Conversion Implementation Analysis

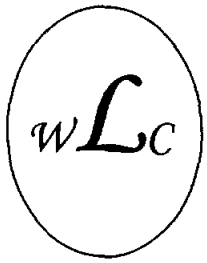
Prepared by

WCL ENTERPRISES

for consideration by the
Harris-Galveston Coastal
Subsidence District

July 1998

Table of Contents



WCL ENTERPRISES

July 24, 1998

Mr. Ronald J. Neighbors
General Manager
Harris-Galveston Coastal Subsidence District
1660 Bay Area Boulevard
Friendswood, Texas 77546-2640

Dear Mr. Neighbors:

WCL ENTERPRISES hereby submits the attached Conversion Implementation Analysis to the Harris-Galveston Coastal Subsidence District for its consideration.

This analysis was prepared by *WCL ENTERPRISES*. In preparing the analysis, *WCL ENTERPRISES* received significant input and assistance from the associated entities with which it submitted its proposal for this project: Akin, Gump, Strauss, Hauer & Feld, L.L.P., Bear Stearns, Maldonado Consulting, Practical Management Concepts, and Rust Lichliter/Jameson. Additionally, *WCL ENTERPRISES* and members of the project team established by *WCL ENTERPRISES* sought, and received, input and suggestions from many individuals. However, the author of this analysis is *WCL ENTERPRISES* only, and none of the conclusions contained herein should be attributed to any other entity or individual.

Very truly yours,

WCL ENTERPRISES

William C. Lenhart, Jr.
Managing Principal

July 24, 1998

Mr. Craig D. Pedersen
Executive Administrator
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

Dear Mr. Pedersen:

The Harris-Galveston Coastal Subsidence District hereby submits the attached Conversion Implementation Analysis prepared by *WCL ENTERPRISES.*

The enclosed report was prepared by an independent contractor pursuant to a scope of work agreed to between the Subsidence District and the Texas Water Development Board and does not represent the work product of the Subsidence District Board of Directors nor staff. This project was initiated in order to receive an independent analysis of alternatives for surface water conversion in north and northwest portions of Harris County, and the conclusions and recommendations contained in the report are the product of the author, *WCL ENTERPRISES.*

Sincerely,

Ronald J. Neighbors
General Manager

cc: Harris-Galveston Coastal Subsidence District Board Members

I - Executive Summary

BACKGROUND

The Harris-Galveston Coastal Subsidence District (HGCSD or the District) is a governmental agency created by the Legislature under Article XVI, Section 59 of the Texas Constitution. The District was created in 1975 by act of the 64th Texas Legislature. The current HGCSD Act (the Act) is found at Chapter 151, Texas Water Code.

The purpose of the Act is to "provide for the regulation of the withdrawal of groundwater within the boundaries of the district for the purpose of ending subsidence, ..." Section 151.004(a).

The District includes all of the area within the boundaries of Harris County and Galveston County. Section 151.003(a).

In 1994, the District began a thorough review of its District Plan. This process included the following steps:

- Update of the water demand projections throughout the entire District.
- Use of a groundwater model to determine the effect of the revised water demand projections on groundwater levels.
- Evaluation of changes in groundwater levels and subsidence at given levels of pumpage.

These analyses confirmed that groundwater pumpage needs to be reduced significantly from current levels. A major step that obviously needs to be taken is the conversion from groundwater to surface water in the north and northwest portions of Harris County (designated by the District as Regulatory Areas 4, 5, 6 and 7, and referred to in this analysis as the study area).

PURPOSE OF ANALYSIS

The purpose of this analysis is to identify steps needed to be taken and possible alternatives to best achieve conversion in the study area.

CONCLUSIONS

The conclusions reached as a result of this analysis include the following:

- The overriding impediment to conversion in north and northwest Harris County is the fact that there currently is no effective disincentive to the continued pumping of groundwater at

current levels. To the contrary, pumpers in this region have a strong incentive to continue on with business as usual.

- North and northwest Harris County are not served by any one political jurisdiction that has the necessary rights to surface water for supply to the study area, and the authority and ability to treat and supply that water. The current population of the study area is over 1.3 million.

- Over the past two decades since MUDs were created as a means to foster development in the greater Houston area, they have become an entrenched part of the governing mechanism in the City's extraterritorial jurisdiction. Each district is governed by its own board of directors. Consequently, there are 407 separate MUDs that exist within the study area. Each district is served by its own set of plant operators, engineers, accountants, and legal advisors. As a result, there is a strong inclination on the part of the boards of directors and members of these groups to maintain the current system of groundwater supply.

- Conversion in the study area is not likely to occur within the foreseeable future unless the District alters its regulatory policies to provide the necessary regulatory disincentive to continued high levels of groundwater withdrawals. Increasing its permit fee to a level that exceeds the cost of treated surface water would provide an effective regulatory disincentive to the continued pumping of groundwater at current levels, and would be by far the simplest and most effective regulatory action the District could take to achieve significant reductions in pumping and overcome the strong inclination of districts within the study area to maintain the current system of groundwater supply. This action should result in conversion at the earliest practicable date. Districts and other groundwater pumpers in the study area would then have a strong economic incentive to cooperate with key entities to arrive at an expeditious, cost-effective conversion solution.

- Compounding the lack of any effective regulatory disincentive and the strong inclination of districts within the study area to maintain the current system of groundwater supply, it appears that the need for significant reduction in current levels of groundwater pumping is not well understood by districts and other entities within the study area. Local officials and the general public need to be better informed about the problem and the serious consequences that will result from delays in conversion.

- The infrastructure needed for conversion in the study area is relatively well-defined. Generally, it consists of the following: facilities to divert water from Lake Houston, a new water treatment plant, and transmission facilities to convey and deliver treated water to districts and other end users within the study area.

- Ideally, there would be consensus among those who are to be supplied treated surface water from the system with respect to the entity or entities that would design, construct, own and operate the system or portions thereof:

While there are a number of entities that could possibly take on this project, the City of Houston is currently the logical entity to design, construct, own and operate at least the primary elements of the system. The City owns Lake Houston and other water supplies from Lake Conroe and Lake Livingston that could be diverted into Lake Houston. Also, the City has extensive experience with projects of this magnitude, and it is by far the major regional supplier of treated surface water in the District. Presumably, the City could supply treated surface water to districts and other users within the study area at a lower price than other possible alternatives.

There appear to be opportunities for districts and other smaller end users within the study area to have a significant role in the design and construction of facilities to convey and deliver water to those entities from the primary treated water transmission facilities.

- If the District does raise its permit fee to provide the necessary disincentive to continued high levels of groundwater pumping, it could utilize these funds by making grants, loans or contractual payments to achieve, facilitate or expedite the conversion. Grants and loans also could possibly be obtained from the TWDB and other governmental entities. Such grants, loans or contractual payments could be made to any entity incurring costs in the design or construction of any portion of the treated surface water system, including any district or end user involved in the design and construction of facilities to convey and deliver water to that entity from the primary treated water transmission facilities.

II - Background and Purpose of Analysis

BACKGROUND

The Harris-Galveston Coastal Subsidence District (HGCSD or the District) is a governmental agency created by the Legislature under Article XVI, Section 59 of the Texas Constitution. The District was created in 1975 by act of the 64th Texas Legislature. The current HGCSD Act (the Act) is found at Chapter 151, Texas Water Code.

The purpose of the Act is to "provide for the regulation of the withdrawal of groundwater within the boundaries of the district for the purpose of ending subsidence, ..." Section 151.004(a).

The District includes all of the area within the boundaries of Harris County and Galveston County. Section 151.003(a).

In 1976, HGCSD adopted its initial District Plan, which focused on the southeastern part of Harris County and all of Galveston County. As conversion was successfully completed in the areas emphasized in the initial Plan and the District gathered additional technical information, it developed a new Plan in 1985 and again in 1992 to reflect these successful conversion efforts and the need to focus on new areas of priority. The 1985 and 1992 Plans divided the entire District into Regulatory Areas, first eight in the 1985 Plan and then seven in the 1992 Plan (see Appendix A at the conclusion of this report for a map of the regulatory areas). The Regulatory Areas have differing times for conversion from groundwater to surface water through the year 2020. These differing conversion times attempt to reflect the potential availability of surface water, geophysical characteristics, areas of high groundwater demand, and projected population growth/water use demand among other critical factors.

Ultimately, under the current Plan, all areas of Harris and Galveston Counties, depending upon their location, will be limited to no more than 10-20 percent of their water usage from groundwater.

In the case of violation of permit allowances, the District has the authority to litigate any noncompliance. However, since this is a time-consuming process, the District attempts to avoid litigation unless it is absolutely necessary.

In 1994, with the availability of 1990 census data, the District began its current process to review the 1992 Plan. This process has involved the following steps:

- HGCSD hired professional engineers (Turner, Collie & Braden) and demographers (American METRO/STUDY Corporation and the University of Houston Center for Public Policy) to update the water demand projections throughout the entire District.

- These projections were fed into a groundwater model to determine their effect on groundwater levels. Again, the District hired outside professionals (LBG Guyton & Associates) to update and calibrate the groundwater model.

- Finally, the change in groundwater levels was fed into a series of subsidence models to project the amount of subsidence at a given level of pumpage. These models were reviewed and recalibrated by another separate, outside professional firm (Fugro-McClelland).

These analyses confirmed that groundwater pumpage needs to be reduced significantly from current levels. While much of the southern, southeastern, and central parts of the District have converted to surface water over the past twenty years, the north and northwest areas of Harris County remain unconverted. That area is denoted as Regulatory Areas 4, 5, 6, and 7 within the District Plan, and is referred to in the analysis as the study area. The analyses confirmed that pumpage in the study area contributes to subsidence in the region. A major step that obviously needs to be taken is the conversion from groundwater to surface water in this area.

PURPOSE OF ANALYSIS

The purpose of this analysis was to identify steps needed to be taken and possible alternatives to best achieve conversion in the study area.

III - Lack of Effective Regulatory Disincentive

The overriding impediment to conversion in north and northwest Harris County is the fact that there is no effective regulatory disincentive currently in place to the continued pumping of groundwater at current levels. To the contrary, pumpers in this region have a strong incentive to continue on with business as usual.

North and northwest Harris County are not served by one political jurisdiction that has the necessary rights to sufficient amounts of surface water and the authority and ability to treat and supply that water. The current population of the study area is over 1.3 million. (Exhibit III-1).

Exhibit III-1
Population of the Study Area
by HGCSD Regulatory Area

Area	Population
4	450,399
5	39,776
6	731,736
7	99,090
Total	1,321,001

Source: US Census, 1990.

Over the past two decades since MUDs were created as a means to foster development in the greater Houston area, they have become an entrenched part of the governing mechanism in the City's extraterritorial jurisdiction. Each district is governed by its own board of directors. Consequently, there are 407 MUDs that exist within the study area. Each district is served by its own set of plant operators, engineers, accountants, and legal advisors. As a result, there is a strong inclination on the part of the boards of directors and members of these groups to maintain the current system of groundwater supply.

HGCSD is justifiably hesitant to use its permitting authority alone to provide the necessary regulatory disincentive for these districts to reduce pumping significantly. Because of the magnitude and cost of developing or causing the development of the necessary regional surface water supply system, it can be argued that surface water simply is not currently available to any one district. It seems ineffective, and perhaps contrary to the HGCSD Act, to issue a permit to any small pumper in the area that absolutely prohibits, after a fixed date, pumping in excess of 10 or 20 percent of that pumper's total demand, when it is not economically feasible for that pumper to acquire a surface water supply on an individual basis. Such an absolute prohibition would almost certainly trigger significant, costly litigation, which itself would almost certainly result in significant delays in achieving conversion. Moreover, if and when it became clear that conversion could not be achieved by the fixed deadline, HGCSD as a practical matter would be forced to extend it, thereby losing regulatory credibility and further undermining its ultimate purpose.

The obvious solution to this need for an effective disincentive is for HGCSD to provide the necessary regulatory disincentive through the setting of its permit fees. HGCSD has the authority to set its permit fee at up to "110 percent of the highest rate charged by the City of Houston for surface water supplied to its customers in the district" 151.28(b). Setting its rate at this level would provide an effective regulatory disincentive to the continued pumping of groundwater at current levels, and would be by far the simplest and most effective regulatory action the District could take to achieve significant reductions in pumping and overcome the strong inclination by districts within the study area to maintain the current system of groundwater supply. There would be no absolute deadline for conversion, but economic forces should nevertheless result in conversion at the earliest practicable date. Districts and other groundwater pumpers in the study area would then have a strong economic incentive to cooperate with key entities to arrive at an expeditious, cost-effective conversion solution.

IV - Lack of Awareness Within the Community

Compounding the lack of an effective regulatory disincentive and the strong inclination of districts within the study area to maintain the current system of groundwater supply, it appears that the need for significant reduction in current levels of groundwater pumping is not well understood by districts and other entities within the study area.

Our work effort in this area included the following:

- Assessing the current level of public understanding of the issues.
- Identifying key sources of information used by citizens to form opinions on the issues of subsidence and conversion from groundwater to surface water.
- Gauging the level of misunderstanding or the degree of misinformation associated with the knowledge base of area residents.
- Accessing community leaders and groups to maximize input to our evaluation process.

RESULTS

Telephone Survey

We conducted a telephone survey of registered voters within the study area, weighted to reflect the population differences across the four areas, using statistically valid sampling techniques, to determine the following:

- Current level of knowledge of subsidence and the problems that may occur.
- Potential economic impacts from continued subsidence and relevance to the entire District not just limited areas.
- Sources of information regarding key local issues.

We chose registered voters because it was assumed that they would more than likely:

- Have lived in the area for some time.
- Own their own home and, hence, pay water bills.
- Be involved in the community in some fashion and use various sources of information to gain knowledge of issues affecting their area.

Exhibit IV-1 provides the questions and responses.

Exhibit IV-1
Results of the Telephone Survey of Registered Voters within the Study Area

Question	Yes	No
1. Do you know where the water you use comes from?	69%	31%
2. Does your water come from surface water or groundwater? (NOTE: Only those respondents indicating that their source of water was groundwater were polled beyond this point; for all others, the interview was terminated.)	N/A	N/A
3. Are you aware that your area of Harris County is required to reduce its reliance on groundwater either through water conservation, water reuse, conversion to surface water, or a combination of all three?	41	59
4. Are you aware that the quality of groundwater you are drinking may not be as high as the quality of surface water that could be available to you?	39	61
5. Are you familiar with what is required to convert from groundwater pumping to surface water usage? (NOTE: If No, then to Q8; if Yes, then to Q6).	23	77
6. How would you rate your familiarity with conversion from groundwater pumping to surface water use?	Excellent Good Poor	19 68 13
7. From what sources have you obtained this information?	News articles Local officials Area meetings Newsletter Other	51 9 8 6 26
8. Are you familiar with the term subsidence? (NOTE: If No, then a brief explanation was provided and then to Q10; if Yes, then to Q9.)	62	38
9. Do you know that groundwater pumping may cause subsidence?	59	41
10. Are you aware that subsidence is a serious problem in Harris, Galveston, and Fort Bend Counties?	57	43
11. Are you aware that your area has incurred subsidence?	36	64
12. Are you aware that subsidence could be a factor in increased flooding in your area?	56	44
13. Do you believe that additional subsidence and flooding could negatively impact your economic situation?	73	27
14. Do you believe that further subsidence could threaten the economic well-being of Harris County in general?	77	23
15. Do you believe that further subsidence could threaten your well-being?	59	41
16. Do you believe that the Port of Houston and the ship channel industries have a major positive impact on our local economy?	86	14
17. Do you believe that NASA has a major positive impact on our local economy?	82	18
18. Are you aware that the area of Harris and Galveston Counties in which the ship channel and NASA are located incurred 9-12 feet of subsidence over the 20 years prior to their conversion to surface water?	27	73
19. Are you aware that further subsidence in those areas could result in business leaving the Houston area and/or NASA facilities being relocated to another part of the country?	35	65
20. Are you aware that continued groundwater pumpage in your area could result in subsidence in the ship channel and NASA areas?	32	68
21. What type of information would be helpful to you in gaining a more thorough understanding of this problem?	Newspaper articles Radio/TV programs Mailings Public meetings Other	35 31 15 14 5

Key points of information that were gained from the telephone survey included the following:

1. Public education and awareness

The results of questions three, five, and eleven underscore the limited sources of information targeted just to this area.

- Less than one-half of the study area's population (41 percent) were aware that there was a requirement to reduce reliance on groundwater.

- Less than one-quarter (23 percent) were aware of what is required in either time or cost to convert from groundwater to surface water.

- Only one-third (36 percent) of the study area's population indicated they were aware that subsidence had already occurred in the study area.

2. Economic impact

While respondents were generally aware that subsidence could affect the economic well-being of Harris County in general (77 percent), a much smaller percentage (59 percent) felt that further subsidence could directly affect their well-being.

As a whole, respondents were much less familiar with impacts that had already occurred around NASA and the Houston Ship Channel (27 percent). Also, there was little understanding of the potential link of greater groundwater pumpage in the study area causing greater subsidence in the Ship Channel and NASA areas (only 32 percent).

3. Public information

Even though the study area is not covered on a daily basis by any newspaper, respondents indicated that newspaper articles were their greatest source of information (51 percent). Respondents also indicated that this would be the best way to receive additional information in the future (35 percent).

Targeted Interviews

In order to complement the information gained from the telephone survey, a series of one-on-one interviews were conducted with key elected officials serving the study area and representatives of organizations that would be involved in water use planning/management within the study area.

Those interviews included the following:

- The Texas State Senators who represent the predominant part of the study area, Jon Lindsay and John Whitmire.

- Attempts were made to visit with all Texas State Representatives whose districts were fully or partially contained within the boundaries of the study area. Those who responded and were interviewed were Fred Bosse, John Culberson, Peggy Hamric, and Paul Hilbert.

- The Harris County Commissioners whose precincts include a portion of the study area, Jerry Eversole and Steve Radack.

- Representatives from the City of Houston whose responsibilities involve water resource planning, facilities construction and management, and financial management, including: Jimmie Schindewolf, Director of Public Works and Engineering; Fred Perrenot, General Manager, Houston Public Utilities; Ron Hudson, Senior Assistant Director for Planning and Operations Support, Public Utilities Group; Chuck Settle, Assistant Director-Planning Section, Public Utilities Group; and John Baldwin, Deputy Director for Resource Management, Department of Public Works and Engineering.

- The General Manager of the San Jacinto River Authority, Jim Adams.

- The Chairman of the Cy-Fair Chamber of Commerce Surface Water Conversion Task Force to the Alliance of North Houston Chambers of Commerce, Joe Wozny.

- The President of the North Harris County Water Users Association, John Harris.

Issues that were raised through these interviews, in no order of priority, included the following:

- The lack of one political subdivision with authority to convert the study area from groundwater to surface water was viewed as a severe obstacle to eventual conversion.

- The large number of entities supplying water to the area, primarily MUDs, have multiple, diverse goals which inhibit developing one plan for conversion that will meet the objectives of all parties involved.

- The issue of conversion is linked inappropriately to annexation by the City of Houston. The interviews indicated that while conversion and annexation may not be linked, the average person in the study area has the perception that conversion is the final step before annexation.

- Technical data that has been provided has not been viewed as accurate, especially that involving the level of subsidence and the likelihood of future subsidence in north and northwest Harris County.

- The area's residents and representatives generally have not yet been provided sufficient information to convince them that subsidence is really a problem in the area.

- The City of Houston is viewed by some as the chief "culprit" in mining groundwater in the area. The perception is that if the City were to stop pumping groundwater, there would not be a subsidence problem.

- Area businesses view the conversion to surface water as necessary to sustain growth.

- The impact on local residents of a large increase in water rates as a result of conversion from groundwater to surface water will be prohibitive.

Public Comments

Among the over 200 organizations we contacted about having a public presentation and opportunity to comment before their board, council, and/or membership were the following:

- All cities and public school districts

- All chambers of commerce

- All fraternal organizations, such as Optimists, Rotary, etc.

- All civic, community, and neighborhood organizations and/or associations

- Major churches

- Minority community organizations

From these contacts, 20 organizations accepted our invitation and scheduled us to make presentations and receive public comment (Exhibit IV-2).

Exhibit IV-2
Organizations to Which Presentations Were Made

Name of Organization
Bridgestone Homeowners Association
Chimney Hill Community Association
Cy-Fair Christian Church
Cypress Creek Christian Church
First Presbyterian Church Kingwood
City of Hilshire
City of Humble
Huntwick Civic Association
City of Jersey Village
Lexington Woods North
Meadows Baptist Church
Mossy Oaks Estates Civic Association
North Houston Association
St. James Church (Spanish)
St. Leo the Great Church (English and Spanish)
Spring Baptist Church
City of Spring Valley
Spring Woods United Methodist Church
City of Tomball

Since it would have been impossible to have public meetings before each of the MUDs within the study area, we made a presentation to the state meeting of the Association of Water Board Directors at South Padre Island in June 1996. At the presentation, the General Manager of HGCSD presented a status report on the results of the other technical studies that had been commissioned by the District, and we presented information regarding the scope and nature of the conversion implementation study.

A majority of citizens who spoke in the public forums were opposed to conversion from groundwater to surface water. The primary reasons given for this opposition generally included one or more of three concerns: the increased cost of surface water, potential annexation by the City of Houston, and lack of compelling data to demonstrate the necessity of conversion.

Several areas, particularly in northwest Harris County, raised problems with their supply of groundwater, such as contamination by natural gas, that were more likely to motivate them to convert to surface water than the presence of any subsidence.

V - Infrastructure and Technical Issues

INTRODUCTION

This element of the study's evaluation was not intended to produce any new technical information, reproduce existing data, nor recommend new technical strategies. Instead, it was designed to assess the currency and usefulness of existing technical data and to identify any gaps in information that would have to be generated prior to conversion from groundwater to surface water.

Briefly summarized, our key work steps involved the following:

- Assessment of existing technical information, its currency, and its usefulness.
- Development of input from key technical advisors to local entities (e.g., engineers, operators, etc.).
- Review of prior plans/studies relating to area conversion to surface water.

RESULTS

Prior Studies

The first step in the process was to identify previously-completed studies whose results involved, or impacted, part or all of the area included in this conversion implementation study. We went back to 1986, beginning the Pate Engineers/Jones & Carter study as our initiation point. Other studies and reports which were reviewed are included in Exhibit V-1.

Exhibit V-1
Studies and Reports Reviewed During Technical Analysis

Name of Study or Report	Date Issued	Author
"A Study of the Relationship Between Subsidence and Flooding"	1986	Turner, Collie & Braden; Pate Engineers, Inc.; and Winslow & Associates
"West Harris County Surface Water Supply Corporation, Implementation Plan"	1987	Dannenbaum Engineering Corporation
"Surface Water Conversion Plan, North Channel Water Supply Corporation"	1987	Pate Engineers, Inc.
"The Northeast Harris County Water Supply Corporation Water Supply Study"	1989	Steffek & Van de Wiele, Inc.
"Regional Water Supply Study for the Cities of Rosenberg and Richmond and Surrounding Areas"	1989	Dannenbaum Engineering Corporation
"Land-Surface Subsidence Resulting from Groundwater Withdrawals in the Houston-Galveston Region, Texas, through 1987"	1990	United States Geological Survey
"Fort Bend County Surface Water Supply Study, Phases 1 and 2"	1993	Lichliter/Jameson & Associates; and Turner, Collie & Braden
"Surface Water Conversion to Control Subsidence"	Not Available	James E. Deberry

We evaluated these key studies and accompanying reports, maps, plans and other information concerning either technical issues related to the need for conversion to surface water or engineering aspects of the infrastructure required for conversion to surface water. We evaluated the findings and recommendations from these efforts, compared to recommended practices and policies, and looked for any conflicts or inconsistencies among the reported data and conclusions from these studies.

A key study relating to the cost and location of the major transmission branches was one conducted by Lockwood Andrews Newnam (LAN) for the City of Houston. While the study has not been completed, officials of the City's Department of Engineering and Public Works, Division of Public Utilities, have made various presentations to civic and community groups in the study area over the past several years which provided summary data regarding cost and design/construction time. This data was used to assist in determining the overall cost and timing associated with development of the needed infrastructure.

The primary conclusions from the studies included the following:

- The City of Houston was the only regional water supplier with enough surface water rights to serve the study area.

- The primary source of water would be Lake Houston.

- A new water treatment plant and transmission line would have to be designed and constructed in order to bring surface water to the area. Existing water treatment plants are at or near capacity, and any expansion would be used to serve existing customer areas.

- It would take approximately six years to design and construct the primary facilities at a cost of approximately $700 million.

- Additional lines would have to be built to connect each local entity with the main transmission line or branches. The cost of these lines is not included in the $700 million estimate above.

Interviews

After completing these initial information-gathering tasks, we conducted a series of interviews with key engineering firms that represented entities covering a large geographic portion of the study area. Those firms involved in the interviews are included in Exhibit V-2.

Exhibit V-2
Engineering Firms Interviewed

Name of Firm
Alexander Engineering
Brown & Gay Engineers, Inc.
Cherry Engineers
Dannenbaum Engineering Corporation
Edminster, Hinshaw, Russ & Stanley
Jones & Carter
Pate Engineers
Steffek & Van De Wiele
Georgia Wilson & Associates
Turner, Collie & Braden

The interviews focused on the following key points:

- The perceived key technical issues affecting the entities represented by the firms.

- The potential for integrating existing water supply facilities of local districts into the conversion plan.

- The identification of any operational issues that would affect the conversion and alternative solutions.

- Recommendations for evaluating alternatives to implement conversion.

We also conducted a limited number of interviews with local developers, builders, environmental representatives, and others that would be involved in any conversion solution to receive their input and identify any issues of concern that required additional evaluation.

The basic conclusions from these interviews were as follows:

1. Necessity to convert from groundwater to surface water

The engineers as a group generally felt that there is a long-term need to convert to surface water, primarily because of concerns about the long-term reliability of groundwater supplies to meet projected growth needs of the area. Reliability issues primarily revolve around declining aquifer levels. Most of the engineers interviewed believe that the aquifer is being "mined", i.e., more water is being withdrawn than is being replaced.

Groundwater quality issues were an important secondary issue. This is particularly true in Regulatory Area 4 where gas intrusion into groundwater sources is a significant issue.

When asked about the positions of the MUDs they represent, **all of the engineers interviewed indicated that the boards of these entities do not feel that the need to convert from groundwater to surface water is significant**. Rather, the boards largely view attempts at conversion to be linked with the City of Houston's strategy to annex the areas.

2. Ability of MUD systems to accommodate conversion from groundwater to surface water

Most of the engineers interviewed indicated that conversion could be accomplished by bringing surface water to existing MUD plant sites and then pumping it out to customers from those locations. Some of the engineers felt that bringing surface water at a pressure level associated with a new surface water system (i.e., at a higher level of pressure than groundwater systems) would be more economical and would allow for reducing the number of water plants that would need to be kept in operation.

3. Best alternative to implement conversion

As with other individuals and groups interviewed, there was **no consensus among engineers regarding the best alternative to implement conversion**. Many felt that no acceptable consensus would ever be achieved. Among the points brought out in the interviews were the following:

- A majority felt that nothing could be accomplished unless the City of Houston annexed the areas along FM 1960 in addition to the Kingwood annexation. Once annexation had occurred, the annexed areas could immediately be converted to surface water.

- Once those areas that had been annexed had been converted, the City of Houston could contract with remaining entities outside the annexed territory. This would facilitate

conversion by bringing major transmission branches closer and, thus, lowering the cost for the connecting entities.

- If an alternative to annexation were to be considered for the management/operation of a surface water system, **the engineers indicated that to make any new system workable the MUDs would likely have to have some role in the implementation in addition to simply contracting for treated water supplied by the City.**

4. Other issues

During the course of the interviews, a variety of other issues were voiced by one or more of those engineers participating, including the following:

- **A majority of those interviewed expressed the opinion that the current timetable for conversion for Regulatory Areas 4-7 is too aggressive and does not reflect the current conditions nor the likely conditions of the future.** However, the engineers did indicate that if the drought conditions of 1996 were to continue or become more frequent in occurrence, then the current water supply would be inadequate and conversion would have to be hastened.

- **The group almost unanimously indicated that contracting with the City of Houston is viewed by their clients as a difficult, time-consuming process.** All of the engineers cited at least one instance to support this contention.

- In addition to the annexation issue, **a primary concern of the board members and residents of the MUDs is the cost of converting to surface water and the subsequent high rates.** This concern reflects the following:

  The infrastructure costs that the MUDs will have to bear to connect to the main transmission branches.

  The on-going transmission costs.

  The City of Houston's intent/policy of recouping a portion of its investment in overall water system infrastructure costs (e.g., Lake Houston and Lake Conroe, facilities to capture and convey Trinity River water, etc.) through its rate structure.

- The older, more developed MUDs and their residents have unique issues which must be addressed if conversion is to occur successfully, according to some of the engineers. Many of the MUDs along FM 1960, particularly in the Champions area, are older, are built out, and have very little, if any, remaining debt. The residents of these areas are largely at, or very near, retirement age, and many are on fixed incomes. Their current water rates are very low and, with their incomes limited, this group is very vocal in opposition to conversion.

- A number of engineers indicated that it is not necessarily in the best interest of the technical and legal consultants for the MUDs to support and/or persuade board members and residents to support conversion, especially if annexation by the City of Houston is required to make it happen. With such change, many of these consultants will lose long-standing, profitable clients. Consequently, any final management/operation structure must consider how to deal with the interests of these support groups.

- According to the engineers interviewed, many of the members of boards of MUDs are not well-informed on the issues of subsidence, requirements for conversion from groundwater to surface water, and overall water reliability. In conjunction with this lack of thorough understanding of the issues is the erroneous belief by many board members of MUDs that the City of Houston's groundwater pumpage is the real problem, and if the City would stop its pumping, there would not be any need for anyone else to convert.

- As a consequence of this lack of information or ill-informed perceptions, any future efforts by the District, or any other entity, need to consider an information/education campaign that raises that level of overall knowledge.

- Some engineers voiced the opinion that the well field in the City of Jersey Village is creating a credibility problem for HGCSD. The greatest level of subsidence is occurring in this area due to the large amount of pumpage, primarily by the City of Houston, and this well field is in Regulatory Area 6. However, Regulatory Area 6 is not scheduled to convert to surface water until five years after Regulatory Area 4, which encompasses most of the area east of Regulatory Area 6 up to Interstate 45. Unless this timetable is adjusted to reflect the key problems, local MUDs will continue to oppose the District Plan.

- The engineers also indicated that the members of the various MUD boards had become accustomed to holding office, some for lengthy periods of time. Since they received various perks, such as compensation for attending meetings and expense-paid annual trips to South Padre Island, these board members were not in favor of giving up their positions to facilitate any conversion alternative.

VI - Design, Construction and Operation Alternatives

INTRODUCTION

This element of the study's overall scope of work was intended to identify and evaluate possible approaches for design, construction and operation of the necessary surface water facilities. Two approaches were used: (1) evaluation of one entity being responsible for all activities described above; or (2) evaluation of different entities playing different roles at each discrete step of the conversion process.

RESULTS - OVERVIEW AND SUMMARY

Background and Alternatives

As noted in the prior section, delivering surface water to the study area will require constructing a large water treatment plant and distribution system. That section already noted studies that had identified tentative locations for the transmission/distribution system and had determined cost estimates for the treatment plant and main distribution system of approximately $700 million.

Alternatives could be developed associated with the exact location of any plant and distribution system; however, since our role was not to duplicate prior technical studies nor create new technical data, we used this pre-identified system and cost estimate to evaluate each management alternative.

Initially, we considered the entities listed in Exhibit VI-1 as potential principal entities for the design, construction and operation process.

Exhibit VI-1
Potential Principal Entities

Entity	Brief Description
City of Houston	Municipal government
San Jacinto River Authority	Authority created by act of the Texas Legislature to transport water to limited areas
Coastal Water Authority	Authority created by act of the Texas Legislature to transport water to limited areas
Harris County	County government
Harris-Galveston Coastal Subsidence District	Authority created by act of the Texas Legislature to regulate groundwater pumpage in certain areas to end subsidence
New governmental authority created by the Texas Legislature	Authority would be a new regional governmental entity
Private firm	Privately-owned, for-profit entity

In evaluating each of these entities, we addressed the following key questions:

- Does the entity have experience, or is there a record of performance by the type of entity elsewhere, to demonstrate that it is a viable alternative?
- Can the entity handle all aspects of the conversion process or is it limited in any way?
- What means of financing will be available to the entity or group to fund the design, construction, and operation of the facilities?
- What potential operational difficulties might exist that could impede the entity in the design, construction or operation of the facilities?
- What legal issues exist that could impede or prohibit the entity from designing, constructing or operating the facilities?

These questions served as the core of the evaluation of each entity. Other issues and/or concerns were generated regarding various options and were addressed for that particular option.

The results of the analysis of each potential principal entity are summarized in Exhibit VI-2.

Exhibit VI-2
Summary of Analysis of Entities

Entity	Summary of Analysis
City of Houston	• Water supplier with sufficient rights to surface water to meet the demands of the study area. • Significant experience in the design, construction and management of projects of this magnitude. • Significant experience as a major regional supplier of treated surface water. • Any infrastructure it finances must be financed through new revenue.
San Jacinto River Authority	• Water supplier, but does not have sufficient rights to surface water to meet the demands of the study area. • No experience designing, constructing, or managing projects of this magnitude. • Same financing requirement as the City of Houston.
Coastal Water Authority	• Primarily, a transporter of untreated water to limited parts of Harris and surrounding counties. • No experience designing, constructing, or managing projects of this magnitude. • Same financing requirement as the City of Houston.
Harris County	• The County does not have water supply powers, nor does it have any rights to surface water. • The County has no experience designing, constructing, or managing projects of this magnitude. • Same financing requirement as the City of Houston.
Harris-Galveston Coastal Subsidence District	• Evaluation of the District as a potential principal entity is inappropriate and/or unnecessary because the District is prohibited by statute from selling water or operating water treatment/transmission facilities. • However, the District does have the clear authority to use funds obtained from its permit fees by making grants, loans or contractual payments to achieve, facilitate or expedite reductions in groundwater pumping or the development or distribution of alternative water supplies.
New authority created by the Texas Legislature	• Would not have sufficient rights to surface water to meet the demands of the study area. • Would have no experience designing, constructing or managing projects of this magnitude. • Would have the same financing requirement as the City of Houston.
Private firm	• Would not have sufficient rights to surface water to meet the demands of the study area. • Depending upon the entity, there would be questions of financing methods and experience. • Essentially the same financing requirement as the City of Houston.

RESULTS - DETAILED DISCUSSION

City of Houston

The only source of sufficient surface water is Lake Houston where the City of Houston owns the predominant rights to the water. While the San Jacinto River Authority owns water rights in Lake Conroe and San Jacinto run-of-river rights, these rights are already designed to meet the

growing needs of Montgomery County and certain industrial users in Baytown. As a consequence, the City of Houston would be the only source of adequate surface water for conversion in the study area.

The City of Houston has proven its capability to design, finance, construct, and operate major water treatment and transmission facilities, either on its own or through a contracted entity. The City already has major water treatment plants in operation in two locations: the Southeast Water Purification Plant in concert with a number of other municipalities, and the East Water Purification Plant, which consists of three plants. The former provides water for southeast portions of the City of Houston, area municipalities, and portions of Galveston County. The latter combination of plants, which is undergoing a major expansion, serves the east, central, and northern areas of the City and, with the expansion, will serve portions of the west side of Houston. From these supply points, the City can adequately meet current needs and some expanded needs in the western part of the City.

In order to expand the system to serve north and northwest Harris County outside the City, a new facility would have to be constructed. As noted in the prior section of this report, the City commissioned LAN to conduct the evaluation of the size, cost, and location of the plant and distribution system to serve that area. Only limited preliminary results have been made available.

In order to finance the construction of this new system, the City has several options:

- Increase rates to current water customers.
- Use alternate financing mechanism, such as general obligation bonds or property tax revenues.
- Issue revenue bonds based upon existing capacity and customers.
- Issue revenue bonds based upon new capacity and contracts with new customers.
- Develop alternate financing vehicles, such as grants or loans from governmental entities or private funding.

Of these alternatives, our interviews with City of Houston personnel indicated that only the last two would be potentially viable. The City's water rates are already among the highest in the state, and it is unlikely that current customers would support construction of facilities not designed to serve their needs.

Municipalities carefully guard extending "the full faith and credit" of the entity, as is required with general obligation bonds, to support questionable projects. Without a customer base, the City could potentially have to assume payment of $700 million in design and construction debt

for a facility that might not be used or end up being underutilized and cannot generate the revenue stream necessary to retire the debt.
Using existing capacity and customer base as a means to support issuance of new revenue bonds is not a viable option either. If the City attempted this method, then, according to our interviews, it could potentially suffer a downgrade in its debt rating (causing an increase in interest costs), and/or a significant increase in existing water rates years in advance of a potential increase in customer base.

Thus, the City is unlikely to construct a facility to transport water unless it first has contracts with customers for that water, or unless alternative financing vehicles are developed.

The City has the capability to manage the plant and transmission lines as well as maintain the system.

San Jacinto River Authority

The San Jacinto River Authority (SJRA) was created by act of the Texas Legislature in 1937. Its boundaries include the entire watershed of the San Jacinto River and its tributaries. By virtue of a contractual agreement with the City of Houston, SJRA is excluded from selling water in Harris County with the exception of the eastern portion (i.e., the area including Baytown).

SJRA has water rights in Lake Conroe and San Jacinto run-of-river rights and has recently purchased additional water rights in the Trinity River. However, the total water rights available to SJRA would not be sufficient to meet the projected demand of the study area, and SJRA is planning to use existing rights, plus any additional ones that it can purchase, to serve the current and future needs of Montgomery County, particularly The Woodlands.

SJRA currently operates several facilities through its three divisions: the Highlands Division (east Harris County), the Lake Conroe Division, and the Woodlands Division. These facilities are adequate to meet the needs of the smaller cities and unincorporated areas that SJRA serves. The Authority does not have taxing capabilities but can issue revenue bonds and other special project bonds secured by a pledge of its net revenues. Since the Authority does not tax and receives no designated funds, it must operate as an enterprise operation and each project must pay for itself.

The General Manager of SJRA indicated during our interview that the Authority could possibly be a financing vehicle for construction of the needed facilities to serve the study area. He indicated the SJRA has the authority currently to serve in that capacity. However, he indicated that SJRA only wanted to deal contractually with one entity, not over 400 different ones.

Operationally, while SJRA has internal expertise in operating certain water treatment and transmission facilities, it does not have experience with any systems of the size of those proposed to serve the study area.

Coastal Water Authority

The Coastal Water Authority (CWA), a conservation and reclamation district of the state of Texas, is located in a three-county area encompassing all of Harris County and parts of Chambers and Liberty Counties. CWA was created by act of the Texas Legislature in 1967. Acquisition and construction of facilities to transport water from the Trinity River to the greater Houston area was the primary reason for its creation.

In its enabling legislation, CWA has the authority to transport and deliver water, to acquire properties and construct facilities to accomplish the transportation of water, and to issue bonds supported by revenues received from the conveyance of water. The latter is the only method of raising revenues available to CWA. Since its inception, CWA has issued $342 million in revenue bonds to finance various projects necessary to pump water from the Trinity River.

CWA and the City of Houston entered into a contract in 1968, which was later amended, by which CWA will construct, operate, and maintain certain facilities necessary to transport untreated water from the Trinity River for the City of Houston. The City repays CWA through revenues from its water and wastewater operations.

CWA holds no rights to surface water and, therefore, it is unable to meet any demand for surface water in the study area. Currently, CWA's primary functions are to:

- Pump untreated water from the Trinity River to the Lynchburg Reservoir.

- Operate and maintain the Lake Houston pump station and the west canal under contract with the City of Houston. These facilities transport raw water to the City's East Water Purification Plant.

- Operate and maintain a water distribution system that begins at the Lynchburg Reservoir and provides untreated water for the industries on the south side of the Houston Ship Channel from Sims Bayou easterly to Galveston Bay and for the industries in the Bayport Industrial Complex (called the Bayport Water System).
- Maintain two laterals which provide untreated water to the City's East and Southeast Water Purification Plants.

- Operate and maintain a water treatment plant, purchased in 1979 from a commercial entity, to provide water only to meet industrial requirements.

Similar to the San Jacinto River Authority, CWA does not have the power to tax and receives no designated funds. Consequently, it must accomplish each project on a self-supporting basis either through negotiated contract, as with the City of Houston, or through the levy of a user charge, such as with the Baytown Water System. This means that financing the projects would require dedicated contracts from users before revenue bonds could be issued or user fees levied.

Operationally, while CWA has internal expertise in operating a limited number of water treatment and transmission facilities, it does not have experience with any systems of the size of those proposed to serve the study area.

Harris County

Harris County is the only political subdivision that includes the entire study area. Sections of Regulatory Areas 4-7 are included in County Commissioner Precincts 3 and 4.

The County does not own any rights to surface water and, therefore, it is unable to meet any demand for surface water in the study area.

Moreover, the County's powers would have to be expanded to permit it to enter the water supply business. If that were done, then the County presumably could charge a property tax on County residents to fund any infrastructure improvements.

Without this authority, the County is limited to providing such services through a not-for-profit entity, such as a water supply corporation.

This idea was proposed several years ago by the then County Judge of Harris County as a means of converting the study area and avoiding the potential of annexation by the City. The water supply corporation would have bought water from a supplier, such as the City of Houston or SJRA, and resold it to MUDs and other entities. However, there appeared to be at least two problems with this alternative:

- First, it involved creating another governmental entity on top of the number already existing. Other existing governmental entities were not supportive of adding another layer of bureaucracy to the situation.

- Second, the concept of a regional water district had been proposed, and defeated, in the late 1980's by residents in the study area.

The proposal was never acted upon by the full Commissioners' Court.

The County has no experience in dealing with water treatment and supply facilities.

Harris-Galveston Coastal Subsidence District

The District was established as a regulatory body to control the pumpage of groundwater in Harris and Galveston counties in order to inhibit subsidence. In order to carry out its business, the Texas Legislature, in the legislation it passed enabling the District's creation and continuing operation, provided for a permit fee on groundwater pumped by any user in its regulatory area.

The District has no rights to surface water, and is prohibited from either selling water or operating a water treatment and transmission facility.

However, the District does have the clear authority to use funds obtained from its permit fees by making grants, loans or contractual payments to achieve, facilitate or expedite reductions in groundwater pumping or the development or distribution of alternative water supplies.

Creation of a New Governmental Authority

We spent limited time evaluating this alternative for the following reasons:

- A new governmental entity would have no rights to surface water and, therefore, would be unable to meet any demand for surface water in the study area.
- A new governmental entity would have no experience in designing, constructing, financing or operating the necessary surface water system.
- A new governmental entity would have the same financing requirement as the City of Houston.
- There was very limited support among local legislators, local officials, and community residents for the creation of another governmental entity to handle this issue.
- The issue of a regional authority had already been defeated by area voters.
- Local MUD boards of directors, and their supporting technical consultants, were too entrenched and politically influential to make this alternative a reality.

Private Firm

The terms outsourcing, privatization and public-private partnership are regularly used interchangeably for this analysis. For purposes of our evaluation, we considered involvement of a private firm in partnership with a public entity. At the very least, a private firm would need to contract with the City of Houston for the necessary supply of raw water from Lake Houston for the study area. Additionally, with concerns about water quality and public health, some governmental entity would have to be involved to provide these assurances.

Public services have a history of being contracted with private firms in a number of areas, primarily electric and gas utilities. According to the Wall Street Journal, "The Imperative to Privatize" (1995), only one-third of water supply and water treatment facilities are contracted out to private companies. Most outsourcing or privatization for these facilities is for specific services, such as design and construction, rather than for an entire operation. However, there are increasing examples of where public entities have contracted with private firms for not only

design and build functions, but also financing, operation, and maintenance (e.g., Seattle, Washington and Cincinnati, Ohio).

We interviewed three firms that all had experience in all aspects of major water treatment and transmission facilities: Montgomery Watson, Wheelabrator, and US Water. All three firms indicated that given the opportunity, they could complete the facilities needed for conversion and operate them for any given period of time. In fact, Montgomery Watson has a five-year contract to operate the southeast plant for the City of Houston.

As will be discussed in the next chapter, all three indicated that not only could they design, construct, and operate the facilities, but they could provide private financing. However, there would have to be some guarantee of payment, such as dedicated revenues or customer contracts. This is essentially the same financing requirement as the City of Houston.

CONCLUSIONS

The City of Houston is the logical entity to design, construct, own and operate at least the primary elements of the system. The City owns Lake Houston and other water supplies from Lake Conroe and Lake Livingston. The City of Houston is by far the major regional supplier of treated surface water in the District, and, presumably, it could supply treated surface water to districts and other users within the study area at a lower price than other possible alternatives.

In recognition of the fact that each district is served by its own set of plant operators, engineers, accountants and legal advisors, there appear to be opportunities for districts and other smaller end users within the study area to have a significant role in the design and construction of facilities to convey and deliver water to those entities from the primary treated water transmission facilities.

The City of Houston, and any district involved in the design and construction of any portion of the system, could, if they chose, contract with one or more private entities for all or any part of their responsibilities.

VII - Financial Issues

INTRODUCTION

Based upon the Lockwood Andrews Newnam study referred to in Chapter V, the anticipated cost to build the facilities necessary to convert the study area to surface water approaches $700 million. The components of this cost estimate are included in Exhibit VII-1.

Exhibit VII-1
Cost Components for Surface Water
Treatment and Transmission Facilities

Component	Cost (millions)
Surface water supply	$125.3
Surface water conveyance	202.3
Surface water production facilities	167.2
Transmission line program	183.7
Total	$678.5

Source: City of Houston

This total is based upon 1994 dollars and may not reflect the actual cost if the project were to be initiated today. Additionally, it does not include the cost to the various MUDs and other entities of connecting to the main transmission lines. Ultimately, the total cost will approach $1.5-2 billion.

Completion of a project like the one proposed does not happen quickly. Based upon estimates provided to us by the City of Houston, this project would require a minimum of six years from the time of adequate customer commitments to complete (Exhibit VII-2). Any delays along the way would only increase the cost estimate and create additional financing issues.

Exhibit VII-2
Milestones Necessary to Complete Surface
Water Treatment and Transmission Facilities

Milestone	Project Year
Revise plant design based upon customer demand	Year 1-2
Start plant construction	Year 3
Start transmission line design	Year 2-3
Start construction of transmission lines	Year 3
Place in service	Year 6

Source: City of Houston

In assessing the financing issues and alternatives, our task was not to derive the total cost of the project, but to identify alternatives that are available to fund the ultimate cost. During this evaluation, we considered a variety of alternatives from traditional means of financing, such as bonds, to new ideas, such as creation of a "conversion bank" to sell credits to entities wanting to

maintain a higher portion of usage of groundwater than approved by the District in lieu of greater or total conversion to surface water.

Given the results of our evaluation of management alternatives and operational issues, we narrowed our evaluation to the following methods of payment:

- General obligation and/or revenue bonds issued by a governmental entity.
- Private sources of financing.
- Grants, loans and contractual payments from the State of Texas, HGCSD and other governmental entities.

RESULTS

Bonds

General obligation (GO) bonds are issued by a governmental entity with its "full faith and credit" to repay them. Ultimately, this means that the governmental entity must use whatever means necessary to repay the debt, including property tax revenue that would otherwise go to meet general operations. Municipal entities are hesitant about applying their "full faith and credit" to projects and usually look very carefully at the types of projects to be funded. There is a limit to how much debt a governmental entity can issue without incurring exorbitant interest costs.

In this evaluation, only the City of Houston and Harris County have the ability to issue GO bonds. The City and the County use these bonds primarily for projects for which there is a long useful life and for which there is no other reliable source of revenue. Typical projects include road construction, library construction, and park land acquisition. The City has a rolling, five-year capital improvements program which it updates annually and which reflects its priorities, many of which are funded with general obligation bonds.

The other type of bond instrument is a revenue bond which is supported by a "stream of dedicated revenue", such as payments for certain charges like the use of water, wastewater treatment, and waste pickup and disposal. The level of the charge, or rate, is determined by the amount of revenue necessary to sustain the payment stream to retire the debt. For funding a project such as the one necessary to treat and transport surface water, revenue bonds are the traditional means of financing.

For the City to use this means of financing, it would require contractual commitments by districts and other users within the study area to pay costs of design and construction of the new facilities. Contractual commitments with all customers will be needed in any event, even if commitments for repayment of debt for design and construction were somehow not needed. The contracts would at least require a commitment for the City to supply treated surface water, and a commitment by the customers to pay at least the cost of raw water and the operating and

maintenance costs of the system. Including debt requirements in such contracts would simply raise the price and, therefore, result in greater resistance by districts and other users.

As discussed earlier in this analysis, the overriding impediment to conversion in north and northwest Harris County is the fact that there is no effective regulatory disincentive currently in place to the continued pumping of groundwater at current levels. To the contrary, pumpers in this region have a strong incentive to continue on with business as usual. If the District increased its permit fee to provide an effective regulatory disincentive to continued pumping at current levels by the districts and other pumpers, those entities should then **want** to enter into the necessary contracts for the supply of treated surface water, so long as the total cost was less than the charge imposed by permit fee.

Private Financing

As discussed below, private financing is not an effective alternative to issuance of bonds.

During our evaluation of three private firms with experience in similar projects, each firm indicated that private financing could be an effective alternative to public financing. We requested information from each firm explaining the parameters of such financing. Only US Water provided information which we used in summarizing this method of financing.

The public perception is that private financing of water infrastructure improvements, such as the facilities associated with conversion of the study area, will be more expensive than public sector financing. However, under certain conditions, private financing may not only be competitive but cheaper.

The key advantage held by the public sector is its ability to raise tax-exempt debt. Since investors who buy public bonds do not have to pay income tax on the interest they receive, public sector interest rates are lower than comparable taxable-interest bonds. Most public infrastructure, as noted earlier in this chapter, is financed with these governmental tax-exempt bonds, which typically carry interest rates about 20-30 percent below comparable private sector equivalents.

Under a public-private partnership arrangement, however, the private sector has access to tax-exempt bonds on a par with the public sector. In fact, new rules from the Internal Revenue Service (January 1997) allow private operators to manage water plants under contracts up to 20 years without eliminating access to tax-exempt debt.

A city, or other appropriate governmental entity, entering into such a long-term management contract can use its tax-exempt debt in place if it wants to do so; or the private sector partner can raise tax-exempt debt through project financing using a vehicle called "exempt-facility private activity bonds". In this way, the tax code allows for infrastructure projects that benefit the public good by involving private sector innovation.

Even if the private sector does not use tax-exempt bonds, it is important to bear in mind the various tax shelters that lower the actual cost of private sector debt. These deductions include interest expense and depreciation. The former, which will vary depending on the private company's tax rate, effectively means that governmental entities are subsidizing the project by that effective tax rate. The use of accelerated depreciation allows the private company to further lower the net after-tax cost of debt bringing it further into line with the public sector's cost of borrowing.

In addition to these tax shelters, all three firms indicated during our interviews that if a long-term contract were possible (i.e., 20-30 years) for design-build-operate, they would make the private financing extremely competitive if not better than public financing. The cost would be lowered on the front end of the contract period and then spread over the years of the contract.

As with the various public sector financing alternatives, however, all the firms indicated that if private financing were used, a payment stream to repay any debt or advance of money would have to be in place. This could be in the form of guarantees from the authorizing entity or a customer base. As a result, this method of financing does not offer an effective alternative to issuance of bonds.

Grants, Loans and Contractual Payments from Governmental Entities

It is possible that the costs of design and construction of the necessary surface water system could be paid or reimbursed, in whole or in part, by grants, loans or contractual payments from the Texas Water Development Board, the District, or some other governmental entity.

Any money contributed by grant, loan or contractual payment toward the costs of design and construction of the surface water system effectively reduces the cost of treated surface water. This in turn results in a lower permit fee needed to provide the necessary economic disincentive.

The current permit fee of the District is approximately only one percent of the City of Houston's current rate for surface water. If the District imposed a permit fee at "110 percent of the highest rate charged by the City of Houston for surface water supplied to its customers in the district", it would then have substantial funds available that it could contribute, by grant, loan or contractual payment, towards the costs of design and construction of the surface water system. Such grants, loans or contractual payments could be made to any entity incurring costs in the design or construction of any portion of the treated surface water system, including any district or end user involved in the design and construction of facilities to convey and deliver water to that entity from the primary treated water transmission facilities. Grants and loans also could possibly be obtained from the TWDB and other governmental entities.

VIII - Conclusions

The conclusions reached as a result of this analysis include the following:

- The overriding impediment to conversion in north and northwest Harris County is the fact that there currently is no effective disincentive to the continued pumping of groundwater at current levels. To the contrary, pumpers in this region have a strong incentive to continue on with business as usual.

- North and northwest Harris County are not served by one political jurisdiction that has the necessary rights to surface water for supply to the study area, and the authority and ability to treat and supply that water. Instead, there are over 400 MUDs and other types of water districts, each with its own elected board of directors. The current population of the study area is over 1.3 million.

- Over the past two decades since MUDs were created as a means to foster development in the greater Houston area, they have become an entrenched part of the governing mechanism in the City's extraterritorial jurisdiction. Each district is governed by its own board of directors. Consequently, over 400 separate governmental entities exist within the study area. Each district is served by its own set of plant operators, engineers, accountants, and legal advisors. As a result, there is a strong inclination on the part of the boards of directors and members of these groups to maintain the current system of groundwater supply.

- Conversion in the study area is not likely to occur within the foreseeable future unless the District alters its regulatory policies to provide the necessary regulatory disincentive to continued high levels of groundwater withdrawals. Increasing its permit fee to a level that exceeds the cost of treated surface water would provide an effective regulatory disincentive to the continued pumping of groundwater at current levels, and would be by far the simplest and most effective regulatory action the District could take to achieve significant reductions in pumping and overcome the strong inclination of districts within the study area to maintain the current system of groundwater supply. This action should result in conversion at the earliest practicable date. Districts and other groundwater pumpers in the study area would then have a strong economic incentive to cooperate with key entities to arrive at an expeditious, cost-effective conversion solution.

- Compounding the lack of any effective regulatory disincentive and the strong inclination of districts within the study area to maintain the current system of groundwater supply, it appears that the need for significant reduction in current levels of groundwater pumping is not well understood by districts and other entities within the study area. Local officials and the general public need to be better informed about the problem and the serious consequences that will result from delays in conversion.
- The infrastructure needed for conversion in the study area is relatively well-defined. Generally, it consists of the following: facilities to divert water from Lake Houston, a new

water treatment plant, and transmission facilities to convey and deliver treated water to districts and other end users within the study area.

- Ideally, there would be consensus among those who are to be supplied treated surface water from the system with respect to the entity or entities that would design, construct, own and operate the system or portions thereof:

  While there are a number of entities that could possibly take on this project, the City of Houston is currently the logical entity to design, construct, own and operate at least the primary elements of the system. The City owns Lake Houston and other water supplies from Lake Conroe and Lake Livingston that could be diverted into Lake Houston, and, therefore, any other entity would have to purchase its surface water from the City. Also, the City has extensive experience with projects of this magnitude, and it is by far the major regional supplier of treated surface water in the District. Presumably, the City could supply treated surface water to districts and other users within the study area at a lower price than other possible alternatives.

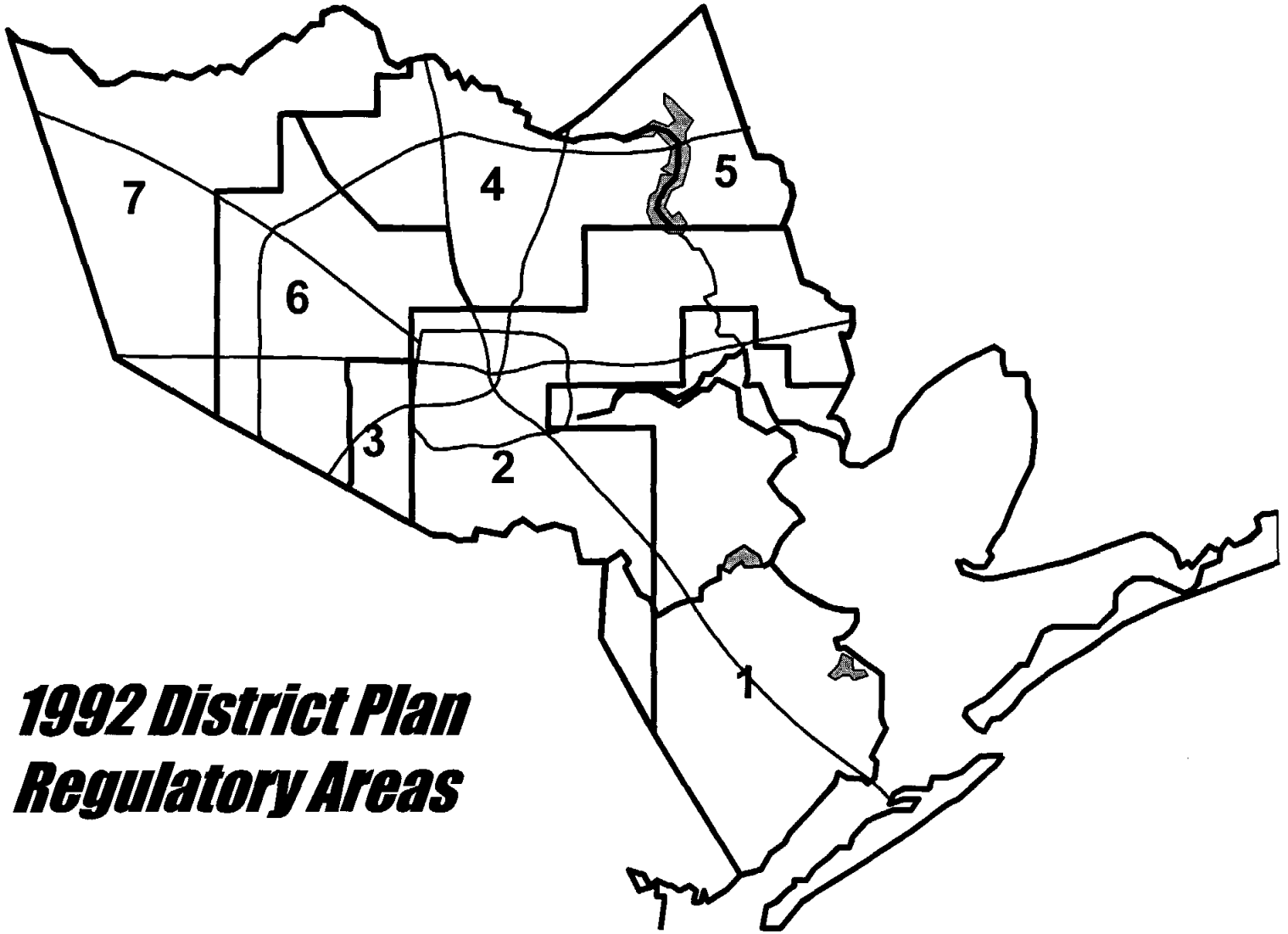
  There appear to be opportunities for districts and other smaller end users within the study area to have a significant role in the design and construction of facilities to convey and deliver water to those entities from the primary treated water transmission facilities.

- If the District does raise its permit fee to provide the necessary disincentive to continued high levels of groundwater pumping, it could utilize these funds by making grants, loans or contractual payments to achieve, facilitate or expedite the conversion. Grants and loans also could possibly be obtained from the TWDB and other governmental entities. Such grants, loans or contractual payments could be made to any entity incurring costs in the design or construction of any portion of the treated surface water system, including any district or end user involved in the design and construction of facilities to convey and deliver water to that entity from the primary treated water transmission facilities.

Appendix A

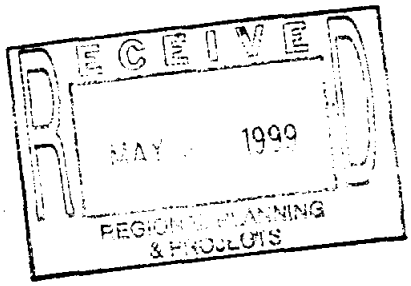
Map of Current Regulatory Areas

Harris-Galveston Coastal Subsidence District



1992 District Plan Regulatory Areas

THE
Subsidence
DISTRICT



May 3, 1999

Mr. Tommy Knowles
Deputy Executive Administrator
Texas Water Development Board
P.O. Box 13231
Austin, TX 78711-3231

Re: Submittal Letter and Response to TWDB Comments, Contract No. 95-483-089

Dear Mr. Knowles:

The purpose of this letter is to respond to the Texas Water Development Board's comments on the Draft Final Report submitted by the Subsidence District under Contract No. 95-483-089 and to submit the enclosed copies of the Final Report. The Board's comments are listed below along with the District's response.

1) Documentation of the City of Houston annexation policy study.

Several years ago, the City of Houston contracted with a consultant to conduct a study related to annexation. The contractor who prepared the Draft Final Report for the Subsidence District was a participant in the City's annexation study and was able to monitor its progress. However, the City never officially adopted or acted on any of the deliverables that were produced from the study, and no copies of the study results have been made available for public review, therefore, the results of the City's annexation policy study were not made a part of the Draft Final Report or the attached Final Report.

2) Documentation of the City of Houston water conservation plan development.

The City of Houston's water conservation plan was under development during the period of time in which the Draft Final Report was being prepared, and the contractor for this report actively monitored its development. However, the City's water conservation plan was still not completed by the time that the Draft Final Report was prepared and submitted to the Subsidence District for review, therefore, details of the plan and its development were not included in the report. Since that time, the City has completed its water conservation plan and a copy is attached to this letter.

HARRIS-GALVESTON
COASTAL SUBSIDENCE DISTRICT
281-486-1105
FAX 281-218-3700
postmaster@subsidence.org
1860 WEST BAY AREA BOULEVARD
FRIENDSWOOD, TEXAS 77546-2640
www.subsidence.org

3) The extent water conservation programs can impact water demand.

Water conservation programs can reduce the total water demand placed on a supply system to varying degrees depending on a number of factors, but this report does not include a quantitative analysis of the possible impact of such programs. Water conservation programs were taken into account in the water demand studies and engineering studies that were reviewed during the development of this report, however this report did not attempt to quantify the extent to which these programs can impact water demand as this was considered to be beyond the scope of the study. As mentioned in the previous response, the development of the City of Houston's water conservation plan was monitored as part of the work product for this report, but the contractor did not attempt to generate independent, analytical results regarding the extent to which water conservation programs can impact water demand.

4) Results of interviews with private operators of water facilities, including those in other parts of the country.

The results of interviews with private operators of water facilities were included on pages 31-32 of the Draft Final Report submitted to the Texas Water Development Board. This section of the report discusses the alternative of implementing a water system through a private firm and includes interviews of three major firms with experience in all aspects of major water treatment and transmission facilities. Those firms were: Montgomery Watson, Wheelabrator, and US Water. The results of these interviews are included in the Draft Final Report and the attached Final Report.

If you need any additional information, feel free to call me at 281-486-1105 ext. 16.

Sincerely,

Ronald J. Neighbors
General Manager

City of Houston Ordinance No. 98-764

AN ORDINANCE RELATING TO WATER CONSERVATION; APPROVING A CITY OF HOUSTON WATER CONSERVATION PLAN, AMENDING THE CODE OF ORDINANCES OF THE CITY OF HOUSTON, CONTAINING OTHER PROVISIONS RELATING TO THE FOREGOING SUBJECT; PROVIDING FOR SEVERABILITY; AND DECLARING AN EMERGENCY.

* * * *

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF HOUSTON, TEXAS:

Section 1. That the City of Houston Water Conservation Plan, attached hereto and incorporated by reference, is approved and adopted.

Section 2. That Section 47-25 of the Code of Ordinances, Houston, Texas is hereby amended to read as follows:

"**Sec. 47-25. Water Emergencies.**

(a) As used in this section, the following terms shall have meanings set forth below, unless the context clearly indicates that another meaning is intended:

Average gross quantity applicable to an individual customer means the monthly average gross quantity of water delivered to a customer during the 12 months immediately preceding the monthly billing cycle in which a critical or serious water shortage period begins.

Average production means the city's daily average combined surface water and groundwater production during a three day period.

Average water pressure means the average pressure within the city's *water* distribution system based on the average 24 hour pressure reading at representative pressure points.

Combined reservoir storage supply means the combined storage quantity of water stored at a point in time in Lake Houston, Lake Conroe and Lake Livingston (city share of storage only).

Conservation surcharge means the amount added to the customer's bill to encourage conservation. The surcharge is determined by the formula shown in subsection (g) below.

Critical water shortage period means a period of time that begins when upon the recommendation of the mayor the city council finds that one or more of the following situations exists and declares the existence of a critical water shortage period by approving a motion to that effect:

(a) Combined reservoir storage supply is approximately 12 months surface water supply for a period of a ten consecutive days;

(b) Average water production is 90 percent of the combined pumpage capacity of the treated groundwater and surface water system; or

(c) Average water pressure within the city's treated water distribution system is 35 pounds per square inch or less.

The declaration may cover all or only part of the city. A critical water shortage period ends when the city council finds that the conditions leading to the declaration of the period no longer exist.

Customer means any person receiving treated water service from the city's water system and for whom (or for which) a meter has been installed. A person served by more than one meter is considered a separate customer for each meter.

Discharge water means to allow, permit or cause treated water to be released through a sprinkler, faucet, hose or similar pressurized source.

Gross quantity means the total quantity of water delivered to a customer during a month.

Mild water shortage period means the period of time that begins when the director finds one or more of the following situations exists:

(a) Combined reservoir storage supply is approximately 24 months surface water supply for a period of ten consecutive days; or

(b) Average water production is 80 percent of the combined pumpage capacity of the treated ground water and surface water system; or

(c) Average water pressure within the city's treated water distribution system is 45 pounds per square inch or less.

The director's declaration may cover all or only part of the city. A mild water shortage period ends when the director finds that the conditions leading to the declaration of the mild water shortage period no longer exist and files the written declaration to that effect with the city secretary.

Serious water shortage period means a period of time that begins when upon the recommendation of the mayor the city council finds that one or more of the following situations exists and declares the existence of a serious water shortage period by approving a motion to that effect:

(a) Combined reservoir storage supply is approximately 18 months surface water supply for a period of ten consecutive days;

(b) Average water production is 85 percent of the combined pumpage capacity of the treated groundwater and surface water system; or

(c) Average water pressure within the city's treated water distribution system is 40 pounds per scare inch or less.

The director's declaration may cover all or only part of the city. A serious water shortage period ends when the city council finds that the conditions leading to the declaration of the serious water shortage period no longer exist.

Target usage during a critical water shortage period means an amount equal to 70 percent of the average gross quantity.

Target usage during a serious water shortage period means an amount equal to 80 percent of the average gross quantity.

Target usage during a serious water shortage period means an amount equal to 80 percent of the average gross quantity.

Water means waters contained in or flowing through any portion of the city's water system.

(b) During a mild water shortage period, the director shall institute a water emergency management information program to inform the public of voluntary measures to be taken to conserve water usage, including but not limited to:

(1) Requesting that customers insulate water pipes rather than running water to keep pipes from freezing;

(2) Requesting that customers check for leaks, dripping faucets, and running toilets and that customers utilize water conservation kits such as displacement bags, low flow shower heads and leak detector tablets;

(3) Requesting voluntary reduction from major customers; and

(4) Instituting a water use reduction program by the city.

(c) During a serious water shortage period it shall be unlawful for any person to:

(1) Cause or allow non-essential water use such as: street washing, flushing fire hydrants, watering parks, golf courses and esplanades, filling swimming pools and the operation of public and private decorative fountains; or

(2) Waste water by:

a. Permitting water from landscape irrigation to escape into gutters, ditches, streets, sidewalks or other surface drains;

b. Failing to repair a controllable leak on the customer's premises within 24 hours of discovery; or

c. Discharging water for outdoor recreation.

(d) During a critical water shortage period it shall be unlawful for any person to:

(1) Cause or allow any outdoor water use; or

(2) Waste water by:

a. Permitting water from landscape irrigation to escape into gutters, ditches, streets, sidewalks or surface drains;

b. Failing to repair a controllable leak on the customer's premises within 24 hours of discovery; or

c. Discharging water for outdoor recreation.

(e) It shall be an affirmative defense to prosecution under subsections (c) and (d) that the water was used:

(1) To alleviate conditions threatening health, safety or welfare of the public;

(2) For municipal operations of flushing water lines for public health purposes;

(3) For the suppression of fires;

(4) For municipal operations of wetting any surface for the purpose of testing for leaks in buildings or structures;

(5) For municipal operations in wetting any surface for the purpose of complying with the air pollution laws of the United States of America;

(6) For maintaining public gardens and arboretums of national, state or regional significance when necessary to preserve specimens; or

(7) For commercial businesses that use water, to maintain (but not expand) their primary business practices (e.g. commercial

car and truck washes, nurseries, turf growers, water haulers, concrete pavers, etc.).

(f) It shall be an affirmative defense to prosecution under subsection (c) only that the water was used:

(1) For watering plants that have been planted or transplanted in the same calendar day on which the discharge occurs; or

(2) For watering plants (other than grass) if the discharge is by water hose held in the hand.

(g) The Department shall impose a conservation surcharge on customers whose billing cycle includes all or part of a serious water shortage period or a critical water shortage period as follows:

A conservation surcharge will be added to the customer's bill if the customer's actual usage exceeds target usage. The formula for determining the conservation surcharge is:

$$CS = X(B)$$

Where:

CS = conservation surcharge

B = Customer's water bill as calculated acc ·ding to the procedures included in article II of this chapter.

X = Percent that the customer's gross quantity of water usage has exceeded the target usage for the serious or critical water shortage period.

Contract treated water customers, emergency back-up customers, transient meter customers and customers having a gross quantity 3,000 gallons or less in any monthly billing cycle are exempted from the customer surcharge for the monthly billing cycle.

(h) During a critical water shortage period, as required for the public health and safety of the citizens and consistent with the city's contracts and state law, the mayor may ration or terminate water service according to the following use priorities:

(1) Public and private schools, colleges, and universities and outdoor customers;

(2) Contract customers, industrial customers and commercial customers;

(3) Residential customers; and

(4) Public or private health facilities and custodial care homes.

(i) The mayor is authorized and directed to monitor the quantity of water pumped into the city's water distribution system and to make the findings and declarations prescribed in this section."

Section 3. The City Council officially finds, determines, recites and declares that a sufficient written notice of the date, hour, place and subject of this meeting of the City Council was posted at a place convenient to the public at the City Hall of the City for the time required by law preceding this meeting, as required by the Open Meetings Law, Tex. Gov't. Code Ann. ch. 551 (Vernon 1994); and that this meeting has been open to the public as required by law at all times during which this ordinance and the subject matter thereof has been discussed, considered and formally acted upon. The City Council further ratifies, approves and confirms such written notice and the contents and posting thereof.

Section 4. If any provision, section, subsection, sentence, clause, or phrase of this ordinance, or the application of same to any person or set of circumstances is for any reason held to be unconstitutional, void or invalid, the validity of the remaining portions of this ordinance or their application to other persons or sets of circumstances shall not be affected thereby, it being the intent of the City Council in adopting this ordinance that no portion hereof or provision or regulation contained herein shall become inoperative or fail by reason of any unconstitutionality, voidness or invalidity of any other portion hereof, and all provisions of this ordinance are declared to be severable for that purpose.

Section 5. There exists a public emergency requiring that this Ordinance be passed finally on the date of its introduction as requested in writing by the Mayor; therefore, this Ordinance shall be passed finally on such date and shall take effect immediately upon its passage and approval by the Mayor; however, in the event that the Mayor fails to sign this ordinance within five days after its passage and adoption, it shall take effect in accordance with Article VI, Section 6, Houston City Charter.

PASSED AND ADOPTED this 2ND day of Sept, 1998.

APPROVED this ___ day of _____, 19____.

Mayor of the City of Houston

Pursuant to Article VI, Section 6, Houston City Charter, the effective date of the foregoing Ordinance is SEP 08 1998.

City Secretary

(Prepared by Legal Dept. _____)
(EWB:pas 8/25/98) Sr. Assistant City Attorney
(Requested by Jerry King, Director, Department of Public Works and Engineering)
(L.D. No. 80-96098-01)

CAPTION PUBLISHED IN DAILY COURT REVIEW DATE: SEP 8 1998

AYE	NO	
✓		MAYOR BROWN
••••	••••	COUNCIL MEMBERS
✓		TATRO
✓		YARBROUGH
✓		WONG
✓		BONEY
		TODD
✓		DRISCOLL
✓		KELLEY
		FRAGA
✓		CASTILLO
✓		PARKER
ABSENT DUE TO BEING ILL		ROACH
✓		SANCHEZ
✓		BELL
✓		ROBINSON
CAPTION	ADOPTED	

CITY OF HOUSTON

WATER CONSERVATION PLAN

INTRODUCTION

On April 7, 1993, the Texas Natural Resources Conservation Commission (TNRCC) adopted rules relating to requirements for the development and contents of water conservation plans submitted to the commission pursuant to its water-related regulatory programs. These programs include the granting and administration of water rights, the regulation of certain water utilities, and the issuance of permits for the discharge of treated wastewater pursuant to Chapters 11, 13, and 26, respectively, of the Texas Water Code (Code). The rules specifically relate to the submission of a water conservation plan with an application of a new or amended water right. In addition, the Texas Water Development Board (TWDB) also requires that the City submit a conservation plan in order to receive revolving loan funds.

In 1994 the City applied for and was awarded a matching funds grant by the Texas Water Development Board to finance a conservation planning study to identify the most cost-effective conservation programs for the City of Houston. The City retained a private consultant to assist in preparing a comprehensive, cost effective water conservation plan.

The TNRCC rule defines a water conservation plan as: "a strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water." The TNRCC rule also emphasizes that water conservation is increasingly recognized as an integral part of water resources planning and management. It states that water conservation can play an important role in meeting current and future water supply, utility infrastructure, and environmental needs.

The need for water conservation is usually driven by the possibility of a water supply shortfall, problems associated with use of groundwater supplies (such as subsidence), or problems transporting and treating an excessive amount of wastewater. In addition to helping to resolve the types of problems listed above, conservation also provides additional benefits through cost savings, particularly from the deferral or avoidance of future capital facilities. The following is a list of the requirements of the TNRCC water conservation rule, Chapter 288 of the Texas Administrative Code (TAC), §§ Subchapter A; 288.1-288.7), and a description of the City's efforts to meet the respective requirements.

(I) MINIMUM REQUIREMENTS

(A) A utility profile including, but not limited to, information regarding population and customer data, water use data, water supply system data, and wastewater system data

(1) City of Houston Retail Billing System

The City's retail system bills individual customers for a little less than half of the total water sold by the City. These customers are defined as retail customers. The remainder is sold to wholesale customers, mainly large industries and municipalities. Wholesale customer is defined as a customer that has a contract with the City to purchase water. The City requires that all wholesale customers prepare and submit a water conservation plan which meets the

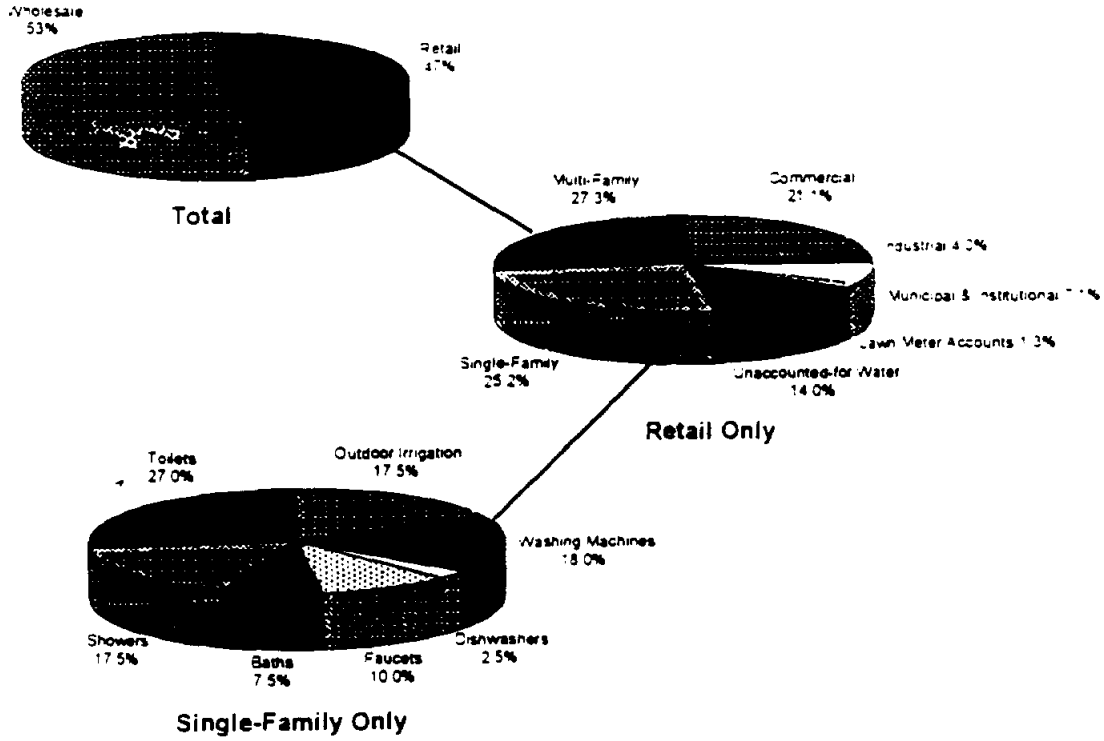
TNRCC minimum requirements. These plans are reviewed for compliance with TNRCC requirements and forwarded to the TNRCC for review. Therefore water sold to wholesale customers is not included for consideration in this plan.

(2) City of Houston Water Use Profile

The second pie diagram in the figure below shows the different categories in the City's retail water billing system, plus unaccounted-for water. Note that more than 50 percent of the water is used by residential accounts, split about equally between single-family and multifamily properties. Commercial and small industrial accounts use another 25 percent. The City and other public/institutional accounts (schools, hospitals, etc.) use 7 percent.

The last pie diagram shows a breakdown of single-family use. (Multifamily use is similar, except for outdoor irrigation which is only 12 percent of multifamily use). The breakdown of indoor use is based on published literature (Water Conservation, AWWA, 1987). Water used in the bathroom accounts for more than half of the indoor use, with toilet use being most significant. Washing machines are a significant use, but dishwashers are not.

HOW HOUSTONIANS USE WATER



(3) Consumption Patterns by Customer Class

Single Family Residential (SFR): This customer group consists primarily of single-family residential accounts but also includes a small number of senior citizen and public works employee accounts. The SFR customer group comprises 43 percent of totalretail accounts and 30 percent of total retail water sales. Consumption in 1994 (average month) was 210 5 gpd per account based on reported number of accounts. The SFR customer group accounts for 25 9 percent of total indoor consumption and 33 8 percent of total outdoor consumption.

The consumption pattern has been very stable over the last four years at 210 gpda, and it appears reasonable to project this level of consumption into future years as a pre-conservation or base rate of travel to be used in determining the effects of various conservation programs.

- **Multifamily Residential (MFR):** The Multifamily Residential customer class is made up of six user groups, with apartments making up about 90 percent of the total category. The MFR class is the largest single customer class with 51.2 percent of total households/accounts served and 32.5 percent of total retail water sales. The MFR group is also the largest category of indoor water use at 34.4 percent but is third, at 24.4 percent, in terms of outdoor water use. This customer class shows an unexplained upward drift in gallons per day per account (gpda).

- **Commercial Accounts:** This customer class makes up only 4.6 percent of total accounts, but 25.3 percent of total retail consumption. Commercial customers account for 25.2 percent of "indoor" consumption and 25.6 percent of "outdoor" consumption. As with SFR and MFR accounts, summer consumption exceeds winter consumption primarily due to irrigation usage, but for commercial accounts, a significant percentage of summer use is attributable to seasonal volume of product produced or customer activity. The consumption pattern has been quite stable at 1,630 gpda.

- **Lawn Meter Accounts:** This customer class is relatively small, but was reported separately because the high summer peaking could be a source of significant potential conservation. This class accounts for only .5 percent of total households/accounts and 1.4 percent of total retail consumption. However, outdoor consumption of lawn meter accounts makes up 8.8 percent of total outdoor water use. This class has demonstrated a stable pattern since mid-1993, at 963 gpda.

- **Municipal and Institutional (M & I) Accounts:** This customer class makes up only 0.6 percent of total accounts but 8.7 percent of total consumption. This class makes up 8.6 percent of total indoor retail consumption and 8.0 percent of outdoor consumption. The largest subgroup within M & I is hospitals (22.1 percent) followed by the City's parks and other irrigation stations (20.5 percent). The City's Parks Department comprise 4.5 percent of total retail outside water use and over 50 percent of total M & I outside water use.

Consumption in gpda has drifted down since 1991 but appears to have leveled off since mid-1993. The current consumption pattern is 4,268 gpda.

- **Industrial Accounts:** This category consists of the 293 commercial and industrial accounts served by the city that have nonstandard sewer agreements. The separate reporting is for monitoring of wastewater activity. Since they are reported separately, they are treated as a separate category, but could be rolled into the Commercial Accounts category for all practical purposes. These accounts use only about 2 percent of indoor, outdoor, and total water. The current average of 14,032 gpda was used for projections of future demand. Most of the large industrial users in Houston are in the wholesale account category and are not included as part of this plan.

- **Wholesale Accounts:** Wholesale water sales are not a direct part of the conservation plan. They are treated in the same manner as all other categories simply to complete the analysis of total water production provided by the City. The volume of wholesale water is greater than retail and cannot be slighted in an overall assessment of supply/demand conditions. Wholesale sales increased from 7.6 billion gallons per month in 1988 to 8.9 billion gallons per month in 1993, the latest year for which data was provided. Sales in 1992 and 1993 were essentially the same at about 9.0 billion gallons per month; this level was projected through 1994 and 1995 to provide a basic forecast for these years for total consolidated wholesale and retail water sales.

(4) Water Service Area Population Projections

Projections of future water demand are driven by projections of changes in the population served by the City of Houston. Population projections from a number of different sources were examined to determine the most useful projection for this study. The primary sources for population projections for the City of Houston are:

- Draft Texas Water Development Board (TWDB) 1996 Consensus Texas Water Plan Projections of Population and Municipal Water
- Trans-Texas Water Program Draft Planning Information Update (July 12, 1995)
- (Recommended) Houston Water Master Plan (HWMP, 1986)
- City of Houston Planning Department population projections for the City

The Draft TWDB plan listed above presents population projections for the City of Houston to the year 2050. The geographic limits are assumed to be the current City limits. Because the City limits are not exactly coincident with the water service area, the population projections may not be entirely representative of the City's water service area. In addition to projections for the City of Houston, the draft plan also includes population projections to the year 2050 for Harris County.

The Trans-Texas Water Program Draft Planning Information Update provides population projections to the year 2050 for river basins located throughout Texas. While the river basin data does not directly apply to the City, the report provides population projections for the Houston Standard Metropolitan Statistical Area (SMSA), which includes all or parts of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. The SMSA represents a potential area of future service, as identified in the HWMP discussed below.

Projected water demands to the year 2030 for alternative service area scenarios are provided in the Houston Water Master Plan (HWMP). In addition, the HWMP provides three separate projections for the City's water service area boundaries to 2030. The scenarios presented in the HWMP to project the City's water service area include (1) all of Harris County, (2) all of Harris County plus a five mile radius surrounding Harris County, and (3) the entire Harris County plus the seven surrounding counties. According to data presented in the HWMP, the City's water service area was projected to extend outside the City limits by the year 1990. However, it appears that this has not yet occurred. The HWMP also provides population projections based on the City's service area expanding to encompass the entire Harris County area and also extending into Brazoria, Fort Bend, Galveston, and Chambers Counties by the year 2030.As with the City's population projections provided by the TWDB, these population projections may not be completely coincident with the population within the City's water service area.

Population Projections

Area	1990	2000	2010	2020	2030	2040	2050	% Change from 1990 - 2050
City of Houston (1)	1,603,524	1,796,943	2,030,820	2,342,906	2,528,380	2,761,854	3,016,887	88.1
City of Houston (2)	1,639,274	1,821,953	2,068,368	2,201,148	2,322,213	-	-	41.7 (5)
Harris County (1)	2,818,199	3,217,689	3,707,869	4,315,000	4,667,749	5,109,533	5,404,722	91.8
Harris County (3)	3,057,196	3,655,949	4,246,284	4,648,048	5,008,047	-	-	63.8 (5)
Houston SMSA (4)	3,691,741	4,321,813	5,080,378	6,012,449	6,737,796	7,551,515	8,240,301	123.2
Projection to be Used for Base Case Analysis	1,603,524	1,796,943	2,030,820	2,342,906	2,528,380	2,761,854	3,016,887	88.1
Projection to be Used for Comparison	2,818,199	3,217,689	3,707,869	4,315,000	4,667,749	5,109,533	5,404,722	91.8

The population of the City of Houston as of April 1, 1990 according to the Census Bureau (as cited by Mr. John Young, City of Houston Planning Department) is 1,630,553.

(1) from TWDB Draft 1996 Consensus Texas Water Plan Projections of Population and Municipal Water Use

(2) from the City of Houston Planning Department (September 1995)

(3) from Houston Water Recommended Plan, Appendix D - Population and Growth Projections, Metcalf & Eddy (May 1986)

(4) from Trans-Texas Water Program Draft Planning Information Update

(4) Houston SMSA (Standard Metropolitan Statistical Area) consists of all or portions of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties

(5) Calculated for 1990 - 2030 only

The population projections presented in these references do not include population increases due to land annexations by the City. The projections are based solely on net migration, births, and deaths. Based on this information and the growth rate for the City of Houston projected by the TWDB, it is assumed that the City will continue to serve the populace within the City limits through the year 2050. However, the service

area may someday extend outwards into portions of Harris County and possibly encompass the entire Harris County area due to future annexations

Two water demand projections were calculated. The first was based on population projections for the City of Houston, as provided by the TWDB. The second water demand projection was based on the Harris County population projections provided by the same agency. The population projections provided by the TWDB were used as the basis to determine the water demand projections for both scenarios because the population projections extend to the year 2050. The City limits population was used as the basis for analysis and the County population will be used for comparison.

(5) Review of Water Demands

Combined single-family and multifamily categories have by far the highest total use, amounting to approximately 53 percent of retail water sales. The next highest category is commercial use, at 21 percent of billed retail sales. The remainder consists primarily of lawn meter, municipal, and institutional accounts.

Water demands increase in the summer due primarily to landscape irrigation. Overall, 16 percent of the billed water use occurs outdoors. The single-family category has the highest contribution to peak demands, 18 percent annually of all water used for exterior purposes. The variation is more extreme in monthly water use; single-family customers use, on average, about 175 gpd/account in the winter and up to 250 gpd/account in the peak summer months. The daily basis variation would certainly be even more extreme, but this data by customer class is not available. It is these peak demands that determine the sizing of capital facilities. If conservation can reduce the peak demands, capital facilities can be either smaller or deferred in time.

(6) Wastewater Treatment

As Houston progresses toward full treatment of domestic as well as commercial and industrial wastewater, there will be benefits realized through a reduction in water consumption and the resulting generation of wastewater volume. This is particularly significant in Houston, because a relatively high proportion of water is used indoors and converted to wastewater.

The City has completed a large wastewater treatment expansion project. Present capacity is sufficient for the foreseeable future. Operating costs of these new and expanded plants can be reduced if water conservation leads to processing less wastewater flow. It is estimated that conservation at a 10 percent level would delay the need for expansion of wastewater treatment capacity during the planning period.

(B) Specification of conservation goal(s) including but not limited to municipal per capita water use goals, the basis for the development of such goals, and a time frame for achieving the specified goals.

The recommenced programs are expected to reduce water demand in the City by 21.9 mgd or 7.3 percent of retail water production by the year 2006. The leak detection program to reduce UAW accounts for approximately 50 percent of the reduction and water savings from programmatic conservation (programs other than unaccounted-for water reductions) are about half the total or 10.43 mgd (3.7 percent).

The per-account usage rates are based on historical consumption and include only the impact of conservation measures in place as of mid-1995. Projecting these rates into future years provides the base volume for analyzing conservation opportunities and for measuring performance after the measures have been put in place.

The City of Houston and Harris County are growing at an average rate of 1.5 to 2 percent per year. The Texas Water Development Board forecasts an 88 percent increase in population between 1990 and the end of the planning period, 2050. These forecasts ignore the effect of annexations, which have been a major source of growth for the City. Water use and population are projected to increase at the rate of 88 percent by the year 2050. Total average annual billed water use is forecast to rise from 225 mgd in 1994 to 405 mgd by the year 2050. Therefore, water conservation programs for this period must be designed for both existing and future customers.

Water use patterns in the commercial/industrial sector are difficult to determine from billing data, prior studies, or published literature. In the City's case much of the heavy industry is served untreated water by contract. Nearly all of the refineries and chemical plants along the Houston Ship Canal are served in this manner.

(C) Metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply

All water sold to City retail customers is metered. City meters are calibrated to an accuracy of plus or minus five percent. The City maintains a program to pull, test, and replace any meters determined to be functioning outside these parameters.

(D) A program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement

The City maintains a program of universal metering of both retail customers and public uses of water which includes testing and repair, and periodic meter replacement.

(E) Measures to determine and control unaccounted-for uses of water. (For example, visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections, abandoned services, etc.

Some system water losses, or unaccounted-for water (UAW), are authorized. Authorized losses include flushing hydrants by fire departments, and water use in unmetered water treatment facilities. These uses are estimated and reported to Utility Customer Service for inclusion in a monthly report to track and identify "lost" water. The remainder of UAW is caused by leaks. The purpose of this program is to reduce leaks from older systems and from broken pipes, joints, or valves. Up to 40 percent of all UAW can be attributed to leaks. For example, if the UAW is greater than 10 percent of total production, then the leakage could be 4 percent, and the COH may find a leak-detection and repair program beneficial. Lower UAW levels usually indicate that leak-detection and repair would not be cost-effective. For the COH service area, leak-detection and repair of water lines is very effective. The following annual averages of UAW have been achieved by the City:

- FY 1991 - 19.5 percent
- FY1992 - 18.3 percent
- FY 1993 - 16.8 percent
- FY 1994 - 17.3 percent
- FY 1995 - 14.3 percent
- FY 1996 - 14.4 percent
- FY 1997 - 13.9 percent

Although the average has been around 17 percent, there is a definite downward trend and the difference between the average in 1991 and the average in 1995 is a decrease of 5 percent. A realistic goal is 10 percent and a realistic time period to achieve this goal is ten years. This goal allows twice as long to achieve the next five percent as it took to achieve the first five percent.

(F) A program of continuing public education and information regarding water conservation

This measure serves as the "glue" to tie all the other measures together. It would not only address specific measures but also cultural/social aspects of establishing or enhancing a water conservation ethic among the COH customers; most importantly, it would convey to the public an understanding of why water conservation is important. Recommended programs include school programs involving theatrical productions, poster contests, T-shirt design contests, presentations and tours with hands-on demonstrations; radio and television time, and printed educational material such as bill inserts. Public education would continue to be used to raise awareness of other conservation measures available to COH customers.

A full-time public information specialist and a school education coordinator would devote most of their time to public education and to implementing a school program throughout the service area. Additional staff may be involved in helping by educating the public through a

speakers bureau, tours producing bill inserts, creating displays at fairs and nurseries, giving presentations, and creating low water-use gardens

A public information and school education program needs goals, staff, and materials. Currently the COH has one person devoted to these programs. It is recommended that that effort be expanded to increase the market penetration of the existing programs. The following steps could be used to add new programs:

The expanded program would target all customers within the COH service areas. The coordinator would develop the program following the steps listed above. Once the statement of purpose has been created, a water conservation theme would be decided upon. This could be based on the results of this study which will identify where most of the conservation benefits will come from.

To convey the importance of water conservation to customers, the program should seek to explain why construction of water facilities may be necessary if water conservation is not practiced, how much these facilities would cost, and then compare these costs to what benefits can be received from conserving water. Public information would be used to promote the other selected conservation programs as well.

The various media forms including bill inserts, ads, and television and radio spots would be used to instill a conservation ethic in the community. The specific material should compliment the other programs such as free audit programs to inform customers how to take advantage of existing conservation programs. For example, a spring bill insert could publicize the availability of irrigation audits to qualified customers (larger water users). Low water use landscaping should be promoted through demonstration gardens and brochures, developed as part of a public education program.

Another recommended expansion of this program is to offer an employee education program for Houston area businesses. This could be done in conjunction with a commercial/industrial water audit program or independently. The education program would teach employees how to spot water waste and about simple, low cost methods to save water. This would complement and give water audits more staying power. The employee education program could be done with focused technical seminars and site visits with presentations, training videos, meetings, site surveys etc.

School Education

Long-term results to eliminate wasteful water-use habits are best achieved by educating young people. Teaching children to respect the value of water will help them grow into responsible adults with a conservation ethic.

Currently, the Water Conservation group sponsors presentations to schools throughout its service area. Last year 250 presentations were given reaching about 2,200 students per month. Pre- and post-presentation surveys are done to gauge effectiveness.

(G) *A water rate structure which is not "promotional"; i.e., a rate structure which is cost-based and which does not encourage the excessive use of water*

The existing CCH rate structure includes inclining blocks and single unit rates for both water and sewer pricing. Sewer pricing is based on total water use. In general these rates structure are cost-based and are not promotional. Traditional objectives in rate structure design include that the rates be based on the costs to serve, that they provide adequate and stable revenues, that they be fair or equitable among customers classes and volume users, and that they be easy to implement and administer. Conservation pricing makes the most sense as part of a broad demand management program.

A single unit rate structure charges the same unit rate for all volume used, usually for all customer classes, but sometimes with a different rate for each customer class. This rate structure has gained in popularity over the traditional declining-block rate structure because of the intuitive appeal of all customers paying the same price for all water use, and the elimination of the perceived unfairness of large water users paying lower rates for high volume under the declining-block rate structures. The uniform volume rate structure is generally accompanied by a fixed monthly service charge, by meter size, that recovers customer costs unrelated to water volume.

Marginal cost or incremental costs of new supplies or of the next increment of treatment facilities are sometimes used as the basis for seasonal or inclining block rates applied year-round. The rationale is to charge existing customers the unit cost of the next increment of supply so that their decision to use or not use their next increment of water is based on the cost of incremental supply. But if there were no account growth or increase in usage within the existing number of accounts, there would be no need for the next increment. Therefore, the existing customers of many utilities believe that incremental water supplies should be paid for, in connection or capacity charges, by future customers since they necessitate the requirement. Since marginal cost pricing is not based on current costs, excess revenues will accrue that must be applied to reductions in the service charge, to off-season rates, or to funds for financing incremental supply facilities. All of these alternative uses of excess revenues must be evaluated for this alternative in achieving fairness in rate structure design and revenue neutrality.

A seasonal rate structure is implemented for water consumed during a utility's peak-use season, either as a means of recovering the incremental cost of providing water during this period or as an inducement to conserve water because of inadequate or constrained supply. Seasonal rate structures can be constructed to apply either summer charges or a tiered rate structure. A summer surcharge could be applied to all summer volume or to summer volume in excess of winter volume. Most water economists prefer using a surcharge on

summer use in excess of winter (indoor) use because the incremental cost of supply can be used as a basis for the rate blocks and the difference in rate blocks can be high enough to induce a consumption response without generating major excess revenues.

Inclining block rates, or tiered block rates, use two or more rate blocks with increasing unit rates as consumption increases from one block to the next. This structure can be applied during the summer only or during the entire year. Depending on the volume breakpoints of the blocks and the number of blocks, the upper blocks will rarely be applied in the off-season. Some utilities try to set each block rate at the cost of peaking or at the cost of each new increment of supply. If the rate blocks are mostly judgmental, the rate structure should be viewed simply as a conservation rate structure which does not require a strict cost-of-service justification. Determination of the number of blocks, price break points, and rate differentials between blocks requires careful analysis that addresses the patterns of use by blocks, the desired effect on consumption, and the impacts on total revenues.

(H) Emergency management plan which includes:

1. *Education and information program concerning the emergency plan*
2. *Notification procedures to identify initiation and termination of the emergency and the corresponding implementation and termination of the emergency measures*
3. *Trigger conditions*
4. *Emergency water-use measures corresponding to each trigger condition*

See Appendix A.

(I) Reservoir systems operations plan, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies

See Appendix B.

(J) A means of implementation and enforcement which shall be evidenced by:

1. *A copy of the ordinance, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and*
2. *A description of the authority by which the water supplier will implement and enforce the conservation plan.*

(II) Additional content requirements. Water conservation plans for municipal uses by public drinking water suppliers serving a current population of 5000 or more and/or a projected population of 500 or more within the next ten years subsequent to the effective date of the plan shall include the following elements:

(A) A program of leak detection, repair, and water loss accounting for the transmission, delivery, and distribution system in order to control unaccounted-for uses of water.

The City of Houston maintains a program to track the water transmission, delivery and distribution system in order to control unaccounted-for uses of water. Information in the monthly report includes: total water pumped, water sold to retail customers, amount of surface water sold, amount of water billed to General Fund departments, water lost, and unaccounted-for water.

(B) A record management system to record water pumped, water delivery water sales and water losses and which allows for the desegregation of water sales and uses into the following user classes; (I) residential,(ii) commercial, and (iv) industrial

The City of Houston maintains a very complex computerized system to break down water sales and water losses and to allow for the desegregation of water sales and uses into more than 70 user classes as shown in the following chart.

City of Houston - Water System
Summary of Accounts by User Code - Average Month, 1994

User Code	Description	Number of Accounts	% of Total Retail
	Single Family Residential:		
01	Residential	310,874	41.5%
02	Senior Citizens	12,061	1.6%
03	Public Works Employees	258	0.0%
	Multi-family Residential:		
14	2 Unit Dwellings	9,388	1.3%
15	3 Unit Dwellings	2,984	0.4%
16	4 Unit Dwellings	6,348	0.8%
17	Condos/Townhouses	23,471	3.1%
18	Apartments	339,009	45.2%
19	Trailer Parks	2,315	0.3%
	Commercial Accounts		
21	One Commercial Unit Structures	28,124	3.8%
22	1 Commercial, 1 Family	98	0.0%
23	2 Commercial Units	59	0.0%
24	3 Commercial Units	31	0.0%
25	Strip Shopping Center	126	0.0%
26	Shopping Center	59	0.0%
27	Hotel/Motel	285	0.0%
28	Office/Bank Buildings	778	0.1%
29	Restaurant or Bakeries	2,329	0.3%
30	Industrial Laundry	15	0.0%
31	Laundry Retail	175	0.0%
32	Laundromat	219	0.0%
33	Plater	24	0.0%
34	Mortuary	74	0.0%
35	Car Wash	229	0.0%
36	Service Station/Auto Repair	1,427	0.2%
62	Effluent Only (Cycle 50)	74	0.0%

City of Houston - Water System
Summary of Accounts by User Code - Average Month, 1994

User Code	Description	Number of Accounts	% of Total Retail
	Commercial Accounts (continued)		
71	Construction Meter	344	0.0%
73	Resale Accounts	7	0.0%
74	Emergency	10	0.0%
72	Lawn Meter Accounts	3,485	0.5%
	Municipal & Institutional		
37	Private Schools	56	0.0%
39	Hospitals	122	0.0%
50	Churches	1,868	0.2%
51	City (General Fund)	1,524	0.2%
52	City (Enterprise Fund)	83	0.0%
53	City/County Government (Billed)	122	0.0%
54	State Government	33	0.0%
55	Federal Government	82	0.0%
56	Public Schools	416	0.1%
57	State Colleges	72	0.0%
60	City (Public Utilities)	123	0.0%
	SUBTOTAL	**749,218**	**100.0%**
	Industrial Accounts	**293**	**0.0%**
	TOTAL RETAIL	**749,511**	**100.0%**

(C) A requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter; if the customer intends to resell the water, then the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with applicable provisions of this chapter

In 1994 the City developed a new model contract for raw water contract customer which includes three conservation-oriented requirements:

1. Contract customers are required to prepare and submit a water conservation plan which meets all requirements of the TNRCC rule.
2. Water rates are no longer based on a "take-or-pay" rate structure.
3. Contract rates are based on a uniform block rate structure which is cost-based.
4. A penalty is added if the contract customer uses an excessive amount more than their normal average for that calendar month (based on usage in previous years' usage).

*(III) **Additional conservation strategies. Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements above, if they are necessary to achieve the stated water conservation goals of the plan. The commission may require that any of the following strategies be implemented by the water supplier if the commission determines that the strategy is necessary to achieve the goals of the water conservation plan:***

*(A) **conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;***

See Minimum Requirements

*(B) **adoption of ordinances, plumbing codes and/or rules requiring water conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;***

See *The Uniform Plumbing Code as Adopted by the City of Houston*

*(C) **a program for the replacement or retrofit of water conserving plumbing fixtures and existing structures undergoing substantial modification or addition;***

See *The Uniform Plumbing Code as Adopted by the City of Houston*

(D) reuse and/or recycling of wastewater and/or greywater;

In May 1992 a study was conducted by Espey, Huston & Associates for the City entitled, "Feasibility of Wastewater Reuse." The study was submitted in fulfillment of Chapter 31 Texas Administrative Code (TAC) Section 305.126 the possibility of substituting reclaimed water for potable water and/or freshwater where such substitution would be both appropriate and cost effective. The result of the preliminary benefit-cost analysis was that "none of the plans was considered economically justifiable at this time." However, the report did recommend that the City should "expeditiously move to replace potable water now used for golf course irrigation with water from adjacent bayous."

The City recently contracted with Espey, Huston & Associates to conduct a follow up study on the feasibility of converting Memorial Park Golf course from using potable water to using bayou water. The findings of the study are supportive of the conversion. The City intends to go forward with conversion of the Memorial Park Golf course irrigation system from potable to bayou water. Other City golf courses are also being considered for such conversion projects. Where feasible, they will also be converted.

(E) a program for pressure control and/or reduction in the distribution system and/or for customer connections;

The City of Houston utilizes 87 pressure reducing valves (PRV's) throughout its water distribution system in an effort to control excessively high pressures. In order to achieve this, these valves can be used separately or in combination. For example, one valve can be used to maintain a constant downstream pressure while another upstream can hold a predetermined minimum pressure, regardless of system demand. The flow in a PRV is controlled by the pressure downstream of it. A spring-loaded diaphragm regulates the size of the opening in the valve. As the downstream pressure increases, the pressure against the diaphragm is increased. The spring forces the diaphragm against the valve seat, thereby restricting the flow through the valve and reducing downstream pressure. Conversely, as the downstream pressure decreases, the diaphragm moves away from the seat and allows water to pass through. Desired system pressures are thus maintained.

(F) a program and/or ordinance(s) for landscape water management;

See Recommended Plan below.

(G) a method for monitoring the effectiveness and efficiency of the water conservation plan;

The effectiveness and efficiency of the performance of each of the conservation programs will be monitored on an on-going basis by conservation staff using a water forecasting software, WaterPlan 2.0 (or comparable software). WaterPlan is a software package which was developed by the American Water Works Association Research Foundation and was used to analyze the City's water, population, and cost data in developing benefit-cost ratios of the recommended programs below

(H) other water conservation practice, method or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

RECOMMENDED PROGRAMS

In order to achieve the specified goals as stated in the "Minimum Requirements, Section ," the following current and additional programs are proposed. These recommended programs include residential and commercial/industrial programs, and programs targeted at public buildings and facilities. The implementation of these programs will be staggered over a five year period with one or more new programs being initiated each year. A list of the programs, water savings, and the associated benefit-cost ratios of each program included in the recommended plan is detailed in the table below. Recommended programs will be implemented by FY2002. Water savings attributable to these programs would increase to 22 mgd of water production by the year 2006 and retail water production would be reduced about 7 percent. The following criteria were used in determining which programs should be implemented.

- Benefit-cost ratio greater than 1.0 (i.e., the program must save more than it cost to implement)
- Reasonable cost (i.e., affordable)
- Significant water savings
- Acceptable non-quantifiable impacts

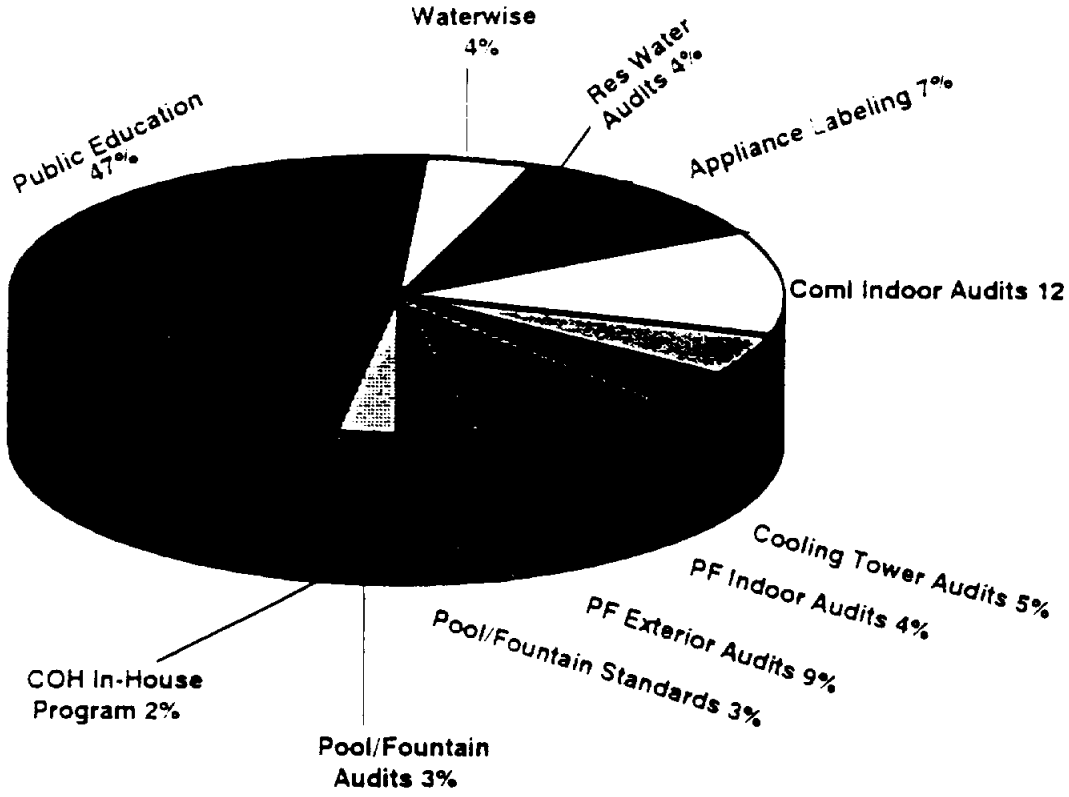
Recommended Programs

Sector	Program	Element	50 Year Avg Water Savings mgd	Water Savings In 2001 mgd	Benefit-Cost Ratio (50 years)
Residential					
	Res Water Audits		0.42	0.18	1.00
	Appliance Labeling		0.71	0.06	21.70
		Subtotal	1.13	0.24	
Commercial					
	Indoor Audits		1.17	0.49	2.23
	Cooling Tower Audits		0.48	0.30	18.60
		Subtotal	1.65	0.79	
Public					
	Indoor Audits		0.36	0.30	3.03
	Exterior Audits		0.86	0.72	10.80
	Pool/Fountain Audits	COH	0.28	0.17	6.26
	Pool/Fountain Standards		0.25	0.04	4.32
	COH In-House Program		0.2	0.20	54.80
		Subtotal	1.95	1.43	
Other					
	Unaccounted-for Water		11.65	6.40	6.28
	Public Education		4.51	3.62	1.78
	Water Wise & Energy Efficient		0.42	0.41	3.68
		Subtotal	16.58	10.43	
		Total	21.31	12.89	3.69

Impact of the Recommended Programs on Revenue

With increased population in the Houston area, and the resulting increased total water demand, the total revenue will continue to increase. The amount of increase will be slightly less (approximately 1.5 percent less over the next ten years) with conservation than without.

Benefits from the recommended programs include capital deferrals such as delaying water purification



plant expansions 2 to 8 years, and delayed and reduced O&M costs. The recommended programs would provide benefits at the rate of $1.14 per 1000 gallons saved for deferred capital and deferred O&M. An additional $0.27 per 1000 gallons saved would result from producing less water (lower O&M). The total benefit from the recommended plan is $1.41 per 1000 gallons saved. These benefits add up to a significant amount over the study period. The present worth of the total benefits of the recommended plan is approximately $262 million. The plan has an overall benefit-cost ratio of 3.7 to 1, which is very cost-effective. This means that by implementing such a conservation plan, the City of Houston would receive a return of about $3.70 for every $1.00 invested in water conservation.

DESCRIPTION OF PROGRAMS INCLUDED IN THE RECOMMENDED PLAN

Residential Water Audits

The City of Houston (COH) would offer an indoor and outdoor water audit to existing single-family and multifamily residential customers with high water use. Audits should target the top 25 percent of water users to ensure significant water savings. It is important to target high water users otherwise the audit may not produce the savings needed to justify the program. The auditors would focus most on outdoor water use, identifying water waste, offering information to improve water use efficiency, and preparing a customized lawn irrigation schedule. Auditors would also conduct a brief indoor audit and install low-cost conservation devices such as low-flow showerheads. Each single-family audit would take approximately one and one-half hours; multifamily audits would take longer, depending upon the building size and the complexity of the irrigation system.

Appliance Labeling

An appliance labeling program is intended to encourage residential customers to purchase water-efficient washing machines and dishwashers. The program provides customers with point-of-purchase information, including an equipment tag, similar to the Appliance Energy Efficiency programs operated by electric utilities. Efficient appliances receive a distinguishing label so they stand out on the retail sales floor. The tag also shows how each appliance compares with others in its category. The program targets all residential customers who are likely to purchase new appliances in the near future, and major vendors/dealers.

Horizontal-axis clothes washers are more water-efficient than conventional vertical-axis top-loading models. Rather than agitate clothes in a tub full of water, as with vertical-axis machines, the horizontal-axis washer lifts clothes up and plunges them down (like a dryer), tumbling clothes in a small amount of water. Horizontal-axis washers can be either top loading or front loading. They are 33 percent more water-efficient on the basis of water used per pound of laundry washed.

Dishwashers currently sold use about 12 gallons of water per completed cycle. Older models use about 14 gallons per cycle. Water-efficient, domestic models are available that use 7.5 gallons per cycle. *Consumer Reports* rates several models of these water-efficient dishwashers highly. The water savings also result in energy savings because these water-efficient models use less hot water.

Commercial/Industrial Indoor Water Audits

This conservation audit targets existing commercial and industrial customers. The top 10 percent of water users in this class would be offered a free interior audit and periodic follow-up to encourage customer implementation of audit findings. Incentives could be offered in a related program. Site-specific audits are an efficient way to lower water use in this category, since industrial customers

usually use more water per account than any other customer category. This audit would be repeated every five years.

An interior audit would be conducted by COH staff or a consultant. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture inspections, leak tests, retrofit possibilities, cooling tower operation and improvements, process water improvements, and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. The participant's actions and water use would be tracked over time. Standards would be based on previous experience and the performance of the latest technology.

The audit report would consider, when appropriate, the following measures:

- Change from water-cooled to air-cooled equipment;
- Change from one-pass to recirculating cooling and heating systems;
- Improve industrial and commercial washers and rinsers;
- Install solenoid and automatic control valves;
- Analyze whether recycling industrial water and separating waste streams are feasible; and
- Determine placement of submeters.

Cooling Tower Water Audits

This conservation audit targets existing commercial and industrial customers. It is similar to the commercial/industrial interior audit program except that it just focuses on cooling towers. Cooling towers consume large amounts of water, depending upon the climate and the efficiency of the unit. Assuming that the largest water users have cooling towers, the top 10 percent of water users in this class would be offered a free interior audit and periodic follow-up to encourage customer implementation of audit findings. Incentives could be offered in a related program. It is estimated that there are approximately 1,000 commercial/industrial cooling towers in Houston.

The purpose of the audit would be to measure the existing number of cycles of concentration (ratio of makeup to bleed water) and suggest improvements in operations, such as the addition of a chemical feed system, to increase the cycles of concentration. The goal of the program would be to raise those sites with less than three cycles of concentration to 5-8 cycles. This audit would be repeated every five years to maintain or improve the conservation level.

The cooling tower audit would be conducted by COH staff or a consultant. The auditor would perform an on-site inspection and produce a customized report that describes system inspections, leak tests, retrofit possibilities, operation changes and improvements, and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. Standards would be based on previous experience and the performance of the latest technology. If the cooling tower is not separately metered and water use is significant and appears to be

efficient placement of submeters would be suggested. The participant's actions and water use would be tracked over time.

Public Facility Interior & Exterior Water Audits

This measure is designed to reduce interior and peak demand by improving indoor water use and outdoor irrigation efficiency. All public buildings and irrigators of landscapes larger than three acres are candidates for this measure. The participants would receive a two-part audit. The first part would focus on indoor water use and would be similar to the commercial/industrial indoor audit, emphasizing the water used in sanitary fixtures likely to be present in city buildings. The second part would instruct landscape site managers to:

- Learn the targeted site's current irrigation efficiency,
- Be advised of available low-cost hardware improvements,
- Receive baseline irrigation schedules,
- Receive instructions about how to modify the schedules according to
- weather changes, and
- Receive water savings information.

Pools and fountains would be excluded from this program if they are covered in another program. Follow-up audits would be provided once every three years. Site building and landscape managers would be responsible for implementing audit findings.

The COH has a program to audit large turf areas owned by the City. The audits recommended a lower water application rate at all City golf courses. The average reduction at City golf courses was 55% compared to annual use. Sharpstown was able to reduce use 41 percent, which shows an 80 percent compliance rate with the recommended schedule. There is a very good potential for this sort of program.

Public Fountain/Pool Water Audit and Repair

This conservation audit targets all publicly owned fountains and pools. There are an estimated 60 public fountains and 260 public pools in the COH service area under the category of municipal and institutional account. This includes the 24 fountains and 44 pools that are city-owned and operated. The qualifying public facility owners/managers would be offered a free fountain/pool audit and periodic follow-up to encourage implementation of audit findings. Incentives could be offered to speed up the repair process.

An interior audit would be conducted by COH staff. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture and valve inspections, leak tests, retrofit possibilities, fountain/pool cleaning and backwashing operation and improvements, and recycling opportunities for each site. A leak test by a private contractor would be provided if warranted. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. The participant's actions and water use would be tracked over time. Standards would be based on previous experience and the performance of the latest technology.

The audit report would consider, when appropriate, the following measures:

- Changes in operation including cleaning and backwashing;
- Leak detection and repair
- Replacement of recirculation pump
- Install solenoid and automatic float (overflow) valves;
- Analyze whether recycling water and separating waste streams are feasible; and
- Determine placement of submeters.

Standards for New Fountains/Pools

This conservation measure targets all new publicly owned fountains and pools. There are an estimated 260 public fountains and 60 public pools in the COH service area. The plans for new fountains/pools would be reviewed to make sure that the equipment is up to state-of-the-art in terms of water efficiency.

A plan review of new facilities would be conducted by COH staff and conveyed to the facility designer. The plan checker would look for the following features: low flow showerheads, ULF toilets, self-closing faucets, dead man switches for hoses, and secured float valves at swimming pools, and re-circulation pumps at pools and fountains. Other features would be compared with existing conservation standards and potentials. Standards would be based on previous experience and the performance of the latest technology.

The COH would develop operations manuals for ensuring proper operation of new equipment. Included would be sections on pool/fountain cleaning procedures, chemical water treatment, filter backwash frequency criteria, pool/fountain emptying and refilling criteria. Guidelines for water use would be developed in terms of a water budget that would be provided to each facility manager. The manual would be loose leaf and a binder would be prepared and given to each new owner/operator. Training seminars for existing maintenance staff would be conducted periodically. The COH would set up a water use tracking system for all new accounts where pools and fountains are separately metered. Installing separate meters would be encouraged and required for large pools. Site visits to new installations would be made for suspected high water users and on-site advice offered.

City of Houston In-House Program

This program targets all City departments that are not now charged for water. Although most City accounts are metered, current City policy is to bill only those departments that are a revenue-supported enterprise. Enterprise departments collect fees, charges or other non-tax revenues. All departments are currently billed for sewer service. However, departments that are not enterprise are not billed for water. Under this new program, a monthly "water statement" would be produced and distributed to each department. A goal of 10% to 20% reduction in water usage would also be imposed for each department.

The goal would be determined by the Water Conservation Branch based on the department s water usage and work responsibilities.

The current policy of not charging for water has led to wasteful practices by those departments. The Parks department uses about 30 percent of water used by this group of departments. Each City department would be given a goal of a 20 percent water use reduction.

COMBINED BENEFITS OF RECOMMENDED PROGRAMS

Implementation of the above programs , will defer all raw water treatment, and major treated water pumping programs. Because it is expected that the City will complete the distribution network as quickly as possible to provide surface water to all consumers, it is not anticipated that water conservation will defer expenditure on the distribution system. The lower consumption gained by water conservation will allow those additional consumers to be served without the development of additional raw water, treatment, and pumping facilities

The benefits from conservation include both current savings in operations and maintenance (O&M) costs and savings from the deferral and/or cancellation of capital projects that would otherwise have been necessary in the absence of conservation. Since new capital projects will require O&M, there are additional benefits from the capital deferrals.

Operations and Maintenance Savings

Short term savings from operating existing facilities can be realized as a result of conservation. While many costs associated with operation and maintenance of a water system are fixed and will not vary with the level of consumption or production, other costs remain that are directly related to the level of production. For example, energy costs and chemical costs are frequently directly related to production levels. O&M savings from conservation were $0.268 (i.e., marginal cost) per 1000 gallons. (Bishop and Weber, "Impacts of Demand Reduction on Water Utilities", AWWARF, 1996).

Capital Savings

The City of Houston is currently in the process of defining its future capital requirements to reduce its groundwater usage and meet future production requirements through surface water supplies. Therefore, capital savings have been estimated by comparing existing treatment plant capacity with the capacity that would be required over the period of this plan (through 2050). Based on water demand projections, adjusted for expected demand reductions from long-term implementation of plumbing code requirements for water conserving toilets, urinals, faucets, and showerheads, the need for additional capacity was estimated, assuming that treatment capacity would be added in 50 mgd increments. Capital costs were estimated based on $1.5 million per mgd of capacity.

Major pumping costs planned over the next 50 years are included in the above figures. Marginal costs for capital were initially estimated based upon the impact of a one-year delay in each of capital increments.

Appendix "A"

CITY OF HOUSTON
WATER EMERGENCY RESPONSE PLAN

July 13, 1998

TABLE OF CONTENTS

I DEFINITION OF TERMS

1) Water shall mean water contained in or flowing through any portion of the City's water system.

2) To discharge water shall mean to allow, permit or cause treated water to be released through a sprinkler, faucet, hose or similar pressurized source.

3) Gross Quantity means the total quantity of water delivered to a customer during a month.

4) Average Gross Quantity applicable to an individual customer means the monthly average gross quantity of water delivered to a customer during the twelve (12) months immediately preceding the monthly billing cycle in which a critical or serious water shortage period begins.

5) a Target usage during a critical water shortage period shall mean an amount equal to seventy percent (70%) of the average gross quantity

b Target usage during a serious water shortage period shall mean an amount equal to eighty percent (80%) of the average gross quantity.

6) Average production shall mean the City's average combined surface water and groundwater production during a three (3) day period.

7) Combined reservoir storage supply shall mean the combined storage quantity of water stored at a point in time in Lake Houston, Lake Conroe and Lake Livingston (City share of storage only).

8) Average water pressure shall mean the average pressure within the City's water distribution system based on the average twenty-four (24) hour pressure reading at representative pressure points.

9) Customer means any person receiving treated water service from the City's water system and for whom (or for which) a meter has been installed. A person served by more than one meter is considered a separate customer for each meter.

10) Conservation Surcharge means the amount added to the customer's bill to encourage conservation. The surcharge is equal to the percentage of the customer's bill which is equal to the percent difference between the gross quantity and the target quantity as defined in this ordinance.

Example: If the customer's average gross quantity for the month in question is twelve thousand (12,000) gallons and the target quantity is ten thousand (10,000) gallons, the conservation surcharge would be equal to twenty percent (20%) of the customer's bill. (12,000 - 10,000 = 2,000
2,000 / 10,000 = 20%)

Appendix "A"

CITY OF HOUSTON
WATER EMERGENCY RESPONSE PLAN

July 15, 1998

TABLE OF CONTENTS

I DEFINITION OF TERMS

1) Water shall mean water contained in or flowing through any portion of the City's water system.

2) To Discharge Water shall mean to allow, permit or cause treated water to be released through a sprinkler, faucet, hose or similar pressurized source.

3) Gross Quantity means the total quantity of water delivered to a customer during a month.

4) Average Gross Quantity applicable to an individual customer means the monthly average gross quantity of water delivered to a customer during the twelve (12) months immediately preceding the monthly billing cycle in which a critical or serious water shortage period begins.

5) a Target usage during a critical water shortage period shall mean an amount equal to seventy percent (70%) of the average gross quantity

b Target usage during a serious water shortage period shall mean an amount equal to eighty percent (80%) of the average gross quantity.

6) Average Production shall mean the City's daily average combined surface water and groundwater production during a three (3) day period.

7) Combined Reservoir Storage Supply shall mean the combined storage quantity of water stored at a point in time in Lake Houston, Lake Conroe and Lake Livingston (City share of storage only).

8) Average Water Pressure shall mean the average pressure within the City's water distribution system based on the average twenty-four (24) hour pressure reading at representative pressure points.

9) Customer means any person receiving treated water service from the City's water system and for whom (or for which) a meter has been installed. A person served by more than one meter is considered a separate customer for each meter.

10) Conservation Surcharge means the amount added to the customer's bill to encourage conservation. The surcharge is equal to the percentage of the customer's bill which is equal to the percent difference between the gross quantity and the target quantity as defined in this ordinance.

Example: If the customer's average gross quantity for the month in question is twelve thousand (12,000) gallons and the target quantity is ten thousand (10,000) gallons, the conservation surcharge would be equal to twenty percent (20%) of the customer's bill. (12,000 - 10,000 = 2,000
2,000 / 10,000 = 20%)

CITY OF HOUSTON

WATER EMERGENCY RESPONSE PLAN

PURPOSE:

The purpose of the Water Emergency Response Plan is to establish policies and procedures for the City of Houston to follow in case of a water shortage emergency.

A water shortage emergency, caused by drought or other uncontrollable circumstances which hinder the City's ability to meet water demand, can range from mild to critical and can disrupt the normal availability of water supplies. Therefore, it is important that the City of Houston establish these policies and procedures so that guidelines exist in the event that a water shortage emergency occurs.

II IDENTIFY EXISTING WATER SUPPLY SYSTEM:

Introduction

The City of Houston's water supply includes both surface water and groundwater resources. The City controls water rights in both the San Jacinto River System (Lake Houston and Lake Conroe) and in the Trinity River System (Lake Livingston). The City also withdraws groundwater from the Chicot and Evangeline Aquifers. However, due to constraints imposed on the use of groundwater by the Harris-Galveston Coastal Subsidence District and contractual requirements for the release of surface water in order to control salt water intrusion in the Trinity River System during the summer months (May 15 to September 15), the City may not have access to all water

rights during specific time periods. Recent studies of the City's projected demand does indicate that the existing usable supply of both surface water and groundwater is adequate for the foreseeable future.

Even though it appears that the City will have an adequate water supply to meet demand for many years, short term problems may occur that could limit treatment capacity and/or the system's ability to deliver safe drinking water. Examples of such problems are:

* Drought conditions which can lead to unprecedented water consumption and severe depletion of fresh water supplies;
* Normal water demand increases which occur more rapidly than expected and exceed the safe capacity of the system;
* Contaminating floods or massive equipment failures.

Because the City's sources of water supply include both surface water and groundwater, the capacity and constraints of each system need to be identified. Presently the eastern half of the City is predominantly served by surface water while the western half is predominantly served by groundwater. The record maximum daily treated water Pumpage, to date, of four hundred and seventy-three million gallons (473 mgd) occurred on July 30, 1986. Of this total, three hundred and one million gallons (301 mgd) or sixty-four percent (64%) came from groundwater sources and the remaining one hundred and seventy-two million gallons (172 mgd) or thirty-six percent (36%) came from surface water sources.

Surface Water

Raw water is treated at the East Water Purification Plant Complex located on Federal Road at Clinton Drive in the eastern part of the City. This complex is composed of three conventional surface water purification plants. The City also has a fourth water treatment plant in Southeast Houston adjacent to Ellington Field.

Groundwater

The percentage of groundwater used by the City has decreased substantially in recent years due to the availability of surface water. This increased use of surface water is primarily in response to the need to control land subsidence within the Harris-Galveston County area.

The need to regulate the withdrawal of groundwater for subsidence control within Harris and Galveston Counties has resulted in the creation of the Harris-Galveston Coastal Subsidence District (HGCSD) by the 64th Legislature. HGCSD has subsequently (latest revision, April, 1992) issued a District Plan which limits groundwater pumpage.

The revised District Plan divides the Harris-Galveston County area into seven (7) regulatory areas. The amount of groundwater usage will be limited to either ten percent (10%) or twenty percent (20%), depending on the regulatory area, by the year 2020.

Conclusion

The major constraint the City faces is the difficulty of the City's water distribution system to meet peak demand due to a lack of balance in the water supply facilities. Specifically, this includes the development of the distribution facilities necessary to transfer surface water from its sources to consumers, and the limitations on groundwater pumpage as set out by Harris-Galveston Coastal Subsidence District Plan. Therefore, the constraints and limitations of both water supply sources must be considered when selecting the trigger conditions that signal a water shortage emergency situation.

Average water pressure within the City's treated water distribution system is forty-five pounds per square inch (45 psi) or less.

A Mild Water Shortage Period ends when the Director of Public Works has declared that the mild water shortage period has ended and has filed a written declaration to that effect with the City Secretary.

2) Serious Water Shortage Period

A Serious Water Shortage Period for all or part of the system will begin when the Mayor and the City Council finds that one or more of the following situations exist and declares it's existence by filing a written declaration to that effect with the City Secretary.

Combined reservoir storage supply is approximately eighteen (18) months surface water supply for a period of ten (10) consecutive days.

or

Average water production is eighty-five percent (85%) of the combined pumpage capacity for treated groundwater and surface water.

or

Average water pressure within the City's treated water distribution system is forty pounds per square inch (40 psi) or less.

A Serious Water Shortage Period ends when the Mayor and the City Council has declared that the serious water shortage period has

ended and has filed a written declaration to that effect with the City Secretary.

3) Critical Water Shortage Period

A Critical Water Shortage Period for all or part of the system will begin when the Mayor and the City Council finds that one or more of the following situations exist and declares it's existence by filing a written declaration to that effect with the City Secretary.

Combined reservoir storage supply is approximately twelve (12) months surface water supply for a period of ten (10) consecutive days.

or

Average water production is ninety percent (90%) of the combined pumpage capacity for treated groundwater and surface water.

or

Average water pressure within the City's distribution system is thirty-five pounds per square inch (35 psi) or below.

A Critical Water Shortage Period ends when the Mayor and the City Council has declared that the critical water shortage period has ended and has filed a written declaration to that effect with the City Secretary.

The permitted amount of groundwater withdrawal is based on the allowable annual pumpage as set by the Harris-Galveston Coastal Subsidence District (HGCSD). The HGCSD allows the City to utilize additional groundwater during peak water demand periods as long as

the City does not exceed the allowable annual pumpage. Should a water shortage period occur, the City will notify the HGCSD of the water shortage period and the possibility of exceeding the allowable groundwater withdrawal.

IV EMERGENCY MANAGEMENT PROGRAM

As the water shortage becomes more pronounced, the response to the shortage will become more drastic. The following programs are for mild, serious and critical water shortage periods.

1) Mild Water Shortage Period

During a mild water shortage period, the Director of Public Works shall institute a water emergency management information program to inform the public of voluntary measures to be taken to conserve water usage, including but not limited to:

a) Request that customers insulate water pipes rather than running water to keep the pipes from freezing.

b) Requesting that customers check for leaks, dripping faucets, running toilets and that customers utilize water conservation kits such as displacement bags, low flow shower heads and leak detector tablets.

c) Requesting voluntary reduction from major customers.

d) Instituting a water use reduction program by the City.

2) Serious Water Shortage Period

During a serious water shortage period, the following emergency management program shall be instituted by the City:

a If a billing cycle includes all or part of the serious water shortage period, a conservation surcharge will be added to the customer bill if the actual usage exceeds target usage as defined for a serious water shortage period. The formula for determining the conservation surcharge is:

CS = X(B)

Where:

CS = Conservation surcharge.

B = Customer's water bill.

X = Percent that customer has exceeded target usage.

Contract treated water customers, emergency back-up customers, transient meter customers and customers having a gross quantity three thousand (3,000) gallons or less in any monthly billing cycle are exempted from the customer surcharge for the monthly billing cycle.

During a serious water shortage period it shall be unlawful for any person to:

a) Cause or allow non-essential water use, such as: Street washing, flushing fire hydrants, watering parks, golf courses and esplanades, filling swimming pools and the operation of public and private decorative fountains.

b) Waste water by:

1) Permitting water from landscape irrigation to escape into gutters, ditches, streets, sidewalks or other surface drains.

2) Failure to repair a controllable leak on the customers premises

within twenty-four (24) hours of discovery.

3) Recreational use of faucets, hoses or hydrants.

The above restrictions shall not apply to the following water use activities:

1) To alleviate conditions threatening health, safety or welfare of the public.

2) For municipal operations of flushing water lines for public health purposes.

3) For the suppression of fires.

4) For municipal operations of wetting any surface for the purpose of testing for leaks in buildings or structures.

5) For municipal operations in wetting any surface for the purpose of complying with the air pollution laws of the United States of America.

6) For maintaining public gardens and arboretums of national, state or regional significance when necessary to preserve specimens.

7) For commercial businesses that use water to maintain (but not expand) their primary business practices (e.g. commercial car and truck washes, nurseries, turf growers, water haulers, concrete pavers, etc.)

8) For watering grass or plants which have been planted or transplanted on the same calendar day on which such discharges occur.

9) For watering plants (other then grass) if such discharge is accomplished through a water hose held at all times in a person's hand.

During a serious water shortage period, contract customers will be contacted and instructed to implement their own serious water shortage conservation plan.

3) Critical Water Shortage Period

During a critical water shortage period, the following emergency management program shall be instituted by the City.

a) If a billing cycle includes all or part of the critical water shortage period, a conservation surcharge will be added to the customer bill if the actual usage exceeds target usage as defined for a serious water shortage period. The formula for determining the conservation surcharge is:

ie: CS = X(B)

Where:

CS = Conservation surcharge.

B = Customer's water bill.

X = Percent that customer has exceeded target usage.

Contract treated water customers, emergency back-up customers, transient meter customers and customers having a gross quantity three thousand (3,000) gallons or less in any monthly billing cycle are exempted from the customer surcharge for the monthly billing cycle.

During a critical water shortage period it shall be unlawful for any person to:

a) Cause or allow any outdoor water use: or

b) Waste Water by:

1) Permitting water from landscape irrigation to escape into gutters, ditches, streets, sidewalks or other surface drains.

2) Failure to repair a controllable leak on the customers premises within twenty-four (24) hours of discovery.

3) Recreational use of faucets, hoses or hydrants.

The above restrictions shall not apply to the following water use activities.

1) To alleviate conditions threatening health, safety or welfare of the public.

2) For municipal operations of flushing water lines for public health purposes.

3) For the suppression of fires.

4) For municipal operations of wetting any surface for the purpose of testing for leaks in buildings or structures.

5) For municipal operations in wetting any surface for the purpose of complying with the air pollution laws of the United States of America.

6) For maintaining public gardens and arboretums of national, state or regional significance when necessary to preserve specimens.

7) For commercial businesses that use water to maintain (but not expand) their primary business practices (e.g. commercial car and truck washes, nurseries, turf growers, water haulers,

concrete pavers, etc)

During a critical water shortage period, contract customers will be contacted and instructed to implement their own critical water shortage conservation plan.

Should the critical water shortage period persist, the City may engage in rationing or terminating water service to selected portions of the distribution system according to the following order:

1) Public and private schools, colleges, universities and outdoor customers.
2) Contract customers, industrial customers, commercial customers and residential customers.
3) Public health and safety facilities.

V PROCEDURES

Notification

It is the responsibility of the Director of the Department of Public Works and Engineering to monitor the daily groundwater and surface water pumpage. The Director will also monitor the combined reservoir conservation storage in Lake Houston, Lake Conroe and Lake Livingston on a monthly basis. The Director will direct water production personnel to bring any decrease in water pressure to trigger levels to his/her immediate attention.

The Director of Public Works and Engineering shall notify the Mayor and the City Council when any one of the trigger conditions occurs. The Director shall also notify the Houston-Galveston Coastal Subsidence District (HGCSD) of any groundwater pumpage that exceeds the permitted amount during a water shortage period. During the

water shortage period the Director will continuously monitor water production, transmission line pressure and lake levels, and report this information to the Mayor and the City Council on a daily basis. Once the water shortage no longer exist, the Director will notify the Mayor and the City Council of this fact.

The Director of the Department of Public Works and Engineering will determine when a mild water shortage period exist and when the period no longer exist. A serious or critical water shortage period will begin and end when the Mayor files a written declaration to that effect with the City Secretary.

Notifying the public at an early stage is essential for the success of the Water Emergency Response Plan. Therefore, in order to ensure public awareness and understanding of the plan, pamphlets explaining the trigger conditions and the program for each stage of the water shortage period will be distributed to the public by the Public Works and Engineering Department if, in the opinion of the Mayor and the City Council, a water shortage period is eminent. The pamphlets will educate the public and provide guidelines for water use for each stage of the water shortage period.

In the event that any one of the trigger conditions occurs without warning, the Public Works Department and Engineering will provide the public with information explaining the trigger conditions and the program for each stage of the water shortage period through the news media (radio and television announcements and through the publication of articles in the local newspapers, handouts, bill inserts, mass mailings, etc.). The Public Works Department and Engineering will also provide the public with information on water conserving methods throughout the water shortage period.

Throughout the water shortage period, the Public Works and Engineering Department will keep the public informed regarding details of the water shortage period and on methods of water

conservation appropriate for the water shortage period through the news media.

Once the water shortage period has passed, the Public Works and Engineering Department will inform the public through television and radio announcements and through published notification in the local newspapers.

Appendix "B"

River and Reservoir System

The reservoir system covered by this operation plan is located on the San Jacinto River which forms approximately sixty (60) miles north of Houston. The river travels approximately twelve (12) miles, enjoining several small tributary streams, until it flows into Lake Conroe. The outflow of Lake Conroe becomes the West Fork of the San Jacinto River and travels approximately thirty-five (35) miles, being enhanced by several tributary streams, until it flows into Lake Houston which is located East of the City of Humble. In addition to the West Fork of the San Jacinto River, Lake Houston receives flow from the East Fork of the San Jacinto River, Caney Creek, Luce Bayou and several smaller tributary streams. The outflow of Lake Houston becomes the San Jacinto River and travels approximately ten (10) miles before emptying into Scott Bay and eventually into the Gulf of Mexico.

Lake Conroe

Lake Conroe was formed by a eleven thousand three hundred (11,300) foot long earth-filled dam including a controlled spillway and has a drainage area of approximately four hundred and forty-five (445) square miles. The lake was completed on September 1, 1972 and impoundment begin January 9, 1973. At maximum normal water level, the lake has a surface area of twenty-one thousand five hundred and seventy-two (21,572) acres and a storage capacity of four hundred and thirty thousand, two hundred and sixty (430,260) acre-feet. The spillway has five (5) 40-foot by 30-foot tainter gates and is located near the center of the dam. Low-flow releases are made through a separate multiple gate inlet tower that has three (3) gated controlled and one (1) uncontrolled opening. The tower is connected to a stilling basin and a concrete weir by a fourteen (14) foot diameter conduit through the dam. The lowest gated outlet is fifty-six and one-half (56.5) feet below the top of the conservation pool, at that level the lake has a capacity of three hundred (300) acre-feet.

Lake Conroe is operated by the San Jacinto River Authority who owns thirty-three percent (33%) of the water, the City of Houston owns the remaining sixty-seven percent (67%). The San Jacinto River Authority has first priority for use of the water in lake Conroe and the first releases of the month are charged to their account, up to their permitted volume, then the water is charged to the City of Houston.

Lake Houston

Lake Houston was formed by two (2) earth-filled embankment sections with a three thousand one hundred and sixty (3,160) foot uncontrolled concrete spillway midway between them and has a drainage area of approximately two thousand eight hundred and

twenty-eight (2.828) square miles. The lake was completed and impoundment began on April 9, 1954. At maximum normal water level, the lake has a surface area of thirteen thousand and sixty-eight (13,068) acres with a storage capacity of one hundred and thirty-three thousand nine hundred (133,900) acre-feet. The spillway has two (2) 18-foot by 20.5-foot tainer gates that can be used for releases below the crest of the uncontrolled spillway and there are two (2) 18-foot by 6-foot flashboard type gates located just east of the spillway. Additionally, there is a thirty-six (36) inch diameter sluice gate that is used for low-flow releases.

The Lake Houston Pump Station and West Canal is operated by the Coastal Water Authority under a contract with the City. There is also a pump station on the east side of the lake operated by the San Jacinto River Authority that pumps water into a canal which they own.

Water Rights

The San Jacinto River Authority has a right to divert fifty (50) million gallons per day and the City of Houston has a right to divert one hundred and forty-nine (149) million gallons per day from the lake.

In total, the San Jacinto River Authority has water rights of seven thousand five hundred (7,500) acre-feet per month and the City of Houston has total water rights of nineteen thousand five hundred (19,500) acre-feet per month from the San Jacinto River and Reservoir System.

Operation Plan

The San Jacinto River Authority releases water from Lake Conroe as follows:

"The City of Houston calls for Water to be released when Lake Houston is 2.0 feet below spillway level, and at the rate called for by the City of Houston. Releases are made through the upper gate until it becomes necessary to open the next lower one to achieve the required flow." The maximum release rate is 700 cfs. At 2.0 feet below the spillway crest, Lake Houston has a storage volume of 113,613 acre-feet.

During periods of low rainfall, water from Lake Houston is released as needed to maintain in-stream flow.

This operation plan has been in effect since Lake Conroe was constructed. Lowering the Lake Houston call volume would adversely impact in-stream flow and recreational activities on Lake Houston while raising the call volume would have very little effect on either reservoir.

To the Honorable City Council of the City of Houston:

In accordance with the provisions of Article VII, Section 7 of the Charter of the City of Houston, I submit and introduce to you the ordinances set out in the attached agenda for the meeting of the City Council of the City of Houston on the 1st and 2nd day of SEPTEMBER, 1998, with the request that all such ordinances, except those making a grant of any franchise or special privilege, be passed finally on the date of their introduction. There exists a public emergency requiring such action and I accordingly request that you pass the same if they meet with your approval.

DATE: SEPTEMBER 1, 1998

Mayor of the City of Houston