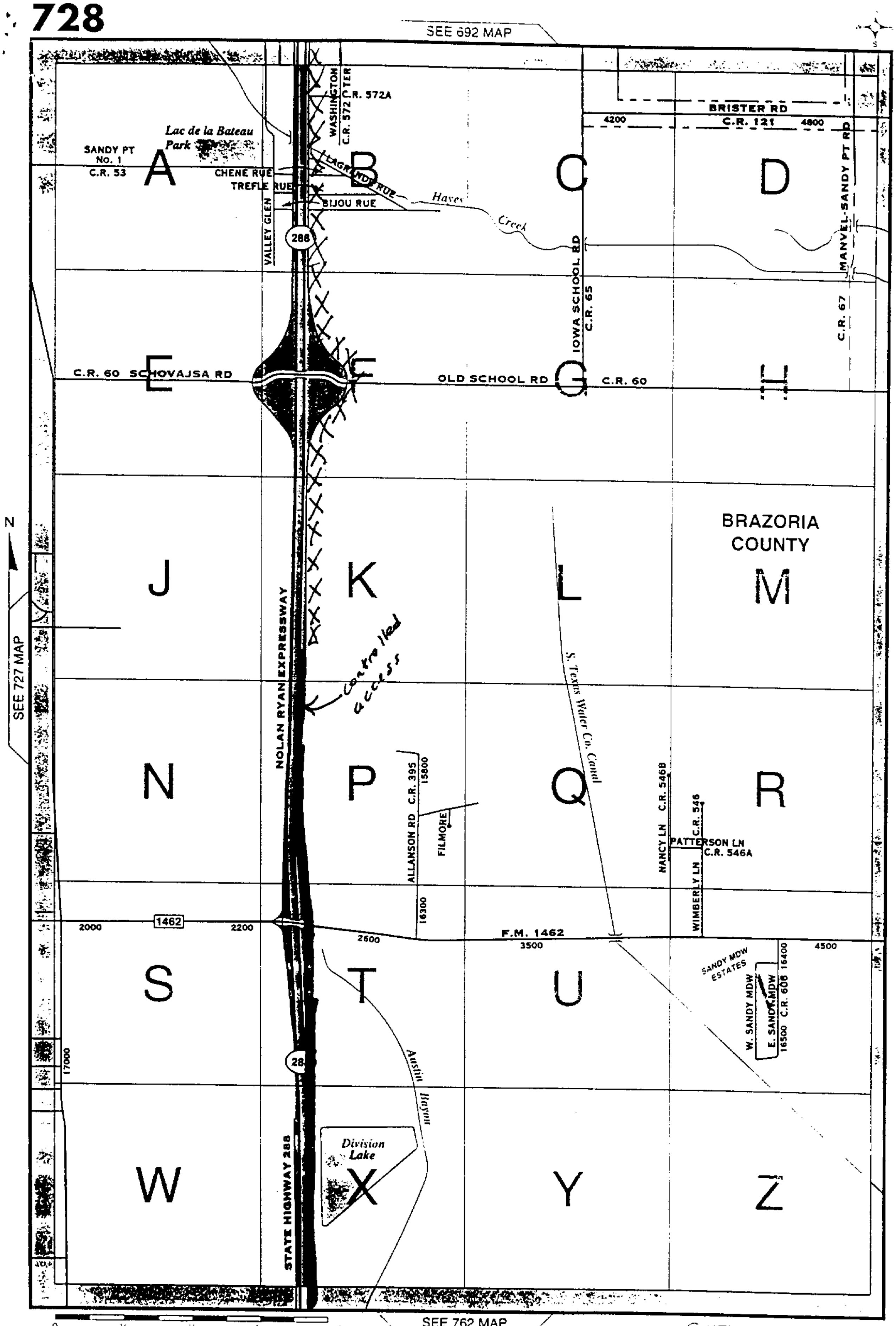

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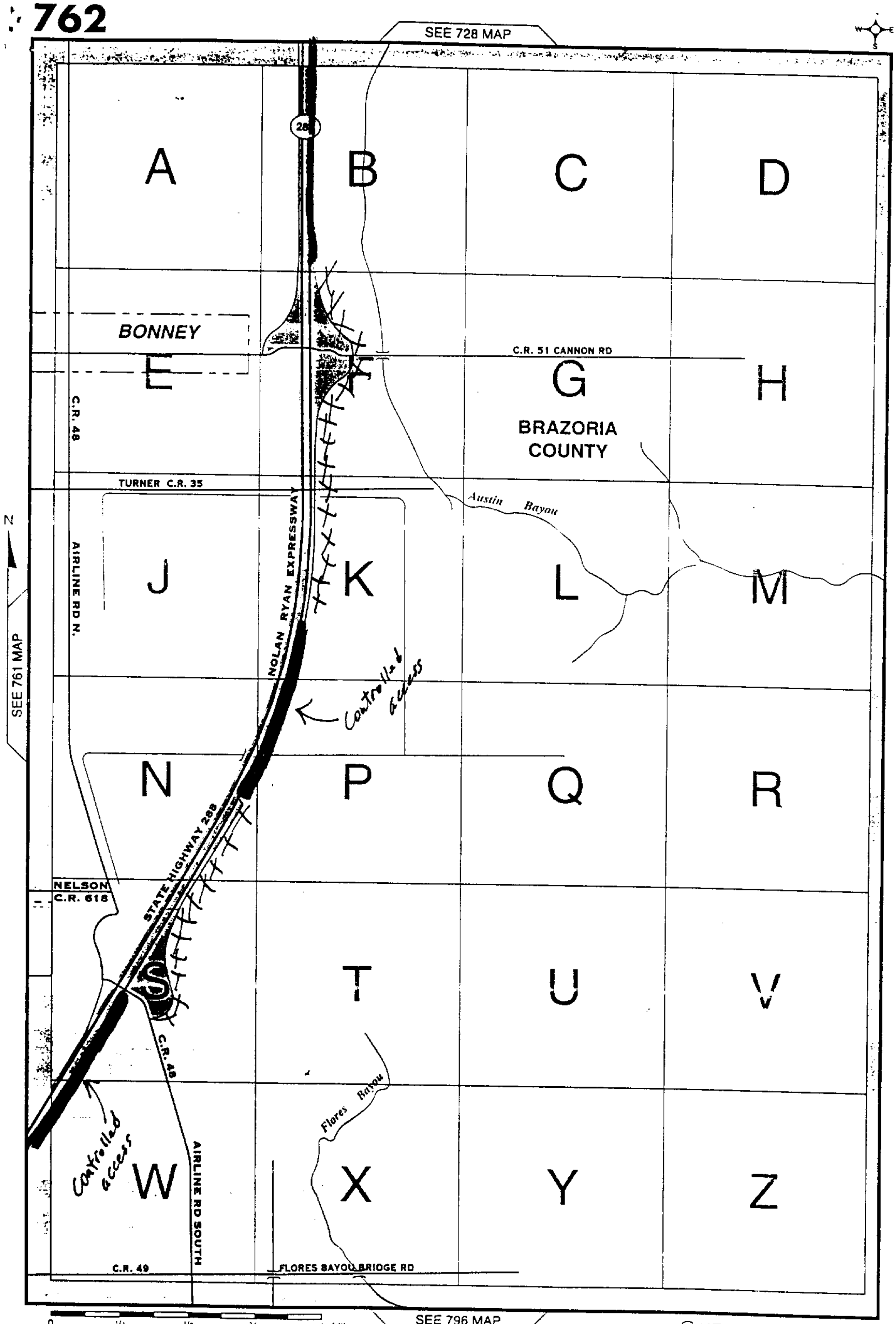

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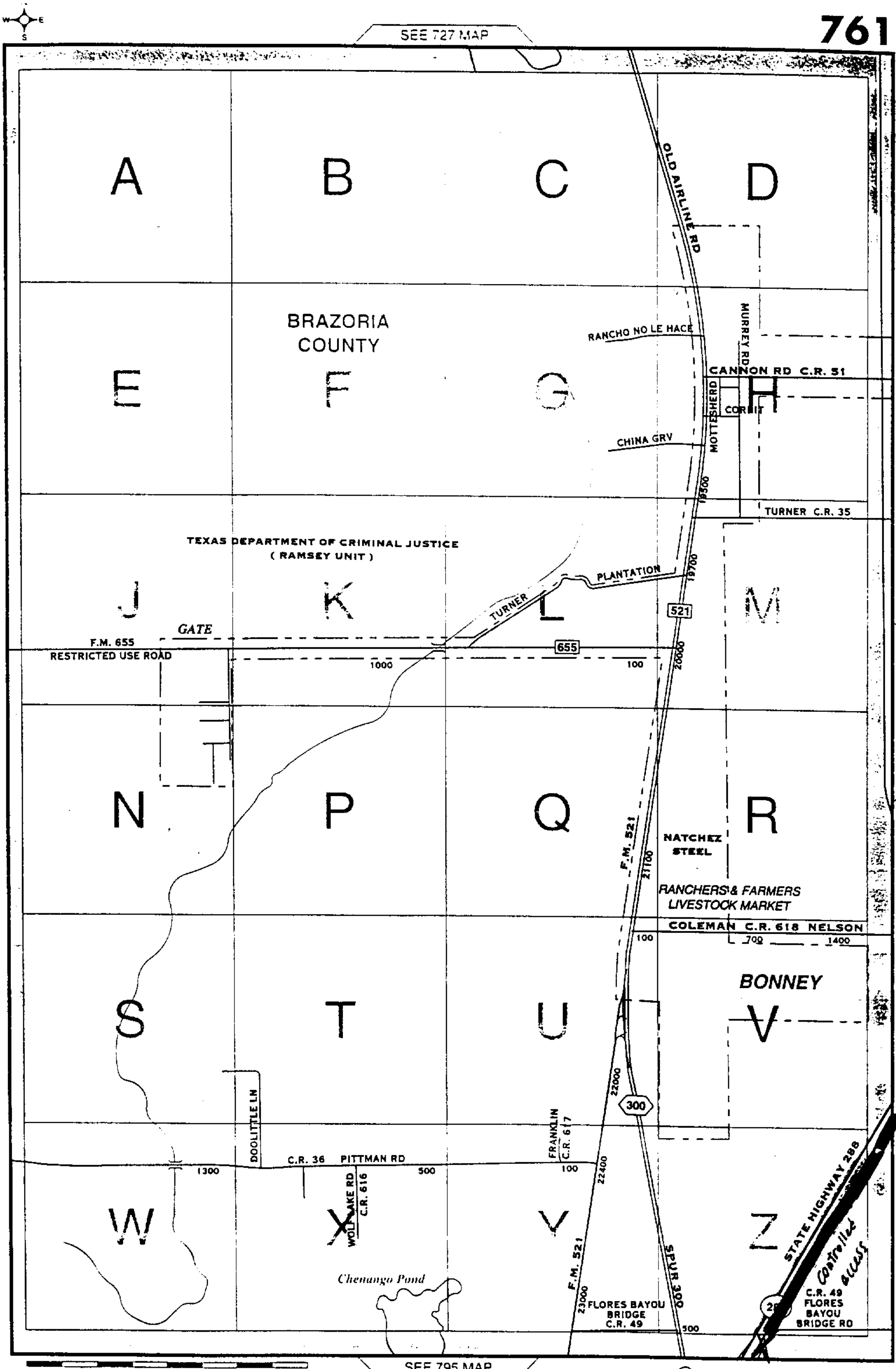

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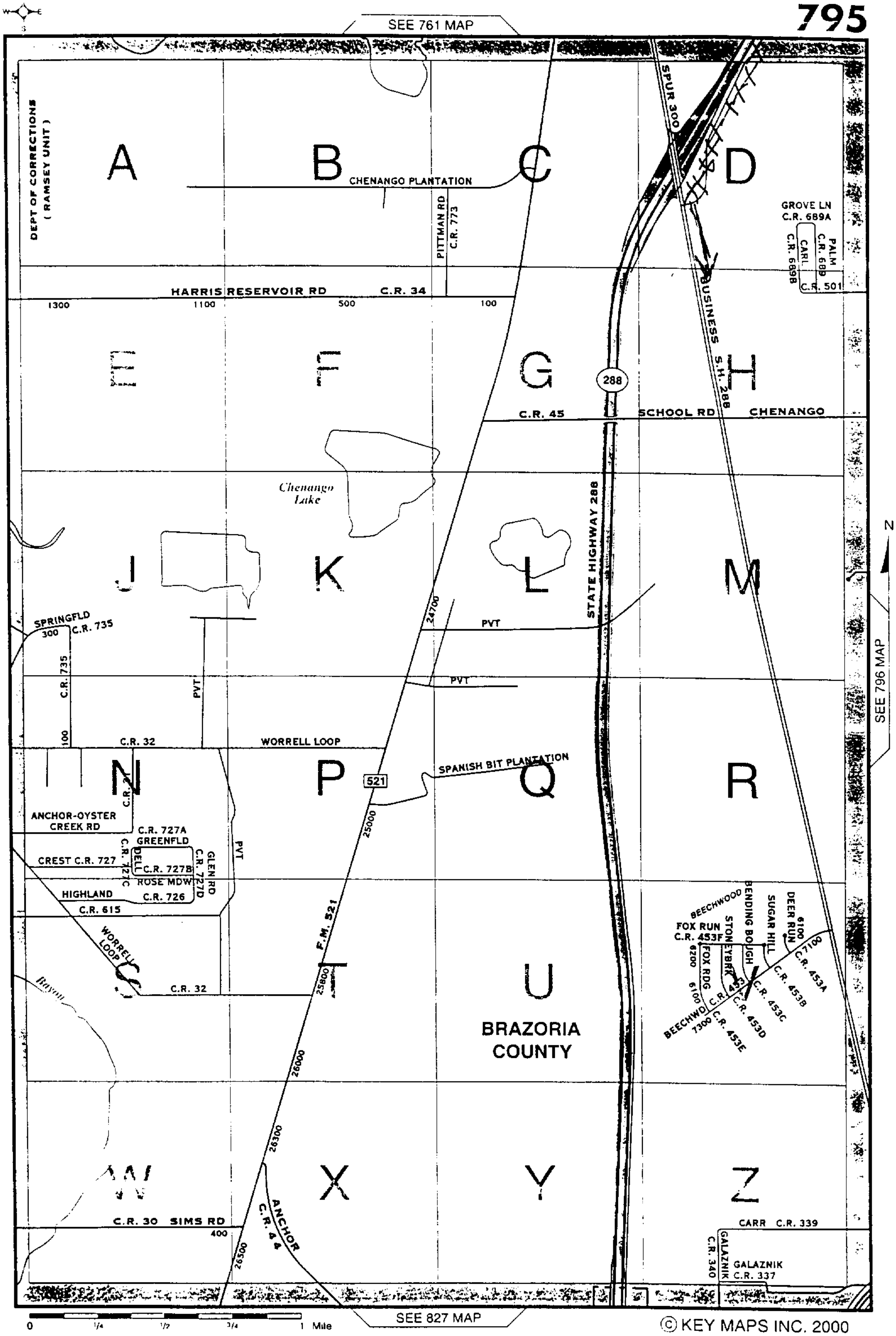

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Appendix N
Comments from the TWDB and the City of Pearland

TEXAS WATER DEVELOPMENT BOARD COMMENTS ON
REGIONAL WATER SUPPLY FACILITY GRANT FOR
MID-BRAZORIA COUNTY REGIONAL WATER PLANNING GROUP
CONTRACT NO. 2001-483-367

SCOPE OF WORK ITEMS

The review of the draft report identified: 1) scope items that were completed, 2) scope items for which documentation is insufficient and 3) scope items that were not completed. Task 12, which is the incorporation of review comments, will occur later and therefore is excluded from this analysis.

Scope Items That Were Completed

Task 3 - Water quality determinations for the SB1 Regional Plan.
Task 4 - Advantages of using treated surface water.
Task 9 – Prepare and distribute preliminary draft report.
Task 10 - Submission of draft report to the TWDB for review.

Scope Items For Which Documentation is Insufficient

1. Task 1 addresses a public notice for a kickoff public meeting. A copy of the notice and possibly other documentation of the public meeting should be included in the report.

2. Task 8 requires up to four progress meetings with plan participants. A statement giving information such as dates and locations of these meetings should be included.

3. Task 11 is to publish a notice of public hearing in local paper and develop a presentation for the public hearing. A copy of the notice and presentation materials should be included.

4. Task 13 is coordination with participants and the TWDB and progress reports. Documentation or at least a statement addressing this task should be included.

Scope Items That Were Not Completed

1. <u>Task 2 is data collection and includes the stipulation that only SB1 or HGCSD population and demand numbers will be used.</u>

   a. Section 3 of the draft report addresses the population and water demand numbers developed for and included in the regional water plan for Region H. The population projections for Angleton, Brookside Village, Danbury and Iowa Colony are consistent with the scope for Task 2; whereas those for Alvin, Manvel and Pearland are not. The population for Hillcrest was rounded up to 1000 for 2000 and 2010, but otherwise matches those approved for the Region H water plan.

   b. The difficulty is that the numbers were increased substantially for Alvin, Manvel and Pearland. The last two paragraphs on pg 3-1 state that the Participating Utilities in the study felt that the "Region H" numbers underestimated the future population for the planning area and that they then prepared individual projections of population and water demand based on recent growth in the area. The report, however, does not describe the data, data sources and methodology used by the Participating Utilities in preparing their individual projections.

c. In developing 50-year projections the TWDB examines and compiles data from the U.S. census on long-term trends in birth and death rates, employment trends, migration rates and other factors. These data are entered into cohort models that generate long-term estimates of population by decades. The population and water demand numbers in the Region H water plan were developed from TWDB model results, with a possible modification in the year 2000 numbers which served as the base year. Year 2000 numbers were adjusted upward to match year the 2000 estimates developed for the Harris Galveston Coastal Subsidence District (Turner Collie & Braden, 1996) or actual population numbers from State Data Center projected to 2000, if either if those numbers were higher than the TWDB estimates for 2000. Projections after 2000 were made using the percent changes from the TWDB modeling effort.

d. The population and water demand projections from the approved Region H plan must be utilized as the basis for facility planning for consistency with Task 2 of the Scope of Work and the Texas Water Code. As noted above the population projections in the Region H plan are based on a technically sound methodology that is generally accepted for 50-year population forecasts.

2. <u>Task 5 is to prepare a regional surface water transmission system</u>

a. The scope for Task 5 specifies that static models would be developed for peak day for all entries and that all model outputs would be reviewed for acceptable line velocities, head losses and pressures. Section 3 of the draft report discusses peak flows but does not provide model results for the peak day.

b. Certain critical information on meeting peak flows and Texas Natural Resource Conservation Commission (TNRCC) requirements for peak flows are not included in the draft report. 30 TAC Chapter 290.45, which is administered by the TNRCC, requires a daily peak system capacity of 0.6 gallons per minute per connection. The daily peak flow developed in Table 3-4 is significantly lower than this TNRCC requirement. The report should address this discrepancy in peak flow amounts.

c. Another consideration is how a peak flow of 63.83 million gallons per day (mgd) will be supplied. The sum of the recommended surface water treatment plant capacity of 25 mgd, 11.47 mgd existing well capacity, and existing wear contracts with Brazosport Water Authority and the City of Houston is less than the total needed. It should be noted that the total peak flow may be lowered after population and water demand projections are adjusted pursuant to the comments on Task 2.

3. <u>Task 6 is to determine costs and conduct cost analyses.</u>

a. All aspects of Task 6 appear complete except for 6.d. and 6.g. Subtask 6.d. is the determination of the cost of a transmission system that would provide peak day requirements to each participant. Before this subtask can be completed, a strategy for meeting peak day requirements as discussed above under Task 5 would have to be determined. Subtask 6.g. is a desktop review of potential biological, cultural resources, and socio-economic impacts of the proposed regional facilities.

4. Task 7 is to prepare a water conservation plan.

   a. The draft report does not address the following requirements, which are part of the preparation of the water conservation plan in the scope of work for Task 7:
   b. 7.c. Develop a consensus model management authority from the participant's viewpoint.
   c. 7.e. Review of water conservation and drought management plans of the plan participants.
   d. 7.g. Identify potential savings from alternative conservation measures.
   e. 7.h. Develop water conservation plan that maintains or improves upon the per capita use reductions built into the Region H plan.

STATUTORY REQUIREMENT

Section 16.054 of the Texas Water Code mandates that individual water plans not be in conflict with the applicable approved regional water plan. Particularly with respect to population and water demands, there are conflicts between the draft report and the approved Region H water plan. The Mid-Brazoria County Planning Group either must revise the draft report to conform to the Region H water plan or have Region H amend its regional water plan to incorporate the revised information.

SUGGESTED CHANGES AND/OR CORRECTIONS

1) The third paragraph on page ES-1 and the second paragraph on page 1-1 refer to 13 counties in Region H. Region H includes 13 complete counties, plus portions of 2 additional counties, for a total of 15.

2) The second paragraph under BACKGROUND on page ES-2 refers to the 2003 State Water Plan in which the quantity of available sustainable surface water will be revisited. The next State Water Plan will be the 2002 State Water Plan. The 2002 State Water Plan will compile the surface water availability information that was presented in the 16 approved regional water plans and should not be considered as a new or independent effort.

3) The third paragraph under BACKGROUND on page ES-2 and the last paragraph on page 1-3 state that Region H will plan and construct facilities. The authority of the Region H water planning group is limited to planning and does not include the construction or development of water supply facilities.

4) The second paragraph under FACILITY DEMAND on page ES-3 refers to the Harris-Galveston Coastal Subsidence District as having responsibility for groundwater usage. The Harris-Galveston Coastal Subsidence District would be better described as a regulatory entity that controls the amount of groundwater pumped.

5) The second bullet under RAW WATER on page ES-7 incorrectly states that Region H proposed that for this option, the MBCPG would initially purchase the water rights owned by the Chocolate Bayou Water Company (CBWC). The recommendation to purchase water rights from the CBWC was made by Turner Collie & Braden in a letter report to

Jim Adams dated February 27. 2001, which appears as Appendix E of the draft report. The letter report was prepared and submitted after the Region H water plan was adopted, and Region H has not taken any formal action on the letter report.

6) The third paragraph on page 1-1 states that the Texas Water Development Board through Region H has just completed their review of the water needs in the area and has compiled a list of proposed projects to supply the region with adequate water supply. Although the TWDB managed the study contract and provided guidance, the Region H Water Planning Group reviewed water needs and compiled the projects.

7) The first paragraph under Planning Area on page 1-2 refers to a list of utilities and manufacturing units electing to be included in the study. No manufacturing units appear on the list.

8) The paragraph on groundwater under WATER SOURCE AND SUPPLY on page 2-1 states that groundwater availability for Brazoria County is 40,400 acre-feet per year. A reference should be provided for the 40,400 acre-feet per year, as it differs from that presented in the Region H plan, which shows the groundwater availability for Brazoria County as 50,315 acre-feet per year from the Gulf Coast aquifer and 85 acre-feet per year from an undifferentiated aquifer.

9) The statement under MID-BRAZORIA COUNTY PLANNING GROUP EXISTING FACILITIES on page 2-2 that the Participating Utilities receive water from the Gulf Coast aquifer or treated surface water from the City of Houston is not consistent with the previous paragraph. The previous paragraph states that Pearland has a contract for surface water with the Gulf Coast Water Authority and that Angleton has a contract for surface water with the Brazosport Water Authority.

10) The Mid-Brazoria County Planning Group Existing Facilities Description on pages 2-2 to 2-6 would be more helpful and easier to understand if it included water supply sources along with facilities. As presently drafted, the report refers only to Angleton's 6 wells and groundwater supply, which gives an inaccurate picture since most of Angleton's supply is surface water purchased from the Brazosport Water Authority. The same applies to Pearland, where the discussion covers Pearland's wells and ground storage tanks but not its contact with the City of Houston for surface water.

11) Table 2-3 on page 2-4 lists the diameter of wells incorrectly as "(Feet)." Should be 'inches'.

12) The last two sentences under the City of Angleton on page 2-5 state that Angleton has experienced taste and odor problems over the past five years and that the 40-year contract with the Brazosport Water Authority is a major constraint to solution of those problems. Additional explanation should be added as to why the 40-year contract is constraining the solution of taste and odor problems.

13) Section 3 of the draft report does not explain why "modified" population projections were considered more reliable ("better reflected realistic projections") than the Region H population projections. These "modified" population projections are nearly twice the Region H population projections for the year 2050 (400,000 vs. 215,000 per Figure 3-1, page 3-2). Based on the 2000 census, Region H population estimates appear to be more accurate than the "modified" population estimates for the year 2000 used in the

report. As it turns out, the previous Region H population projections for the year 2000 were already greater than the 2000 census estimate by approximately 5,000 people (see table below). In addition, the "modified" 2000 population value used as a starting population (100,000) in the draft report appears to be approximately 15,000 too great (based on 2000 Census numbers).

CITY	Census 2000	Region H 2000	Numerical Difference (Region H-Census)	% Difference
Angleton	18130	23870	5740	32%
Alvin	21413	24075	2662	12%
Danbury	1611	1870	259	16%
Manvel	3046	5152	2106	69%
Pearland	37640	31983	-5657	-15%
	81840	*86950*	*5110*	*6%*
2000 TWDB-2000 Census Proj.				

14) The projected water use estimates in this report (based on the "modified" population projects) may be greatly overstated. For the City of Manvel's 2050 water demand, the Turner Collie & Braden letter report (February 2001) estimates 1.1mgd (see Appendix E) whereas Table 2-3 of this report shows 4.4 mgd. Angleton is another example. Table 3-1 on page 3-1 shows an average daily demand for Angleton of 2.89 mgd for the year 2000, where as information submitted to the TWDB as part of a funding application reports an average daily demand of 2.0 mgd. Therefore, the resulting projected total water demands, water treatment plant capacity, storage capacity, pipeline sizes, and capital and operating cost estimates as well as the conservation plan also may be greatly overstated. The result of implementing a construction program based on overestimated capacity needs could include significant excess infrastructure capacity and inefficient operation.

15) Portions of the report for example Figures 3-1 and 3-2 use the label "Populations based on regional surveys". For consistency the label should be "modified" populations, per the last paragraph on page 3-1.

16) Table 3-4 on page 3-4 gives a peaking factor of 2.61 for Hillcrest. Is there a reason for Hillcrest having a significantly higher peaking factor than any other Participating Utility?

17) The second sentence in the last paragraph on page 3-5 should be clarified to state "This table shows that the MBCPG has 3.63 mgd in reserve or excess capacity beyond the year 2000 peak demand."

18) The first bullet at the top of page 3-7 states that the City of Angleton's contract with the Brazosport Water Authority will continue through the planning horizon, which is 2050. This is in contrast to the statement on page 2-5 that it is a 40-year contract.

19) The fourth bullet on page 3-7 states that the Participating Utilities will meet peak daily demand through water stored in their individual water distribution system infrastructure. TNRCC requirements are for 200 gallons storage per connection and a system capacity of 0.6 gpm per connection. The 200 gallons per connection is addressed and the required ground storage tank volumes are presented in Table 6-9 on page 6-13.

However that amount of storage does not satisfy the requirement for capacity of 0.6 gpm per connection.

20) Table 3-7 on page 3-7 shows Pearland needing an additional 13.66 mgd by 2050. The approved need for Pearland as presented in the Region H plan is about 5.4 mgd.

21) The first paragraph under Brazos River on page 3-9 refers to the TWDB Region H report dated April 2001. This report is not listed in the Bibliography in Appendix A, and it is not clear what report is being referred to.

22) The first paragraph on page 4-1, the first paragraph under RAW WATER DELIVERY SYSTEM on page 6-16, and the first paragraph under Raw Water Sources on page 6-17 refer to a Region H report dated February 2001, which is the letter report included in Appendix E. This letter report was prepared by Turner Collie & Braden and was not a specific deliverable under their contract to the San Jacinto River Authority on behalf of the Region H water planning group. For purposes of the contract it was intended that the information would be incorporated in the Region H water plan. For this and other reasons the letter report has not been reviewed or approved by the TWDB or the Region H water planning group. Accordingly it should be referenced only as a Turner Collie & Braden report that was submitted to the Chairman of the Region H water planning group.

23) The paragraph under Proximity to Major Highway and Utilities on page 5-5 refers to HL&P. Houston Light and Power has changed its name to Reliant Energy.

24) The discussion of economic methodology on page 7-1 should explain the basis for including inflation in the economic analysis.

25) The discussion of non-economic factors on pages 7-3 and 7-4 should explain how the relative non-economic criteria weights were assigned/established.

26) The first bullet on page 7-7 states that the deal between the Chocolate Bayou Water Company and the North Harris County Regional Water Authority was tabled due to various concerns. The two parties had entered into an option contract. One or more of the conditions in the contract could not be met, and no final contract was pursued. The term tabled infers that a contractual arrangement still may be in the works versus in actuality the negotiations ended without a final contract.

27) The first entry in the Bibliography in Appendix A should be revised to reflect the Region H water plan prepared by the Joint Venture of Brown & Root and Turner Collie & Braden, Ekistics Corp. and LBG-Guyton Associates.

28) The title for Appendix B should be changed to reflect that it contains two separate analyses: 1) the water conservation and drought contingency plan and 2) resource management authority alternatives. The present title of Resource Management Plan is not specific enough.

29) The first paragraph under Service Area Description on page 1 of the Mid-Brazoria County Planning Group Water Conservation Drought Contingency Plan refers to the Region H Board. The reference should be corrected to read Region H water planning group or Region H group.

30) The first paragraph under Groundwater Protection on page 1 of the Mid-Brazoria County Planning Group Resource Management Authority Alternatives incorrectly states that TNRCC approval is required to install and operate a new well.

31) The first paragraph under Brazos River Authority on page 2 of the Mid-Brazoria County Planning Group Resource Management Authority Alternatives incorrectly states that the Brazos River Authority operates the Brazosport Water Plant in Freeport.

F A X

MWH
MONTGOMERY WATSON HARZA

5100 Westheimer, Suite 580
Houston, Texas 77056

Tel: 713-403-1600
Fax: 713-850-7901

Date: **September 18, 2001**

To:	Ernest Rebuck	**Fax No:**	512-475-2053
From:	Chris Canonico	**Reference:**	
Subject:	Mid-Brazoria County Regional Water Planning Group Draft Report	**No. of Pages:** **(including cover)**	**11**

Dear Mr. Rebuck,

Please find attached the responses to the Texas Water Development Board's comments dated August 20th, 2001 on the draft report for the Mid-Brazoria County Planning Group Regional Water Feasibility Study.

Thanks,

Chris Canonico.

If you do not receive all pages, or if there are any problems with this transmission, please call the receptionist at 713-403-1600.

MONTGOMERY WATSON HARZA'S RESPONSE TO TWDB COMMENTS DATED 8/20/2001

Montgomery Watson Harza's responses to "Scope Items For Which Documentation is Insufficient"

1. Task 1 addresses a public notice for a kickoff public meeting. A copy of the notice and possibly other documentation of the public meeting should be included in the report.

   Response: A copy of the public notice of kickoff meeting and presentation will be incorporated as an appendix .

2. Task 8 requires up to four progress meetings with plan participants. A statement giving information such as dates and locations of these meetings should be included.

   Response: Dates and locations of meetings will be incorporated in the appendix.

3. Task 11 is to publish a notice of public hearing in local paper and develop a presentation for the public hearing. A copy of the notice and presentation materials should be included.

   Response: Copy of the notice and presentation will be incorporated in the appendix.

4. Task 13 is coordination with participants and the TWDB and progress reports. Documentation or at least a statement addressing this task should be included.

   Response: A summary of the progress reports will be incorporated in the appendix.

Montgomery Watson Harza's responses to "Scope Items That Were Not Completed"

1. Task 2 is data collection and includes the stipulation that only SB1 or HGCSD population and demand numbers will be used.

   Response: TWDB Region H population and water demand numbers will be used.

2. Task 5 is to prepare a regional surface water transmission system
   a. The scope for Task 5 specifies that static models would be developed for peak day for all entries and that all model outputs would be reviewed for acceptable line velocities, head losses and pressures. Section 3 of the draft report discusses peak flows but does not provide model results for the peak day.

   Response: Model results will in incorporated as a separate appendix.

   b. Certain critical information on meeting peak flows and Texas Natural Resource Conservation Commission (TNRCC) requirements for peak flows are not included in the draft report. 30 TAC Chapter 290.45, which is administered by the TNRCC, requires a daily peak system capacity of 0.6 gallons per minute per connection. The daily peak flow developed in Table 3-4 is significantly lower than this TNRCC requirement. The report should address this discrepancy in peak flow amounts.

   Response: The WTP will provide a maximum flow equal to the capacity of the plant. During peak flow days, the participating utilities will meet peak flow demand flows through a combination of WTP flow, existing well flow, and future wells as needed to be in compliance with TNRCC regulations.

   c. Another consideration is how a peak flow of 63.83 million gallons per day (mgd) will be supplied. The sum of the recommended surface water treatment plant capacity of 25 mgd, 11.47 mgd existing well capacity, and existing wear contracts with Brazosport Water Authority and the City of Houston is less than the total needed. It should be noted that the total peak flow may be lowered after population and water demand projections are adjusted pursuant to the comments on Task 2.

   Response: The WTP will provide a maximum flow equal to the capacity of the plant. During peak flow days, the participating utilities will meet peak flow demand flows through a combination of WTP flow, existing well flow, and future wells as needed to be in compliance with TNRCC regulations.

3. Task 6 is to determine costs and conduct cost analyses.

a. All aspects of Task 6 appear complete except for 6.d. and 6.g. Subtask 6.d. is the determination of the cost of a transmission system that would provide peak day requirements to each participant. Before this subtask can be completed, a strategy for meeting peak day requirements as discussed above under Task 5 would have to be determined. Subtask 6.g. is a desktop review of potential biological, cultural resources, and socio-economic impacts of the proposed regional facilities.

Response: The transmission system from the water treatment plant is sized to transport the maximum output from the WTP and carry flow to the individual Participating Utility distribution system. Each Participating Utility will augment this water with water from wells to meet peak flow is their distribution system. As part of the desktop review of biological, cultural resources, and socio-economic impacts of the proposed facilities, letter was sent to the Texas Historical Commission. Meetings were held with Participating Utilities to review non-economic factors including impact on biological and socio-economic conditions on the site. These factors are presented in Section 7.

4. Task 7 is to prepare a water conservation plan.

a. The draft report does not address the following requirements, which are part of the preparation of the water conservation plan in the scope of work for Task 7:
b. 7.c. Develop a consensus model management authority from the participant's viewpoint.

Response: Formation of a Regional District under the Texas Water Code.

c. 7.e. Review of water conservation and drought management plans of the plan participants.

Response: Water conservation and drought management plans from the cities of Alvin, Angleton, Pearland and Manvel were reviewed to compile the Water Conservation and Drought Contingency Plan and Resource Management Authority Alternatives in Appendix B. Other cities did not provide water conservation plans.

d. 7.g. Identify potential savings from alternative conservation measures.

Response: This will be incorporated in the Water Conservation Plan.

e. 7.h. Develop water conservation plan that maintains or improves upon the per capita use reductions built into the Region H plan.

Response: This will be incorporated in the water conservation plan.

Montgomery Watson Harza's responses to "suggested changes and/or corrections"

1) The third paragraph on page ES-1 and the second paragraph on page 1-1 refer to 13 counties in Region H. Region H includes 13 complete counties, plus portions of 2 additional counties, for a total of 15.

Response: Change will be incorporated.

2) The second paragraph under BACKGROUND on page ES-2 refers to the 2003 State Water Plan in which the quantity of available sustainable surface water will be revisited. The next State Water Plan will be the 2002 State Water Plan. The 2002 State Water Plan will compile the surface water availability information that was presented in the 16 approved regional water plans and should not be considered as a new or independent effort.

Response: Change will be incorporated.

3) The third paragraph under BACKGROUND on page ES-2 and the last paragraph on page 1-3 state that Region H will plan and construct facilities. The authority of the Region H water planning group is limited to planning and does not include the construction or development of water supply facilities.

Response: Change will be incorporated.

4) The second paragraph under FACILITY DEMAND on page ES-3 refers to the Harris-Galveston Coastal Subsidence District as having responsibility for groundwater usage. The Harris-Galveston Coastal Subsidence District would be better described as a regulatory entity that controls the amount of groundwater pumped.

Response: Change will be incorporated.

5) The second bullet under RAW WATER on page ES-7 incorrectly states that Region H proposed that for this option, the MBCPG would initially purchase the water rights owned by the Chocolate Bayou Water Company (CBWC). The recommendation to purchase water rights from the CBWC was made by Turner Collie & Braden in a letter report to Jim Adams dated February 27. 2001, which appears as Appendix E of the draft report. The letter report was prepared and submitted after the Region H water plan was adopted, and Region H has not taken any formal action on the letter report.

Response: Change will be incorporated.

6) The third paragraph on page 1-1 states that the Texas Water Development Board through Region H has just completed their review of the water needs in the area

and has compiled a list of proposed projects to supply the region with adequate water supply. Although the TWDB managed the study contract and provided guidance, the Region H Water Planning Group reviewed water needs and compiled the projects.

Response: Change will be incorporated.

7) The first paragraph under Planning Area on page 1-2 refers to a list of utilities and manufacturing units electing to be included in the study. No manufacturing units appear on the list.

Response: Change will be incorporated.

8) The paragraph on groundwater under WATER SOURCE AND SUPPLY on page 2-1 states that groundwater availability for Brazoria County is 40,400 acre-feet per year. A reference should be provided for the 40,400 acre-feet per year, as it differs from that presented in the Region H plan, which shows the groundwater availability for Brazoria County as 50,315 acre-feet per year from the Gulf Coast aquifer and 85 acre-feet per year from an undifferentiated aquifer.

Response: Change will be incorporated.

9) The statement under MID-BRAZORIA COUNTY PLANNING GROUP EXISTING FACILITIES on page 2-2 that the Participating Utilities receive water from the Gulf Coast aquifer or treated surface water from the City of Houston is not consistent with the previous paragraph. The previous paragraph states that Pearland has a contract for surface water with the Gulf Coast Water Authority and that Angleton has a contract for surface water with the Brazosport Water Authority.

Response: Change will be incorporated.

10) The Mid-Brazoria County Planning Group Existing Facilities Description on pages 2-2 to 2-6 would be more helpful and easier to understand if it included water supply sources along with facilities. As presently drafted, the report refers only to Angleton's 6 wells and groundwater supply, which gives an inaccurate picture since most of Angleton's supply is surface water purchased from the Brazosport Water Authority. The same applies to Pearland, where the discussion covers Pearland's wells and ground storage tanks but not its contact with the City of Houston for surface water.

Response: Change will be incorporated.

11) Table 2-3 on page 2-4 lists the diameter of wells incorrectly as "(Feet)." Should be 'inches'.

Response: Change will be incorporated.

12) The last two sentences under the City of Angleton on page 2-5 state that Angleton has experienced taste and odor problems over the past five years and that the 40-year contract with the Brazosport Water Authority is a major constraint to solution of those problems. Additional explanation should be added as to why the 40-year contract is constraining the solution of taste and odor problems.

Response: The paragraph has been clarified.

13) Section 3 of the draft report does not explain why "modified" population projections were considered more reliable ("better reflected realistic projections") than the Region H population projections. These "modified" population projections are nearly twice the Region H population projections for the year 2050 (400,000 vs. 215,000 per Figure 3-1, page 3-2). Based on the 2000 census, Region H population estimates appear to be more accurate than the "modified" population estimates for the year 2000 used in the report. As it turns out, the previous Region H population projections for the year 2000 were already greater than the 2000 census estimate by approximately 5,000 people (see table below). In addition, the "modified" 2000 population value used as a starting population (100,000) in the draft report appears to be approximately 15,000 too great (based on 2000 Census numbers).

CITY	Census 2000	Region H 2000	Numerical Difference (Region H-Census)	% Difference
Angleton	18,130	23,870	5,740	32%
Alvin	21,413	24,075	2,662	12%
Danbury	1,611	1,870	259	16%
Manvel	3,046	5,152	2,106	69%
Pearland	37,640	31,983	-5,657	-15%
	81,840	*86,950*	*5,110*	*6%*
2000 TWDB-2000 Census Proj.				

Response: The "modified" population projections have been replaced by Region H population projections.

14) The projected water use estimates in this report (based on the "modified" population projects) may be greatly overstated. For the City of Manvel's 2050 water demand, the Turner Collie & Braden letter report (February 2001) estimates 1.1mgd (see Appendix E) whereas Table 2-3 of this report shows 4.4 mgd. Angleton is another example. Table 3-1 on page 3-1 shows an average daily demand for Angleton of 2.89 mgd for the year 2000, where as information submitted to the TWDB as part of a funding application reports an average daily

demand of 2.0 mgd. Therefore, the resulting projected total water demands, water treatment plant capacity, storage capacity, pipeline sizes, and capital and operating cost estimates as well as the conservation plan also may be greatly overstated. The result of implementing a construction program based on overestimated capacity needs could include significant excess infrastructure capacity and inefficient operation.

Response: The population projections have been changed to reflect Region H numbers.

15) Portions of the report for example Figures 3-1 and 3-2 use the label "Populations based on regional surveys". For consistency the label should be "modified" populations, per the last paragraph on page 3-1.

Response: Change will be incorporated.

16) Table 3-4 on page 3-4 gives a peaking factor of 2.61 for Hillcrest. Is there a reason for Hillcrest having a significantly higher peaking factor than any other Participating Utility?

Response: The peaking factor documented is as reported by Hillcrest Village.

17) The second sentence in the last paragraph on page 3-5 should be clarified to state "This table shows that the MBCPG has 3.63 mgd in reserve or excess capacity beyond the year 2000 peak demand."

Response: Change will be incorporated.

18) The first bullet at the top of page 3-7 states that the City of Angleton's contract with the Brazosport Water Authority will continue through the planning horizon, which is 2050. This is in contrast to the statement on page 2-5 that it is a 40-year contract.

Response: Change has been incorporated.

19) The fourth bullet on page 3-7 states that the Participating Utilities will meet peak daily demand through water stored in their individual water distribution system infrastructure. TNRCC requirements are for 200 gallons storage per connection and a system capacity of 0.6 gpm per connection. The 200 gallons per connection is addressed and the required ground storage tank volumes are presented in Table 6-9 on page 6-13. However that amount of storage does not satisfy the requirement for capacity of 0.6 gpm per connection.

Response: Change will be incorporated.

20) Table 3-7 on page 3-7 shows Pearland needing an additional 13.66 mgd by 2050. The approved need for Pearland as presented in the Region H plan is about 5.4 mgd.

Response: Change will be incorporated.

21) The first paragraph under Brazos River on page 3-9 refers to the TWDB Region H report dated April 2001. This report is not listed in the Bibliography in Appendix A, and it is not clear what report is being referred to.

Response: The report referred to on page 3-9 is the letter report prepared by Tuner Collie & Braden for the TWDB, dated February 27, 2001. The report mentioned on page 3-9 will be edited accordingly.

22) The first paragraph on page 4-1, the first paragraph under RAW WATER DELIVERY SYSTEM on page 6-16, and the first paragraph under Raw Water Sources on page 6-17 refer to a Region H report dated February 2001, which is the letter report included in Appendix E. This letter report was prepared by Turner Collie & Braden and was not a specific deliverable under their contract to the San Jacinto River Authority on behalf of the Region H water planning group. For purposes of the contract it was intended that the information would be incorporated in the Region H water plan. For this and other reasons the letter report has not been reviewed or approved by the TWDB or the Region H water planning group. Accordingly it should be referenced only as a Turner Collie & Braden report that was submitted to the Chairman of the Region H water planning group.

Response: The change will be incorporated.

23) The paragraph under Proximity to Major Highway and Utilities on page 5-5 refers to HL&P. Houston Light and Power has changed its name to Reliant Energy.

Response: Change will be incorporated.

24) The discussion of economic methodology on page 7-1 should explain the basis for including inflation in the economic analysis.

Response: An explanation for basis of inflation will be incorporated.

25) The discussion of non-economic factors on pages 7-3 and 7-4 should explain how the relative non-economic criteria weights were assigned/established.

Response: Change will be incorporated.

26) The first bullet on page 7-7 states that the deal between the Chocolate Bayou Water Company and the North Harris County Regional Water Authority was

tabled due to various concerns. The two parties had entered into an option contract. One or more of the conditions in the contract could not be met, and no final contract was pursued. The term tabled infers that a contractual arrangement still may be in the works versus in actuality the negotiations ended without a final contract.

Response: Change will be incorporated to reflect that the no final contract was completed.

27) The first entry in the Bibliography in Appendix A should be revised to reflect the Region H water plan prepared by the Joint Venture of Brown & Root and Turner Collie & Braden, Ekistics Corp. and LBG-Guyton Associates.

Response: Change will be incorporated.

28) The title for Appendix B should be changed to reflect that it contains two separate analyses: 1) the water conservation and drought contingency plan and 2) resource management authority alternatives. The present title of Resource Management Plan is not specific enough.

Response: Change will be incorporated.

29) The first paragraph under Service Area Description on page 1 of the Mid-Brazoria County Planning Group Water Conservation Drought Contingency Plan refers to the Region H Board. The reference should be corrected to read Region H water planning group or Region H group.

Response: Change will be incorporated.

30) The first paragraph under Groundwater Protection on page 1 of the Mid-Brazoria County Planning Group Resource Management Authority Alternatives incorrectly states that TNRCC approval is required to install and operate a new well.

Response: Change will be incorporated.

31) The first paragraph under Brazos River Authority on page 2 of the Mid-Brazoria County Planning Group Resource Management Authority Alternatives incorrectly states that the Brazos River Authority operates the Brazosport Water Plant in Freeport.

Response: Change will be incorporated.

CITY OF PEARLAND COMMENTS ON REGIONAL WATER PLANT FEASIBILITY STUDY FOR MID-BRAZORIA COUNTY REGIONAL WATER PLANNING GROUP

No.	Commentator	Page No.	Comment	Response
1		ES-1	This will be very expensive since all rights are gone.	
2.		ES-1, Figure ES-1	Pearland City limits NOT correct at FM 521	Change incorporated
3.		ES-4	very important as to where the plant should be located. The further East you go the more treated water pipelines we will need to cross to get to Pearland.	
4.		ES-7	Option 1 is my vote although there are questions that need answers?	
5.		ES-10	Manvel would be excellent for Pearland's use	
6.	Gene Simeon, City of Pearland	ES-10	I'm afraid of just being a customer - If supplies get short the ability to just buy water dwindles - Last year it happened to Texas City area - buying water from Houston.	
7.		3-2	with planning area or entire city?	Part of City of Pearland in the planning area.
8.		3-3	with planning area? Total facility is greater?	Part of City of Pearland in the planning area.
9.		3-5	My vote is to buy Pearland's wells and do an 80-20 or 60-40 split.	
10.		3-10	"Technologically feasible" does not guarantee palatable	
11.		6-2, Figure 6-1	Pearland City limits are out of date.	Change incorporated
12.		7-7	Scary	
13.		7-13	very significant point for Pearland	
14.		8-1	Again - I would rather be a provider than just a buyer subject to rationing	

Appendix O
Hydraulic Modeling Results

H2ONET Report - WTP at GCWA Site at Pressure

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	12	0.57	50	173.94	53.73
2	16	13.66	60	256.54	85.2
3	18	3.77	55	249.33	84.24
4	20	0.24	50	223.07	75.03
5	200	0	60	279.11	94.98
6	22	2.45	20	144.58	54
7	24	0.48	20	80.09	26.05
8	28	4.13	40	171.17	56.86
9	34	0	50	237.33	81.21
10	36	0	20	167.19	63.81
11	42	0	60	264.52	88.66

H2ONET Report - WTP at GCWA Site to Ground Storage Tanks

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	12	0.57	50	89.44	17.1
2	16	13.66	60	172.04	48.57
3	18	3.77	55	214.33	69.07
4	20	0.24	50	188.07	59.85
5	200	0	60	244.11	79.81
6	22	2.45	20	92.06	31.24
7	24	0.48	20	45.09	10.87
8	28	4.13	40	75.62	15.44
9	34	0	50	202.33	66.03
10	36	0	20	132.19	48.63
11	42	0	60	229.52	73.49

H2ONET Report - WTP at Site A at Pressure

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	12	0.57	50	168.21	51.24
2	16	13.66	60	250.81	82.72
3	18	3.77	55	274.97	95.36
4	20	0.24	50	243.74	83.99
5	22	2.45	20	169.37	64.75
6	24	0.48	20	162.6	61.82
7	28	4.13	40	196.81	67.98
8	31	0	55	274.98	95.36
9	34	0	50	248.66	86.12
10	36	0	20	191.99	74.56
11	42	0	60	258.79	86.18

H2ONET Report - WTP at Site A to Ground Storage Tanks

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	12	0.57	50	90.04	17.36
2	16	13.66	60	172.65	48.83
3	18	3.77	55	204.8	64.94
4	20	0.24	50	173.57	53.57
5	22	2.45	20	46.98	11.7
6	24	0.48	20	57.73	16.36
7	28	4.13	40	66.09	11.31
8	31	0	55	204.81	64.94
9	34	0	50	178.49	55.7
10	36	0	20	87.11	29.09
11	42	0	60	180.63	52.29

H2ONET Report - WTP at Site E at Pressure

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	10	0.57	50	188.27	59.94
2	14	13.66	40	229.34	82.08
3	18	3.77	55	177.89	53.27
4	20	0.24	50	182.67	57.51
5	22	2.45	20	179.35	69.08
6	24	0.48	20	196.54	76.53
7	26	4.13	30	259.92	99.67
8	38	0	40	196.04	67.64
9	40	0	20	215.43	84.72

H2ONET Report - WTP at Site E to Ground Storage Tanks

Number	ID	Demand (mgd)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	10	0.57	50	85.06	15.2
2	14	13.66	40	126.13	37.34
3	18	3.77	55	96.73	18.09
4	20	0.24	50	72.77	9.87
5	22	2.45	20	52.57	14.12
6	24	0.48	20	97.72	33.69
7	26	4.13	30	190.92	69.76
8	38	0	40	127.04	37.73
9	40	0	20	116.6	41.88