L C R A

LAKEWAY AREA RECLAIMED WATER

REGIONAL REUSE UTILITY

FEASIBILITY STUDY

FINAL REPORT

LOWER COLORADO RIVER AUTHORITY

LAKEWAY AREA RECLAIMED WATER

REGIONAL REUSE UTILITY

FEASIBILITY STUDY

FINAL REPORT

Prepared By:

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Austin, Texas

Prepared For:

Lower Colorado River Authority
Water and Wastewater Engineering Program

In Conjunction With:

City of Lakeway
Hurst Creek Municipal Utility District
Lakeway Municipal Utility District
Texas Water Development Board

May, 1995

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May 23, 1995

Mr. Bill Leisering, P.E.
Senior Engineer
Wastewater Engineering
Lower Colorado River Authority
P.O. Box 220
Austin, Texas 78767-0220

Re: Lower Colorado River Authority
Lakeway Regional Reuse Study
Final Report

Dear Mr. Leisering:

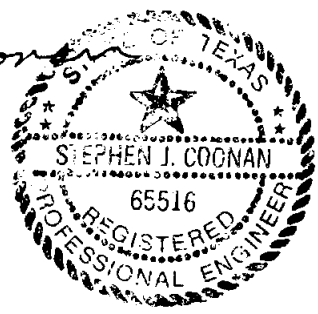
Alan Plummer Associates, Inc. (APAI) is pleased to provide you with an original of the final report for the above referenced project. The report presents a summary of our conclusions and recommendations concerning the feasibility of implementing a Regional Reuse Utility in the Lakeway Area.

We appreciate the assistance that we have received from you and your staff on this project, as well as the staff of the other project participants. If you or any of the other participants have any questions concerning the report, please contact me. I look forward to our final public meeting to discuss the conclusions and recommendations.

Sincerely,

ALAN PLUMMER ASSOCIATES, INC.

Stephen J. Coonan, P.E.
Project Manager



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LIST OF ABBREVIATIONS

APAI	Alan Plummer Associates, Inc.
Austin	City of Austin
BOD_5	Five Day Biochemical Oxygen Demand
CFU	Colony Forming Units
District No. 17	Travis County Water Control & Improvement District No. 17
EPA	Environmental Protection Agency
ETJ	Extraterritorial Jurisdiction
HCMUD	Hurst Creek Municipal Utility District
LCRA	Lower Colorado River Authority
LMUD	Lakeway Municipal Utility District
MGD	Million Gallons Per Day
MUD	Municipal Utility District
NCDC	National Climatic Data Center
NTU	Nephelometer Turbidity Units
TAC	Texas Administrative Code
TNRCC	Texas Natural Resource Conservation Commission
TSS	Total Suspended Solids
TWBD	Texas Water Development Board
USGS	United States Geological Survey
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

The Lakeway area is experiencing significant growth. The pace of this growth is expected to continue and intensify over the foreseeable future. In order to continue providing reliable wastewater service to the area, Lakeway Municipal Utility District (LMUD) and Hurst Creek Municipal Utility District (HCMUD) will need to expand their effluent management facilities in the future. Due to state environmental regulations designed to protect the unique environmental character of the area, the expanded effluent management facilities must not discharge to Lake Travis or its tributaries.

In order to assist the two municipal utility districts (MUDs) in their efforts to plan for the continued growth of the area, the Lower Colorado River Authority (LCRA), together with the City of Lakeway, the two MUDs, and the Texas Water Development Board (TWDB) undertook a study to evaluate the feasibility of implementing a regional reuse utility in the Lakeway area. As originally conceived, the regional utility would provide effluent management services to the two MUDs by providing operators of irrigation systems in the area with reclaimed water. By providing reclaimed water to area golf courses, individual residents, and other entities interested in using water for irrigation purposes, the regional reuse utility would be assisting in the safe management of wastewater effluent and aiding in water conservation efforts. In addition to these benefits, by using individual lawn irrigation as a management activity, the amount of land that would need to be set aside from the developable inventory for effluent disposal purposes would be decreased.

It is anticipated that a regional reuse utility would be implemented in phases. The initial phase would involve providing the pipeline necessary to link the three existing effluent disposal systems. The opinion of probable cost to accomplish this task is $210,000. The linked systems will have a total capacity to dispose of 0.72 mgd of effluent. The cost per 1000 gallons of effluent disposed is estimated to be $0.08.

The second implementation phase of a regional reuse utility would be to provide additional capacity to meet the growth in the area. It is anticipated that the regional utility will need to provide 333 acre-feet of additional effluent storage capacity, and 45 additional acres of cedar tree irrigation before the year 2020. Many of these improvements will be required in response to the development of the Rough Hollow and Lakeway West areas within LMUD. The opinion of probable costs for these improvements, not including additional wastewater treatment capacity, additional collection system, is approximately $15.8 million. Based on a total wastewater contribution of 1.912 MGD in 2020, these additional facilities represent a cost of $2.13 1000 gallons.

The implementation of a regional reuse utility in the Lakeway area could provide effluent management services for the LMUD and the HCMUD. The provision of services by a regional entity could provide benefits to the two MUDs and their customers through a more efficient use of existing facilities. The efficient utilization of existing facilities could delay the need for one or both of the MUDs to construct additional facilities. The deferral of these costs would provide a significant benefit. However, it is not envisioned that a regional reuse utility will be able to provide effluent management services to the area with less infrastructure than the two MUDs would require if they provided service separately.

In order to realize these potential savings due to project deferrals, the regulatory status of effluent management operations in the area will have to change. Currently, HCMUD maintains the authorization to discharge up to 0.25 MGD of tertiary treated effluent to several ponds located in the middle of the Hills golf course on Hurst Creek. By utilizing this authorized discharge, in combination with the existing effluent management capacity in LMUD, the combined, permitted capacity in the area is 0.94 MGD. If a regional utility were implemented, the authorization to discharge effluent to Hurst Creek may be rescinded. This would actually result in an overall decrease in the disposal capacity of approximately 23 percent.

As a result, unless the right to discharge to Hurst Creek can be assumed by the regional reuse utility, the implementation of a regional reuse utility in the Lakeway area is not considered

feasible at this time. The two MUDs can continue to operate their existing systems as they are without constructing additional facilities, except those identified in permit requirements. If HCMUD were to lose its ability to discharge effluent to Hurst Creek during its next renewal process, the feasibility of implementing a regional utility should be re-evaluated.

Even though the creation of a regional reuse utility does not appear to be feasible at this time, the MUDs can derive some benefit from forming a regional alliance. The two MUDs and other providers of wastewater treatment services in the Lake Travis area face similar challenges in the future. As a result the following recommendations are made.

1) LMUD and HCMUD should continue to operate independently at this time.

2) LMUD and HCMUD should monitor the results obtained from the cedar tree irrigation operation in preparation for the next permit renewal process.

3) LMUD and HCMUD should pursue alternative funding sources for a possible pilot project involving residential irrigation with reclaimed water. Possible sources might include the Texas Water Development Board and research oriented organizations such as the American Water Works Association Research Foundation or the Water Environment Research Foundation.

4) LMUD and HCMUD should investigate other innovative technologies such as the use of constructed wetlands.

5) LMUD should consider requesting amendments to its permit to allow the transfer of effluent between the two disposal systems. A strong case could be made that this is a minor amendment since the effluent disposal locations, rates, or quality limits would not be affected.

6) As an alternative to a permit amendment, LMUD could seek authorization to move effluent from one disposal system to the other under Chapter 310. It would need to be clear in the reuse notification that the combination of effluent applied in accordance with Chapter 309 and 310 would not exceed the application rates identified in the permit.

7) In order to reduce the amount of raw water used to irrigate The Hills Golf Course, LMUD and HCMUD could file a reuse notification to send effluent from LMUD to HCMUD when LMUD has more effluent than is needed for its golf courses.

However, the State may be concerned over the difference in effluent limits and the introduction of this effluent into the HCMUD pond system.

8) LMUD and HCMUD should monitor the efforts currently beginning concerning the revision of Chapter 310 and Chapter 317 of the TNRCC Permanent Rules and provide comments as necessary.

9) As an alternative to Chapter 310 reuse notification, it may be possible to reduce the amount of raw water required for The Hills Golf Course by diverting a portion of raw wastewater from LMUD to HCMUD for treatment on a contract basis for some period of time. This may provide some benefit to LMUD by delaying the need for planning the next capacity expansion and/or allowing development in the Rough Holland Lakeway West areas to be initiated before a new plant is brought on-line.

CHAPTER I
INTRODUCTION

The Lower Colorado River Authority (LCRA), in cooperation with Lakeway Municipal Utility District) LMUD, Hurst Creek Municipal Utility District (HCMUD), the City of Lakeway, and the Texas Water Development Board, retained the services of Alan Plummer Associates, Inc. (APAI) to conduct a study to determine the feasibility of implementing a regional reuse utility in the Lakeway area. This report presents the results of that study.

PROJECT OBJECTIVE

The primary objective of this study is to determine if increased reuse, facilitated by a Regional Reuse Utility is a feasible alternative for the proper management of wastewater treatment plant effluent in the Lakeway area. The study will provide an opinion of most probable infrastructure needs and costs. Additionally, the scope of management responsibilities of the utility and potential regulatory requirements will be discussed. A secondary objective will be to develop an opinion of the range of probable costs to provide reclaimed water for residential lawn irrigation. This range may be used by residential developers to estimate the range of acceptable costs of providing dual water systems in new developments.

PROJECT BACKGROUND

The study area for this project includes the City of Lakeway and its extraterritorial jurisdiction (ETJ), HCMUD, and LMUD. The boundary of the study area is illustrated on a United States Geological Survey (USGS) Map in Appendix A. The study area includes approximately 5000 acres located in western Travis County, Texas. The study area is located along the southeastern shore of Lake Travis.

The management of wastewater in the Lake Travis area has been a local environmental issue for many years. As a result of public input, the Texas Natural Resource Conservation Commission (TNRCC) adopted rules prohibiting new or expanded direct discharges of effluent into Lake

Travis or its tributaries. In order to comply with these rules, future growth in the area will either require the installation of on-site septic systems or the expansion of the HCMUD and LMUD systems as no-discharge facilities.

The development or expansion of no-discharge facilities requires significant planning to obtain the effluent storage and disposal sites required. As a result, a regional study for the Lakeway area was undertaken to evaluate whether the beneficial reuse of effluent could provide an alternative means of meeting the effluent disposal needs of the area. In addition, the study evaluated whether a regional reuse utility could facilitate the beneficial reuse of effluent in a manner that would address the effluent management needs as well as enhancing the use of water resources in the area. LCRA, HCMUD, LMUD, and the City of Lakeway agreed to participate in the joint, regional study. Funding for the study was secured through in-kind and cash contributions by each of the entities. To increase the funding available for the project, a matching grant from the Texas Water Development Board (TWDB) was obtained.

As providers of centralized wastewater collection and treatment services, HCMUD and LMUD must always be planning for the future wastewater needs in their service areas. As a result of the state regulation prohibiting new or expanded discharges of wastewater to Lake Travis, the timely planning of future facilities is even more important. The land-disposal of properly treated effluent requires additional land and facilities that are not typically provided at wastewater treatment facilities. Participation in this study will assist HCMUD and LMUD in their planning activities.

The City of Lakeway is affected by limits on wastewater disposal capacity within its corporate city limits and ETJ. The lack of wastewater disposal capacity would adversely affect the continued, orderly growth within the City's jurisdiction. Changes in growth patterns may affect future municipal services and the tax rates leveed to support those services.

The LCRA, as a regional entity, is interested in safeguarding the water quality within the Colorado River Basin. Assisting local entities with the planning for the disposal of wastewater generated within the basin is a major consideration in protecting the water resources within the area. In addition, LCRA is committed to promoting the reuse of reclaimed water as a water conservation measure.

The TWDB is committed to assisting entities throughout the state in developing, planning, and protecting water resources. Regionalization and the use of reclaimed water are objectives that are important to the TWDB.

PROJECT STUDY AREA

As previously indicated, the study area encompasses approximately 5,000 acres in western Travis County, Texas. The following sections include some general information concerning the study area.

Topography

The study area is located in the Lower Colorado River Basin with Lake Travis adjacent to its northwestern boundary. The area is located in The Hill Country of Texas with many hills and steep slopes. The elevations range from a low of 681 feet above mean sea level (msl) at Lake Travis to a high of 1,174 feet msl. The general slope of the land is from the southeast to the northwest. Slopes in the area average around 5 percent, with maximum slopes in excess of 30 percent.

The unique natural beauty of the area is reflected in the panorama of rolling hills, plateaus, and steep canyons. Vegetation ranges from meager patches of grasses on stony slopes to dense oak trees and lines of cedar trees in the canyons and draws.

Climatic Conditions

Rainfall data was obtained from EarthInfo Inc., and the Texas Natural Resource Information System. Rainfall records from 1969 through 1993 were recorded at a weather station located at Mansfield Dam on Lake Travis. These records were supplemented with adjusted EarthInfo National Climatic Data Center (NCDC) data. The NCDC data consisted of monthly rainfall accumulations at the Austin Municipal Airport from 1930 to 1982. The monthly ratios of Mansfield Dam data to the Austin Airport data were calculated for common years. These ratios were used to adjust the USGS data for the years 1930 through 1968. The results of this analysis are presented in Appendix B.

The average rainfall for the study area was determined to be 33 inches. Average rainfall for Travis County for the years 1951 through 1980 was 31.5 inches. The higher rainfall average for the study area may be the result of the rise in elevation in western Travis County coupled with the moisture from southeastern winds. The 25-year frequency rainfall for the study area was calculated to be 48.3 inches. This number will be used later in treated wastewater storage and irrigation calculations.

Evaporation data was obtained from the Texas Water Development Board, Report 64 Monthly Reservoir Evaporation Rates for Texas 1940 through 1965. The annual net evaporation rate was calculated to be 2.65 feet for this period.

Table I-1 provides the average and 25-year frequency monthly rainfall accumulations for the adjusted Mansfield Dam rainfall records and the corresponding average net evaporation rates. The wettest months are shown to be in late spring and early fall. As expected, evaporation rates are highest in July and August, where 44 percent of the average annual net evaporation is realized.

Temperatures for Travis County range from a mean minimum of 39-degrees Fahrenheit in January, to a mean maximum of 95 degrees Fahrenheit in July. Blanco and Burnett Counties,

TABLE I-1

LAKEWAY-HISTORICAL RAINFALL AND EVAPORATION
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Month	Average* Rainfall Accumulation (inches)	25-Year* Frequency Rainfall Accumulation (inches)	Average Net* Evaporation Rates (inches)	25-Year** Frequency Net Evaporation Rates (inches)
Jan	2.3	3.6	0.5	0.8
Feb	2.5	4.0	0.1	0.6
Mar	2.1	3.1	1.8	4.1
Apr	3.3	5.5	0.8	4.3
May	4.2	6.9	2.2	3.6
Jun	4.0	3.9	3.7	7.7
July	1.8	2.9	6.7	10.3
Aug	2.1	4.0	7.2	10.6
Sep	3.3	4.3	4.1	8.9
Oct	3.4	4.4	3.0	5.5
Nov	2.3	3.1	1.3	3.4
Dec	1.9	2.6	0.4	1.6
Totals	**33.3**	**48.3**	**31.8**	**61.3**

* 1930-1993
** 1940-1965
Source: Rainfall - EarthInfo National Climatic Data Center and Texas Natural Resource Information Systems
Evaporation - Texas Water Development Board Report 64

west of the study area, have cooler winters and warmer summers than the Travis County average. This suggests the study area may have more extreme temperature variations than Travis County as a whole.

Soils

Soil in much of the undeveloped upland areas is shallow with numerous limestone fragments. The texture of the soil is predominately gravelly clay loam, gravelly loam, loam, or clay loam. Limestone rock outcrops are commonly found on steep slopes.

A large part of the soil-moisture, available from rainfall, is lost due to runoff or seepage into the limestone formations. In most of the undisturbed upland areas the soil, in its natural state, is not suitable for crops. Additionally, the local soil is not suitable for impeding seepage from wastewater ponds. Imported clay soil or a synthetic liner should be used in a wastewater pond installation.

Soil depth may increase to 14 inches near creeks and in the valleys of large ravines and canyons. Deeper soil is likely to be located within areas that could be defined as Critical Water Quality Zones by the Watershed Ordinances of the Cities of Lakeway and Austin.

Economy

The study area is predominately residential. Commerce is primarily service-related businesses that cater to the local population. Very few office buildings and industries are located in the study area. As with many areas outside of major metropolitan centers, there is a significant number of people that commute to the metropolitan area for work.

Factors likely to limit economic growth in the area include municipal services such as water and wastewater; vehicle traffic conditions, especially for commuters; disposable income of potential second-home buyers; and the availability of services normally preferred by retired individuals

such as medical. Wastewater disposal capabilities may be the most imperative of the factors listed above.

Water Conservation Efforts

As a condition of the TWBD planning grant, the project participants are required to address the issue of water conservation within the study area. The water conservation efforts underway in the study are summarized in Appendix C.

Governmental Jurisdictions

Governmental entities that exercise jurisdiction over the study area include various state agencies such as the TNRCC and state-established entities such as LCRA, Travis County, City of Austin, City of Lakeway, LMUD, HCMUD, Travis County Water Control and Improvement District No. 17 (District No. 17), and Lake Travis Independent School District. Numerous federal agencies, such as the Environmental Protection Agency (EPA) and the U.S. Fish & Wildlife Service, also have jurisdiction.

State of Texas

The State of Texas, through the TNRCC, regulates waste-related activities and administers water rights. The TNRCC regulates the disposal of wastewater through the issuance of permits. The TNRCC has specific rules concerning wastewater treatment plants located within the Lake Travis watershed. These rules do not allow a direct discharge into the Lake.

The TNRCC also regulates, by Texas Administrative Code (TAC) rules, the design of wastewater collection, treatment, and disposal systems, and reclaimed water reuse. These rules are technically-based minimum design standards and require that the wastewater and reuse systems be designed by a professional engineer. The final design documents must be approved by the TNRCC prior to construction. The TNRCC, through 30 TAC, Chapter 285, Subchapter Y,

designated the LCRA as the entity to perform all license functions related to on-site wastewater disposal systems.

The Lower Colorado River Authority

The LCRA was established by an Act of the Texas Legislature in 1934 as a government agency to serve a 10-county district in Central Texas. Among the resource protection responsibilities given to the LCRA are soil conservation, flood control, water management, preservation of fish and wildlife, and pollution abatement.

As mentioned above, the LCRA has been delegated the authority, by the TNRCC, for review of on-site septic systems in areas which includes the study area. Additionally, the LCRA is an active participant in any activity that could affect the water quality of Lake Travis.

Travis County

The County regulates activities that affect their roads and right-of-ways. The activities regulated include drainage and pipeline construction. A site development permit may need to be obtained from Travis County for construction of wastewater conveyance, treatment, and disposal facilities.

City of Austin

The City of Austin's (Austin) population size qualifies it as a "Home Rule" city as defined by the Local Government Code of the State of Texas. Austin's ETJ extends up to five miles from its corporate limits. The ETJ area includes part of the study area. Austin regulates development activities in the area to protect water quality. A portion of these regulations address wastewater disposal practices. Development within the Austin ETJ will require an Austin permit.

City of Lakeway

The City of Lakeway and its ETJ are contained within the study area. The City of Lakeway exercises control over development in this portion of the study area through Zoning and Watershed Ordinances and a Building Code. These ordinances include rules governing the disposal of wastewater in the area. Development within the City of Lakeway or its ETJ will require a permit.

Lakeway and Hurst Creek Municipal Utility Districts

LMUD and HCMUD are districts formed under state statute to provide water and wastewater services. LMUD was created February 17, 1972, by order of the Texas Water Rights Commission. HCMUD was formed October 1979, by order of the Texas Water Commission. Both districts provide water and wastewater service. Both districts regulate water and wastewater designs and installations in their respective areas.

Travis County Water Control &Improvement District No. 17

District 17 was created by order of the Commissioner's Court of Travis County on December 8, 1958, and operates under Chapter 51 of the Texas Water Code. In the Greater Lakeway Area, District 17 provides water services to Lake Travis Independent School District and Travis Plaza shopping center at Lohman's Crossing and State Highway 620. Additionally, District 17 provides water service to the Triangle Area that is south of Lakeway Boulevard, west of Lohman's Crossing, and northwest of State Highway 620.

CHAPTER II
EXISTING WASTEWATER TREATMENT FACILITIES

Centralized wastewater disposal services for the study area are provided by Lakeway Municipal Utility District (LMUD) and Hurst Creek Municipal Utility District (HCMUD). The City of Lakeway does not provide wastewater collection or treatment service. The wastewater systems for LMUD and HCMUD are described below. In addition to the organized wastewater systems, a substantial portion of the study area utilizes on-site disposal systems.

LAKEWAY MUNICIPAL UTILITY DISTRICT

LMUD provides wastewater services to customers within its boundary. In addition, LMUD provides services to a number of out-of-district customers inside the city limits of City of Lakeway. LMUD operates three wastewater treatment plants (WWTP): the Central WWTP, the Inn and Marina WWTP, and the World of Tennis WWTP. Each of these WWTPs and its respective effluent disposal method is discussed below.

Central Wastewater Treatment Plant

The Central WWTP is the largest of the three plants and serves most of the residential areas. The Central WWTP is permitted by Texas Natural Resource Conservation Commission (TNRCC) Permit No. 11495-001. The permit allows for the treatment and disposal of 0.25 million gallons of wastewater per day (MGD) under an interim limit. The permit has a final limit of 0.52 MGD once an expansion to the WWTP and effluent disposal facilities is completed.

The existing WWTP and the plant expansion are mechanical plants using the contact stabilization process. The treated wastewater effluent is discharged to an existing 17,437,000-gallon earthen pond and a 429,000-gallon steel tank. The effluent is used to irrigate 107 acres of the Yaupon Golf Course and 11 acres of roadway median along Lakeway Boulevard. The storage pond was built to exclude surface runoff from rainfall. The pond is designed not to overflow when

operated at capacity and during a year with rainfall that has a return frequency of 25-years or less.

As part of the plant expansion, LMUD is proposing to irrigate cedar trees during the winter months. With this type of irrigation operation acting as a relief mechanism, the existing turf irrigation and effluent storage capacity are adequate for the final permitted flow increase to 0.52 MGD. The WWTP was serving 1,568 connections as of June 1994.

The existing WWTP and the proposed expansion will produce secondary type effluent, which corresponds to 20 mg/L five-day biochemical oxygen demand (BOD_5) and 20 mg/L total suspended solids (TSS). Water that has received this degree of treatment is suitable for use as irrigation water on permitted lands. The current permit restricts irrigation to periods when the property is not occupied by humans.

Inn and Marina Wastewater Treatment Plant

As with the Central WWTP, the Inn and Marina WWTP uses the contact stabilization process. The Inn and Marina WWTP is permitted by TNRCC Permit No. 11495-002. The permit allows for the treatment and disposal of 0.065 MGD.

The treated wastewater effluent is discharged to an on-channel pond located on the Live Oak Golf Course. The water is commingled with stormwater runoff that drains to the golf course pond. The water in the pond is used to irrigate the 105-acre golf course. The TNRCC permit requires operation of the irrigation system such that the water in the pond will not normally discharge to Lake Travis. The permit allows for an incidental discharge when rainfall runoff volumes are equivalent to or greater than the rainfall runoff volume produced within the pond watershed by a one-inch per hour rain for three hours. Since this pond is subject to the influences of storm water runoff, the volume available for effluent storage is less than the total pond volume. The permit indicates that 2.5 MG are available for effluent storage.

The TNRCC permit requires advanced secondary treatment, which corresponds to a 10 mg/L BOD_5 and 15 mg/L TSS effluent quality limit. This permit is more stringent than the Central Plant permit because the discharge is into an "on-channel" pond. The wastewater flow from the Inn and Marina area is seasonal with peaks in August and low flows in December. The WWTP is operating within its capacity. The WWTP was serving four connections as of June 1994. These connections are the commercial businesses associated with the Inn and Marina area on Lake Travis.

World of Tennis Wastewater Treatment Plant

The World of Tennis WWTP is permitted by TNRCC Permit No. 11495-003. The permit allows for the treatment and disposal of 0.105 MGD. The treatment plant uses the contact stabilization process and serves the World of Tennis and the western portion of the District. The WWTP was serving 240 connections as of June 1994.

The treated wastewater effluent is discharged into the same on-channel pond that receives flow from the Inn and Marina WWTP. Water from this pond is used to irrigate the Live Oak Golf Course. The TNRCC permit requires advanced secondary treatment for the same reasons stated for the Inn and Marina WWTP.

HURST CREEK MUNICIPAL UTILITY DISTRICT

HCMUD owns and operates one wastewater treatment facility. This WWTP serves all of the HCMUD service area. The service area is predominately residential.

The WWTP is permitted by TNRCC Permit No. 12215-001. The permit allows for the treatment and discharge of 0.25 MGD in the Interim Phase and 0.65 MGD in the Final Phase. HCMUD is currently operating at the 0.25 MGD Interim Phase.

The WWTP is a complete-mix activated sludge plant. The WWTP discharges tertiary-quality water, which corresponds to a 5 mg/L BOD_5, 10 mg/L TSS and 2 mg/L total phosphorus effluent limit. The effluent is discharged to a 350,000-gallon storage tank. Water from the tank is used to irrigate 173 acres of the Hills of Lakeway Golf Course and driving range and the Academy of Golf 3-hole course. Water not used for irrigation is discharged to a series of five ponds on Hurst Creek then to Lake Travis.

Presently, the WWTP is operating below the Interim Phase flow rate limit of 0.25 MGD. The WWTP was serving 405 connections as of May 1994.

SEPTIC SYSTEMS WITHIN THE STUDY AREA

Septic Systems are regulated by the State through the TNRCC. Lower Colorado River Authority (LCRA) reviews the construction plans to aid in the protection of water in the Lower Colorado River Basin and as a service to the State.

LMUD and the City of Lakeway both contain homes that utilize septic tank systems. LMUD records indicate there are 796 active septic tanks in its water service area, which includes the City of Lakeway. Records indicate that HCMUD does not contain any active septic tank systems.

CHAPTER III
EXISTING WATER TREATMENT FACILITIES

Lakeway Municipal Utility District (LMUD) owns and operates two water treatment plants (WTPs). Hurst Creek Municipal Utility District (HCMUD) owns and operates one WTP. These facilities are described in detail below.

LAKEWAY MUNICIPAL UTILITY DISTRICT

LMUD obtains raw water from Lake Travis. This water is treated and distributed to it customers. Lower Colorado River Authority (LCRA) provides raw water to LMUD. Current uninterruptable water contracts for the area provide water on demand for $0.32 per 1,000 gallons.

Raw Water Contract

Lake Travis is the source for raw water for this area. LMUD purchases raw water from the LCRA and has recently reached its contracted raw-water limit of 1,228 uninterruptable acre-feet per year. LMUD is currently renegotiating its raw water contract with LCRA.

Water Treatment Capacity

LMUD owns and operates the 0.65 MGD Live Oak WTP and the 1.50 MGD Central WTP. The combined total WTP capacity is 2.15 MGD. LMUD is in the process of expanding its WTP capacity to 3.65 MGD.

HURST CREEK MUNICIPAL UTILITY DISTRICT

HCMUD also obtains raw water from Lake Travis. The raw water contract and WTP are discussed below.

Raw Water Contract

HCMUD obtains their raw-water from Lake Travis through a contract with LCRA. The contract is for 1,600 uninterruptible acre-feet per year. Raw water purchased in 1993 was 26 percent of the total contracted amount.

Water Treatment Capacity

HCMUD owns and operates a 1.207 MGD WTP.

INTERCONNECT AGREEMENTS

During the summer of 1986, LMUD and HCMUD jointly constructed an interconnection between their respective water systems, so that potable water could be transferred from one water system to the other in either direction. This interconnection consists of approximately 600-feet of 8-inch pipe and two meters to monitor flow.

Additionally, the LMUD has an interconnect agreement with District 17 under which District 17 will supply treated water to LMUD when District 17 has excess water available. The current price for this is $1.25 per 1000 gallons.

CHAPTER IV
EXISTING AND PROJECTED UTILITY DEMANDS

The proper planning of utility services require that the future demands for those services be determined. In order to estimate the demands, it is necessary to know something about the historical population growth and the historical per capita demands for utility services. The following sections discuss these issues.

POPULATION

Historical population data and projections of population growth were provided for the study area by the City of Lakeway. Due to the overlapping jurisdictions, and the fact that portions of the study area are not served by a centralized wastewater collection system, it is necessary to provide population information for several categories. The information provided by the City of Lakeway included projections of sewer connections and septic systems through the year 2020. This information is presented in Table IV-1.

The projected growth rate in the number of connections is 86 connections per year. This value is based on historical records of housing permits. Figure IV-1 identifies the number of housing permits issued each year since 1976.

The City of Lakeway provided two different density assumptions for a population estimate. The low-case projection assumes an average population of 2.0 individuals per connection. The high-case projection assumes an average of 2.4 individuals per connection. Population projections based on 2.0 and 2.4 persons per connection are presented in Tables IV-2 and IV-3, respectively.

In 1990, the City of Lakeway adopted a Master Plan. This plan assumed that the calculated number of persons per connection is 2.41 people. The plan also presented data comparing similar figures for the City of Austin (2.45 people per connection) and Travis County (2.53 people

TABLE IV-1

PROJECTED SEWERED AND SEPTIC CONNECTIONS FOR STUDY AREA LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

	Sewered Connections			Septic Connections	
Year	Lakeway MUD/ID*	City of Lakeway OD**	Hurst Creek MUD	City of Lakeway OD**	City of Lakeway ETJ
1990	1532	16	233	771	474
1993	1849	30	350	807	490
1995	1970	36	450	864	500
2000	2300	400	700	700	550
2005	2900	600	950	700	600
2010	3500	800	1200	500	650
2015	4100	1000	1200	300	700
2020	4700	1200	1200	100	750

*In Lakeway Municipal Utility District
**Out of Lakeway Municipal Utility District

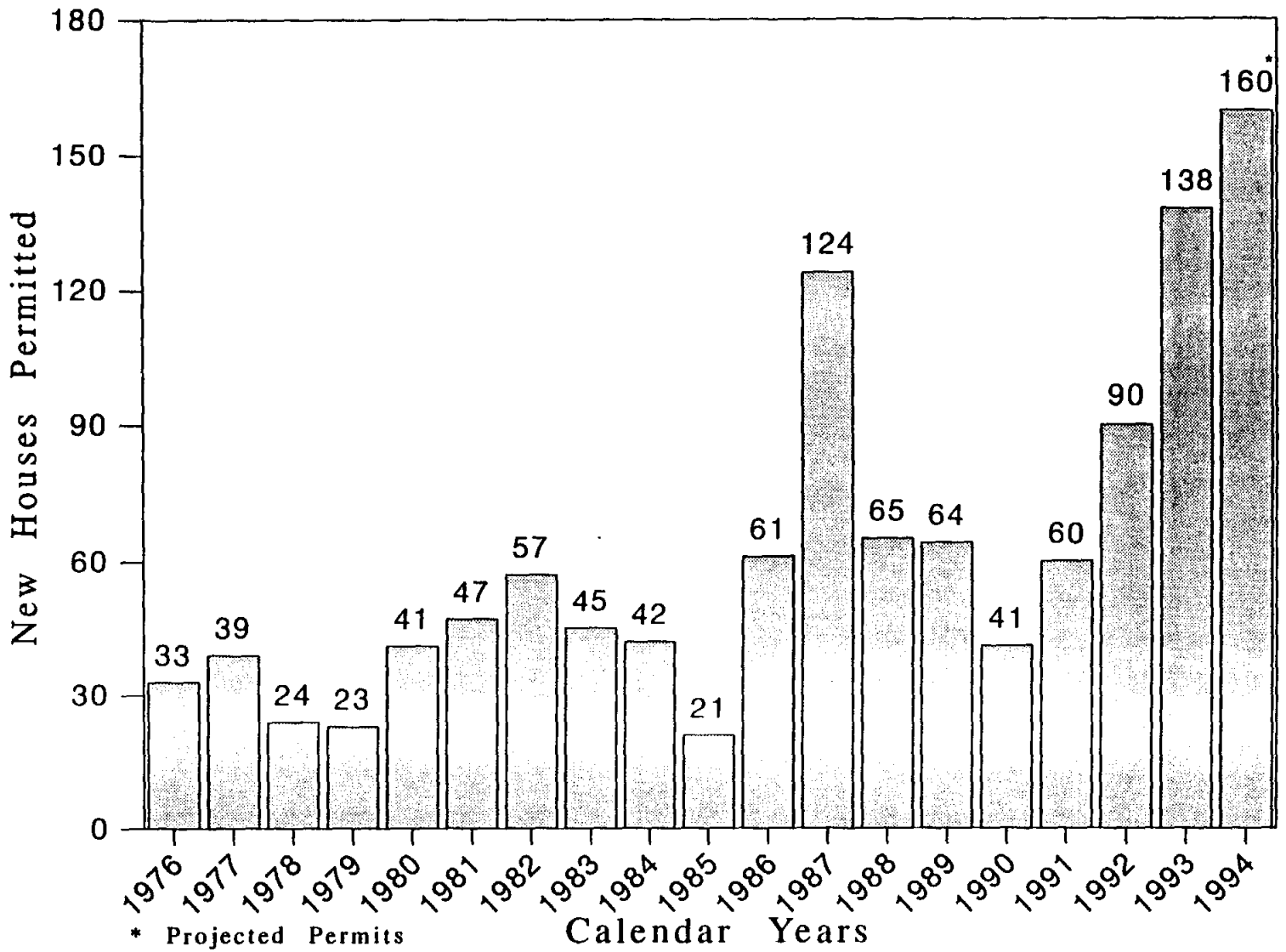

FIGURE IV-1
HISTORICAL RECORDS OF HOUSING PERMITS FOR CITY OF LAKEWAY
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

TABLE IV-2

POPULATION PROJECTION FOR STUDY AREA USING 2.0 PEOPLE/CONNECTION LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

	Sewered Connections			Septic Connections		
Year	Lakeway MUD/ID*	City/ OD**	Hurst Creek MUD	City/ OD**	ETJ	Total
1990	3064	32	466	1542	948	6,052
1993	3698	60	700	1614	980	7,052
1995	3940	72	900	1728	1000	7,640
2000	4600	800	1400	1400	1100	9,300
2005	5800	1200	1900	1400	1200	11,500
2010	7000	1600	2400	1000	1300	13,300
2015	8200	2000	2400	600	1400	14,600
2020	9400	2400	2400	200	1500	15,900

*In District
**Out of District

TABLE IV-3

POPULATION PROJECTION FOR STUDY AREA
USING 2.4 PEOPLE/CONNECTION
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

	Sewered Connections			Septic Connections		
Year	Lakeway MUD/ID*	City/ OD**	Hurst Creek MUD	City/ OD**	ETJ	Total
1990	3677	38	559	1850	1138	7,262
1993	4438	72	840	1937	1176	8,463
1995	4728	86	1080	2074	1200	9,168
2000	5520	960	1680	1680	1320	11,160
2005	6960	1440	2280	1680	1440	13,800,
2010	8400	1920	2880	1200	1560	15,962
2015	9840	2400	2880	720	1680	17,520
2020	11280	2880	2880	240	1800	19,080

*In District
**Out of District

per connection). Based on this information, the high-case projection using an average of 2.4 individuals per living unit will be used.

The population of the study area essentially consists of two groups. The first group encompasses full-time residents such as families with children and people retired from their careers. This group is the larger of the two groups and is expected to grow at a faster rate than the second group. The second group consists of part-time residents, such as people with second homes.

The 1990 U.S. Census population estimate for the City of Lakeway was 4,044. The City of Lakeway estimated the U.S. Census figure may be low by as much as 25 percent, since part-time residents were not counted. This would indicate that approximately 560 connections in the study area may be servicing residences with part-time occupancy.

The growth within the area is expected to occur through a combination of construction of residences on remaining vacant lots in areas of existing development and the development of previously undeveloped tracts. The latter is expected to occur within the Rough Hollow and Lakeway West portions of Lakeway Municipal Utility District (LMUD). These two areas are projected to add significant population to the LMUD and it is anticipated that an additional wastewater treatment facility will be required to provide service to these areas.

New developments are also anticipated in the portion of the Lakeway Extraterritorial Jurisdiction (ETJ) that is outside the LMUD and Hurst Creek Municipal Utility District (HCMUD) boundaries. Since this area is not in the existing service area of the two municipal utility districts (MUDs), it is projected that wastewater needs in the area will be addressed through on-site treatment units. It is possible that either HCMUD or LMUD could extend service to these areas through annexation; however, it is expected that water service to these areas will be provided by Travis County Water Control and Improvement District No. 17 (District 17) since the area is included in the District 17 Certificate of Convenience and Necessity. Significant negotiations would be required to allow this type of arrangement. As a result, the assumption that on-site systems will be used in these areas will be maintained.

WASTEWATER CONTRIBUTION

Information concerning historic wastewater flows in LMUD and HCMUD is available from monthly records maintained by the MUDs. Historical flow rates for the LMUD and HCMUD WWTPs are listed in Tables IV-4 and IV-5. Based on this information, it appears that 275 gallons per day per connection for LMUD customers and 220 gallons per day per connection for HCMUD customers are reasonable values to use for future wastewater generation projections. The average wastewater contribution per connection in LMUD may be higher than in HCMUD, because the collection system is older and may be experiencing more storm water inflow and infiltration.

The projected wastewater flows for LMUD and HCMUD are presented in Table IV-6. The total wastewater flow anticipated in 2020 for both systems is 1.912 MGD. This is equivalent to a 4.1 percent increase in wastewater generation per year for the next 25 years.

The total projected flow significantly exceeds the permitted capacity of the existing treatment facilities. It is anticipated that a new treatment plant will be constructed once the Lakeway West and Rough Hollow areas begin development. The site of this new treatment facility is not yet known. However, it is expected that it would be located in the Lakeway West area.

WATER DEMANDS

In order to project future water demands for the area, it is necessary that information concerning historic, per capita water consumption be developed. Potable water demand information was obtained from billing information from the two MUDs. Tables IV-7 and IV-8 summarize the water consumption information.

TABLE IV-4
HISTORICAL WASTEWATER TREATMENT PLANT FLOWS*
LAKEWAY MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Date	Total WWTP Flow	Lakeway MUD Lakeway World of Tennis	Lakeway MUD Inn and Marina WWTP	Lakeway MUD Central Plant	Connections to Central Plant	Central WWTP GPCnD*
1/92	0.849	0.160	0.035	0.511	NR	NA
2/92	1.062	0.188	0.046	0.599	NR	NA
3/92	0.728	0.125	0.046	0.458	NR	NA
4/92	0.528	0.091	0.045	0.302	NR	NA
5/92	0.648	0.116	0.047	0.399	NR	NA
6/92	0.720	0.139	0.052	0.446	NR	NA
7/92	0.514	0.090	0.056	0.287	973	295
8/92	0.526	0.106	0.062	0.284	973	292
9/92	0.501	0.094	0.055	0.282	1008	280
10/92	0.460	0.080	0.050	0.267	1008	265
11/92	0.538	0.116	0.038	0.312	1045	299
12/92	0.575	0.131	0.021	0.344	1045	329
1/93	0.627	0.137	0.027	0.372	1074	346
2/93	0.658	0.137	0.035	0.385	1074	358
3/93	0.591	0.118	0.050	0.345	1114	310
4/93	0.562	0.094	0.051	0.355	1114	319
5/93	0.565	0.085	0.052	0.366	1165	314
6/93	0.576	0.094	0.053	0.365	1165	313
7/93	0.509	0.066	0.056	0.321	1225	262
8/93	0.450	0.065	0.061	0.258	1225	211
9/93	0.493	0.084	0.060	0.292	1276	229
10/93	0.501	0.067	0.053	0.316	1276	248
11/93	0.492	0.068	0.036	0.325	1316	247
12/93	0.455	0.063	0.019	0.307	1316	233
1/94	0.490	0.075	0.030	0.326	1368	238
2/94	0.494	0.077	0.044	0.326	1368	238
3/94	0.546	0.102	0.044	0.346	1447	239
4/94	0.516	0.083	0.045	0.333	1447	230
5/94	0.556	0.09	0.051	0.346	1568	221

*Average 275 GPCnD
NR - Not Reported
NA - Not Applicable

TABLE IV-5
HISTORICAL WASTEWATER TREATMENT PLANT FLOWS*
HURST CREEK MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Date	Hurst Creek MUD Hurst Creek Plant No. 1	Active Connection to HCMUD WWTP	HCMUD WWTP GPCnD*
1/92	0.143	298	480
2/92	0.229	301	761
3/92	0.099	304	326
4/92	0.090	306	294
5/92	0.086	291	296
6/92	0.083	309	269
7/92	0.081	313	258
8/92	0.074	313	238
9/92	0.070	331	211
10/92	0.063	329	191
11/92	0.072	332	217
12/92	0.079	333	237
1/93	0.091	334	272
2/93	0.101	336	300
3/93	0.078	339	230
4/93	0.062	342	181
5/93	0.062	349	176
6/93	0.064	352	182
7/93	0.066	358	185
8/93	0.066	365	181
9/93	0.057	369	154
10/93	0.065	370	176
11/93	0.063	375	168
12/93	0.066	376	176
1/94	0.059	384	154
2/94	0.047	391	120
3/94	0.054	396	136
4/94	0.055	401	137
5/94	0.069	405	170

*Average 220 GPCnD (2/92 data excluded)
NR - Not Reported
NA - Not Applicable

TABLE IV-6

PROJECTED WASTEWATER TREATMENT PLANT FLOWS
LAKEWAY MUNICIPAL UTILITY DISTRICT AND
HURST CREEK MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Year	Lakeway MUD Central Plant (MGD)	Lakeway MUD Inn and Marina WWTP (MGD)	Lakeway MUD Lakeway World of Tennis (MGD)	Hurst Creek MUD WWTP (MGD)	Total WWTP Flow (MGD)
1995	0.435	0.047	0.117	0.090	0.689
2000	0.585	0.047	0.158	0.140	0.930
2005	0.758	0.048	0.204	0.190	1.200
2010	0.933	0.049	0.250	0.240	1.472
2015	1.105	0.050	0.297	0.240	1.692
2020	1.278	0.050	0.344	0.240	1.912

TABLE IV-7

HISTORIC POTABLE WATER DEMAND
LAKEWAY MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Billing Period*	Total Average Water Demand MGD	No. of Active Connections	Average Daily Demand GPCnD
July - Aug. 1992	0.8490	1770	480
Sep. - Oct. 1992	0.6573	1820	361
Nov. - Dec. 1992	0.3681	1826	202
Jan. - Feb. 1993	0.3806	1884	202
Mar. - Apr. 1993	0.4893	1970	248
May - June 1993	0.8039	2063	390
July - Aug. 1993	1.4120	2164	652
Sep. - Oct. 1993	0.7734	2227	347
Nov. - Dec. 1993	0.4955	2260	219
Jan. - Feb. 1994	0.5000	2319	216
Mar. - Apr. 1994	0.7749	2459	315
May - June 1994	1.3857	2633	526

*Customers received waterbill every other month.
MGD - million gallons per day
GPCnD - gallons per connection per day

TABLE IV-8

HISTORIC POTABLE WATER DEMAND
HURST CREEK MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Billing Period	Total Average Monthly Demand MGM	No. of Connections	Average Daily Demand GPCnD
Jan. 1992	2.49	298	269
Feb. 1992	2.14	301	245
Mar. 1992	4.22	304	448
Apr. 1992	5.27	306	574
May 1992	3.35	291	371
June 1992	5.46	309	589
July 1992	6.70	313	691
Aug. 1992	5.89	313	607
Sep. 1992	6.98	331	703
Oct. 1992	5.06	329	496
Nov. 1992	3.02	332	303
Dec. 1992	2.23	333	216
Jan. 1993	2.65	334	256
Feb. 1993	2.68	336	285
Mar. 1993	2.57	339	245
Apr. 1993	3.67	342	358
May 1993	3.97	349	367
June 1993	4.19	352	397
July 1993	9.13	358	823
Aug. 1993	11.89	365	1051
Sep. 1993	7.48	369	676
Oct. 1993	5.78	370	504
Nov. 1993	3.20	375	284
Dec. 1993	3.64	376	312
Jan. 1994	2.90	384	244
Feb. 1994	2.53	391	231
Mar. 1994	4.49	396	366
Apr. 1994	4.80	401	399
May 1994	5.66	405	451

MGM - million gallons per month
GPCnD - gallons per connection per day

Based on this information, it appears the average water consumption per connection is 347 gallons per day for LMUD customers and 440 gallons per day for HCMUD customers. The higher water demand for HCMUD customers is believed to be due to more intensive lawn and landscaped-area irrigation and more irrigable area per connection.

Future water demands can be projected by multiplying the number of anticipated connections to the potable water systems by the average water demand per connection. These projections were completed separately for HCMUD and LMUD. Projections for the area outside the two MUDs but inside the Lakeway ETJ were not made since these water demands will be met by District 17. Tables IV-9 and IV-10 contain the respective projected water demands for LMUD and HCMUD through the year 2020.

For the purposes of this study, a constant per connection water use factor was used through the year 2020. With the implementation of a water conservation plan, some reduction in per capita water consumption could be achieved over time. However, the use of the constant factor represents the worst-case scenario for future water treatment capacity requirements. This scenario would allow for maximum benefits derived from the substitution of reclaimed water for potable water. If a substitution project is determined to be feasible, this assumption should be evaluated further.

TABLE IV-9

PROJECTED WATER DEMAND FOR LAKEWAY MUNICIPAL UTILITY DISTRICT LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Year	No. of Connections	Average Demand* MGD	Peak Monthly Demand** MGD
1995	2506	0.870	1.634
2000	3250	1.128	2.119
2005	4100	1.423	2.673
2010	4950	1.718	3.227
2015	5800	2.013	3.782
2020	6650	2.308	4.336

MGD - millon gallons per day
*Based on 347 gallons per connection per day
**Based on 652 gallons per connection per day
Note: Existing water treatment capacity = 1.215 MGD
Proposed water treatment capacity = 3.650 MGD

TABLE IV-10

PROJECTED WATER DEMAND FOR HURST CREEK MUNICIPAL UTILITY DISTRICT LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Year	No. of Connections	Average Demand* MGD	Peak Monthly Demand** MGD
1995	450	.198	.419
2000	700	.308	.651
2005	950	.418	.884
2010	1200	.528	1.116
2015	1200	.528	1.116
2020	1200	.528	1.116

MGD - millons gallons per day
*Based on 440 gallons per connection per day
**Based on 930 gallons per connection per day
Note: Existing water treatment capacity = 1.207 MGD

CHAPTER V

FUTURE EFFLUENT MANAGEMENT ALTERNATIVES

For growth to continue in the Lakeway area, additional effluent management mechanisms must be developed. Alternatives for effluent disposal, related water balance calculation results, recommended combinations of components, and opinion of most probable costs comprise this chapter and are presented below.

EFFLUENT MANAGEMENT ALTERNATIVES

As previously discussed, additional effluent management capabilities must be developed to accommodate the increasing wastewater flows projected to be generated by the continued growth of the Lakeway area. These new capabilities can be provided through an expansion of the existing management practices or alternative management activities such as the proposed irrigation of cedar trees during the winter months or the beneficial reuse of the effluent. With the assistance of the project participants, the following potential methods of effluent management have been identified.

- Golf course irrigation
- Roadway median irrigation
- Parks and other open space irrigation
- Irrigation of public areas around townhome developments
- Residential irrigation
- Irrigation of cedar trees

Each of these potential effluent management practices has different advantages and disadvantages associated with its implementation. The following discussions present this information.

Golf Course Irrigation

The irrigation of golf courses is currently the primary effluent management method practiced in the study area. This type of effluent management has been practiced successfully for a number of years and is anticipated to continue in the future. Since this type of irrigation is currently being practiced, it is expected that the expansion of golf course irrigation to new golf courses developed in association with the development of Rough Hollow or Lakeway West could be accomplished with minimal regulatory resistance and little or no changes to the treatment processes. However, the development of a new golf course would represent a significant loss in the total amount of land available for development. In addition, the construction and operation of a golf course are expensive propositions.

Median Irrigation

Lakeway Municipal Utility District (LMUD) is currently irrigating a portion of the median area on Lakeway Blvd. This type of effluent management practice could be expanded to other median areas in the existing service area as well as new median areas developed as part of Rough Hollow or Lakeway West. Since this type of irrigation is currently being practiced, it is expected that the expansion to other areas could be accomplished with minimal regulatory resistance and little or no changes to the treatment processes. The expansion of this type of irrigation could be facilitated through the planning process of any new development. However, this type of effluent management may moderately reduce the amount of developable area available.

Park and Other Open Space Irrigation

The Lakeway area has a number of parks that are currently being irrigated with potable water. The irrigation activities at these areas could be converted to using reclaimed water. Information concerning the existing irrigation demand at several parks was provided by LMUD. This information is presented in Table V-1. Figure V-1 illustrates the location of these parks.

TABLE V-1

HISTORICAL PARK IRRIGATION*
CITY OF LAKEWAY
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Irrigation Period	Porpoise Park (x1000 gallons)	Dragon Park (x1000 gallons)	Lakeway Drive Greenbelt (x1000 gallons)
July - Aug. 1992	22	122	13
Sep. - Oct. 1992	6	115	4
Nov. - Dec. 1992	**	**	**
Jan. - Feb. 1993	1	**	**
Mar. - Apr. 1993	**	**	**
May - June 1993	**	**	**
July - Aug. 1993	22	**	56
Sep. - Oct. 1993	**	2	22
Nov. - Dec. 1993	**	3	25
Jan. - Feb. 1994	**	8	**
Mar. - Apr. 1994	**	8	**
May - June 1994	**	3	34

*Source: Lakeway Municipal Utility District Water Service Records
**No irrigation during this period

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It is anticipated that new development in the Rough Hollow and Lakeway West area will also include several parks. As a result, an effluent management method, such as park irrigation could be developed within the existing and future service areas for the two municipal utility districts (MUDs). Development of this type of effluent management method is not expected to decrease the available acreage for development since it is anticipated that parks will be an integral part of any major new development.

In addition to the parks, there are other open spaces that could be irrigated with reclaimed water. Specifically, irrigating the airfield, city hall, and other public facilities with reclaimed water could be included as additional effluent management methods.

Large Irrigation Users

The Lakeway area has several developments that include landscaped common areas. Typically, these developments are townhomes or cluster homes built in close proximity to each other. The developments have homeowners organizations that are responsible for maintaining the common areas. In several instances, these common areas are currently irrigated with potable water that is provided through a separate water meter to an underground irrigation system. This type of irrigation could be accomplished with reclaimed water. Information concerning the historical irrigation demands for several of these sites is available from the LMUD billing records. This information is provided in Table V-2. Figure V-1 illustrates the location of these users.

It is anticipated that townhome or cluster home developments will be included as part of the development of Lakeway West and Rough Hollow. As a result, it is anticipated that this type of effluent management could be developed in the existing and future service area for the MUDs.

TABLE V-2

HISTORICAL CONDOMINIUM IRRIGATION*
CITY OF LAKEWAY
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Irrigation Period	Bluffs (x1000 gal.)	Champions Lane (x1000 gal.)	Casa Verde (x1000 gal.)	Fairway Villas (x1000 gal.)
July - Aug. 1992	**	574	248	32
Sep. - Oct. 1992	7	278	100	25
Nov. - Dec. 1992	14	**	**	**
Jan. - Feb. 1993	16	**	1	**
Mar. - Apr. 1993	20	**	10	**
May - June 1993	22	35	120	50
July - Aug. 1993	22	204	476	169
Sep. - Oct. 1993	20	106	69	127
Nov. - Dec. 1993	22	**	1	51
Jan. - Feb. 1994	22	**	**	69
Mar. - Apr. 1994	23	47	198	101
May - June 1994	22	110	409	146

*Source: Lakeway Municipal Utility District Water Service Records
**No irrigation during this period

Residential Irrigation

The irrigation of residential lawns represents a significant portion of the water demand for the Lakeway area. This demand could be met through the use of reclaimed water. The amount of demand for residential irrigation water can be estimated from historical water use records. Typically, residential water consumption peaks during the summer months as a result of irrigation demands. Water consumption during the winter months is usually at a minimum since irrigation activities do not occur during this period. The difference between the minimum water usage in the winter and other times of the year is assumed to be primarily associated with irrigation activities.

This assumption can be verified by comparing the monthly water demand information to the monthly wastewater contribution information. If the minimum winter water demands are associated with internal water uses, it is anticipated that the wastewater contribution would be slightly less than the water demand. Figures V-2 and V-3 present this information for LMUD and Hurst Creek Municipal Utility District (HCMUD).

The information for LMUD indicates that wastewater contribution actually exceeds water demand during the winter months. This would appear to indicate that LMUD is receiving significant amounts of infiltration and inflow to its wastewater collection system. As a result, the assumption that the minimum water demand during the winter represents internal uses only is not confirmed or refuted.

The information for HCMUD varies from year to year. During January and February of 1992, wastewater contributions greatly exceeded the water demands. This was probably due to infiltration and inflow associated with the "Christmas Flood of 1991". During the winter of 1992/1993, wastewater contributors were slightly higher than water demands. Again, this may have been due to high rainfall amounts during this time. However, the wastewater contribution during the winter of 1993/1994 was significantly less than the water demand. The wastewater

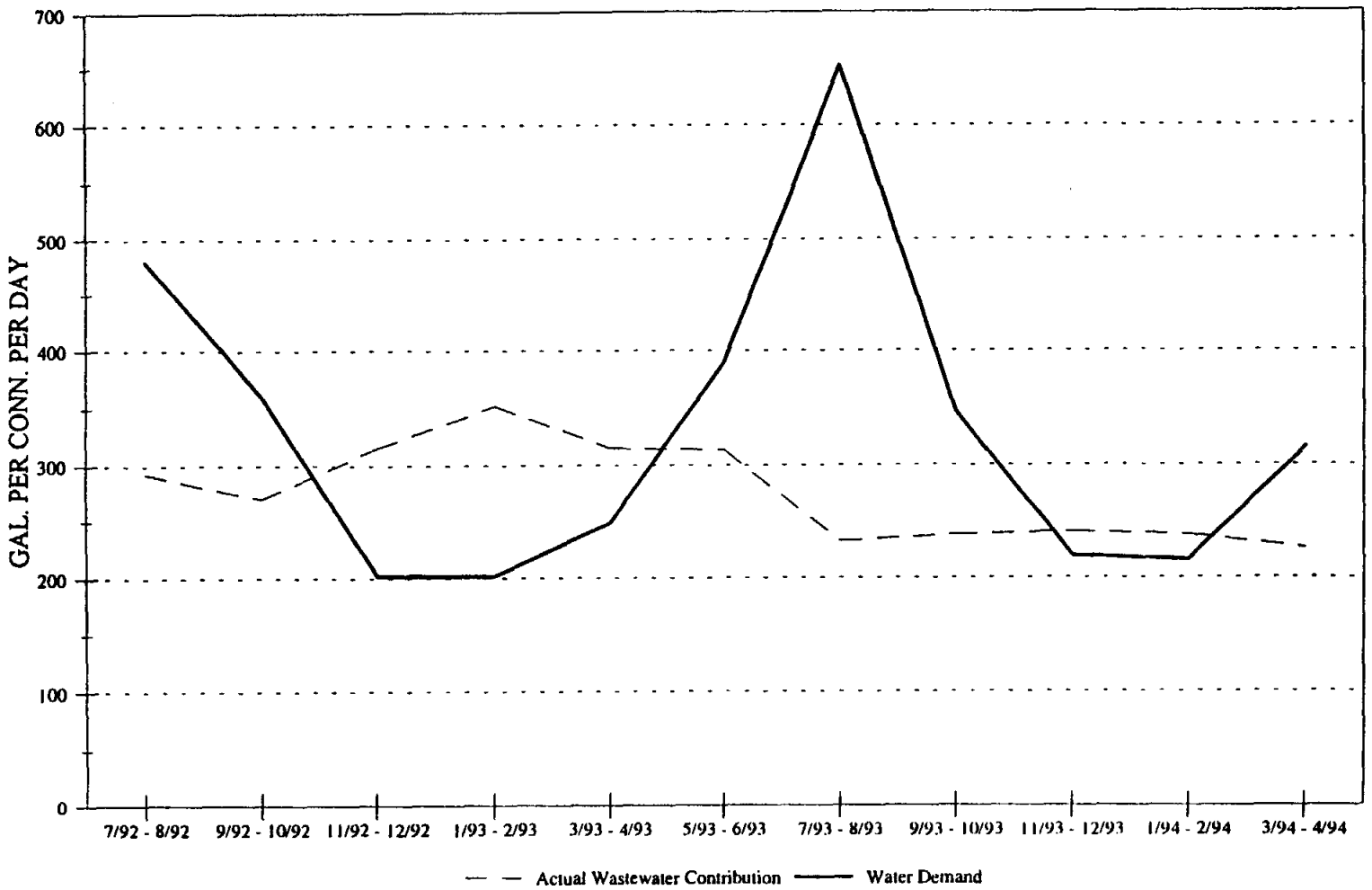


FIGURE V-2

WASTEWATER CONTRIBUTION VS WATER USAGE
LAKEWAY MUD
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

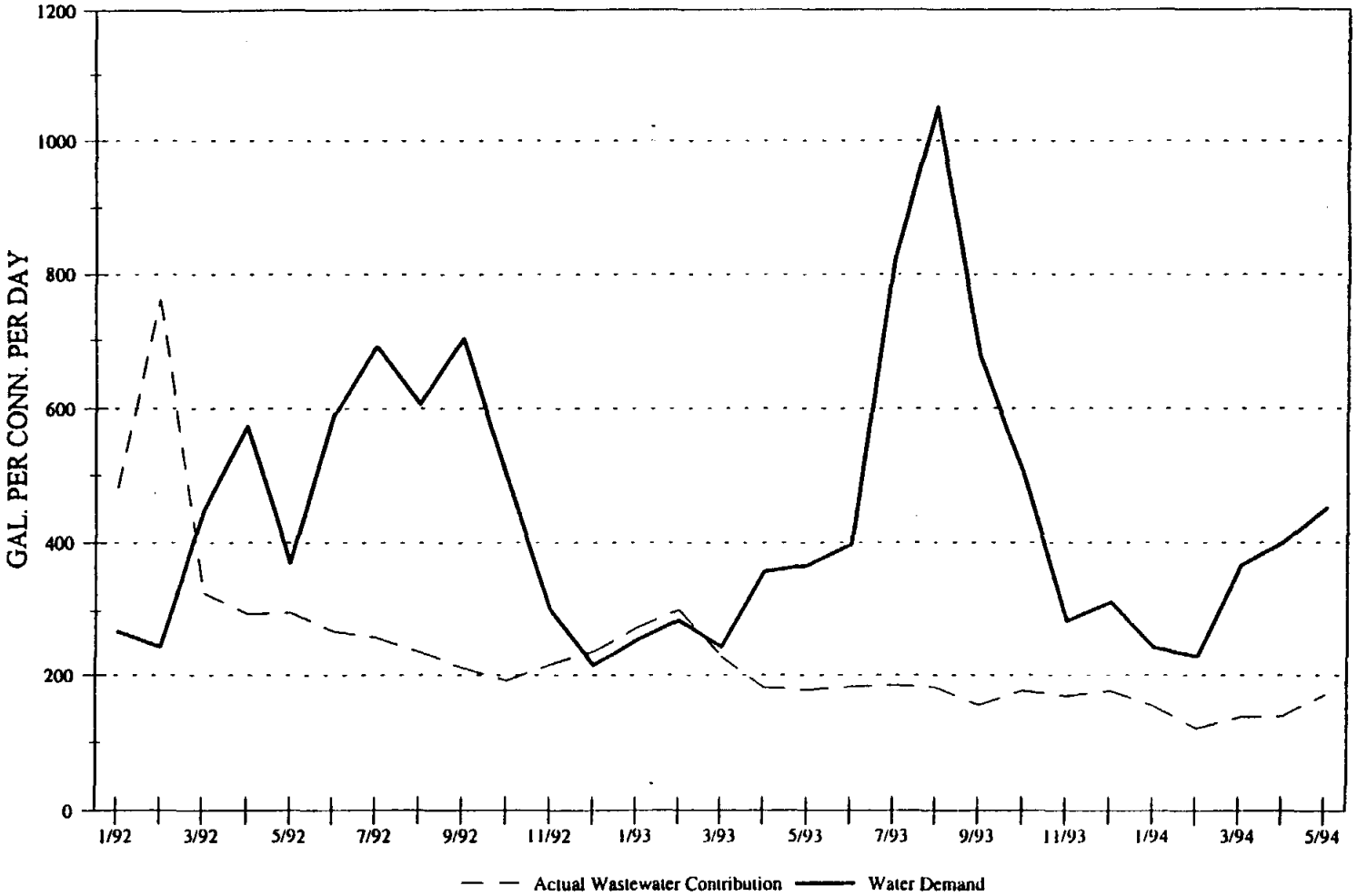


FIGURE V-3

WASTEWATER CONTRIBUTION VS WATER USAGE
HURST CREEK MUD
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

contribution during this time was approximately 165 gallons per connection per day. In fact, 165 gallons per day was the average wastewater contribution from May 1993 to May 1994.

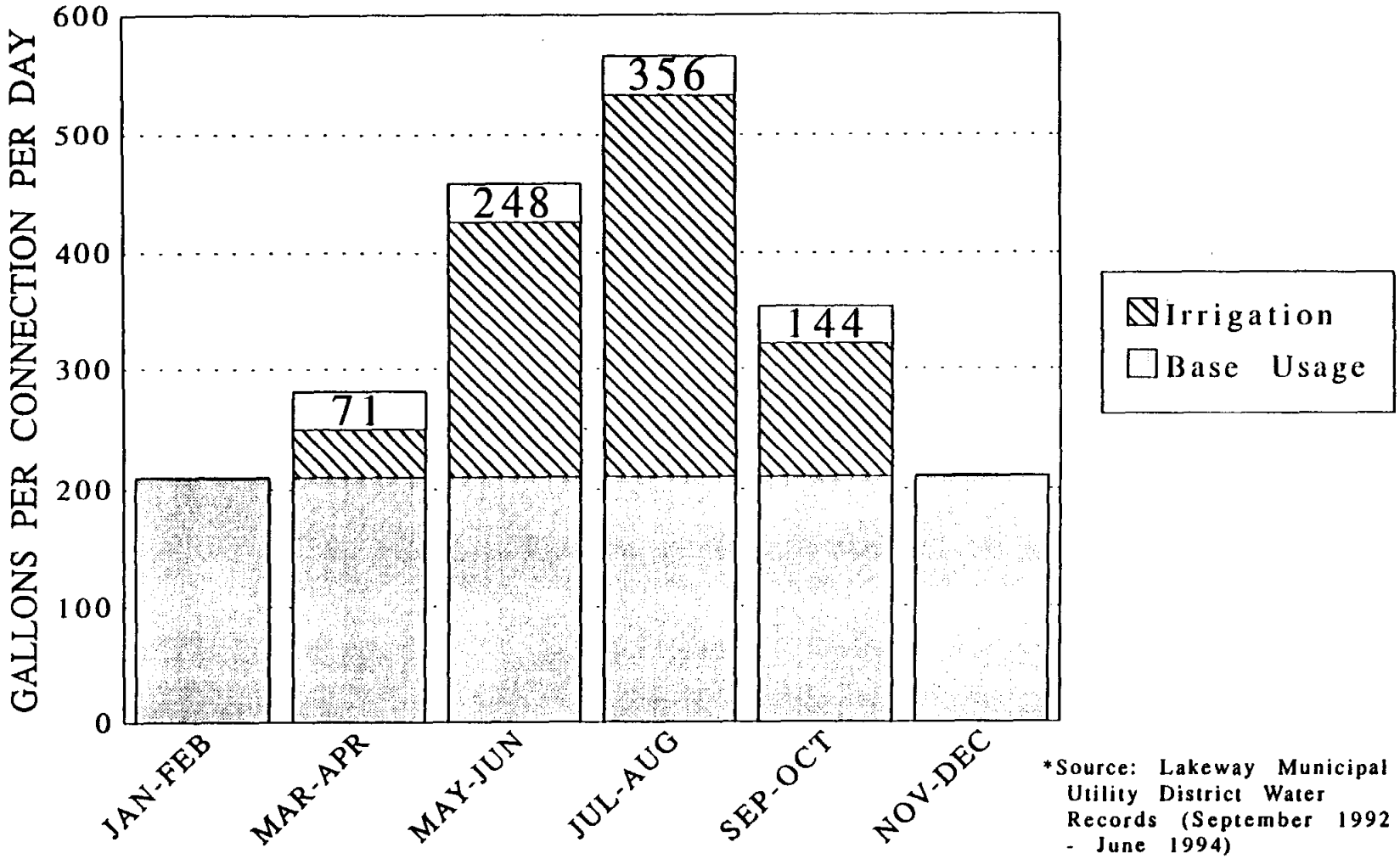
The relatively constant wastewater contribution levels during this time can be assumed to represent the internal water uses. As a result, water demands for HCMUD in excess of 165 gallons per connection per day can be assumed to be primarily associated with irrigation activities, even during the winter months.

The information concerning the monthly variation in water demand for LMUD and HCMUD is presented in Figures V-4 and V-5. Based on this information, it appears as though the annual irrigation demand in LMUD is 60,000 gallons per connection. The annual irrigation demand in HCMUD is approximately 100,000 gallons per connection.

Cedar Tree Irrigation

Lakeway MUD has been authorized, through its 1994 permit amendment for the Central Plant, to include the irrigation of cedar trees as an effluent management technique. The permit issued by the TNRCC allows cedar tree irrigation on a demonstration basis. Under the permit terms, LMUD will be irrigating 45 acres of cedar trees during the winter months. The irrigation will only occur during periods when the production of effluent exceeds the evapotranspiration demands of the golf course and the amount of effluent being stored is increasing rapidly. By using the cedar tree irrigation in this manner, LMUD will be reducing the amount of storage required during the winter months. It is unknown whether the TNRCC will approve another cedar tree demonstration project until sufficient data exists to justify the method as proven technology.

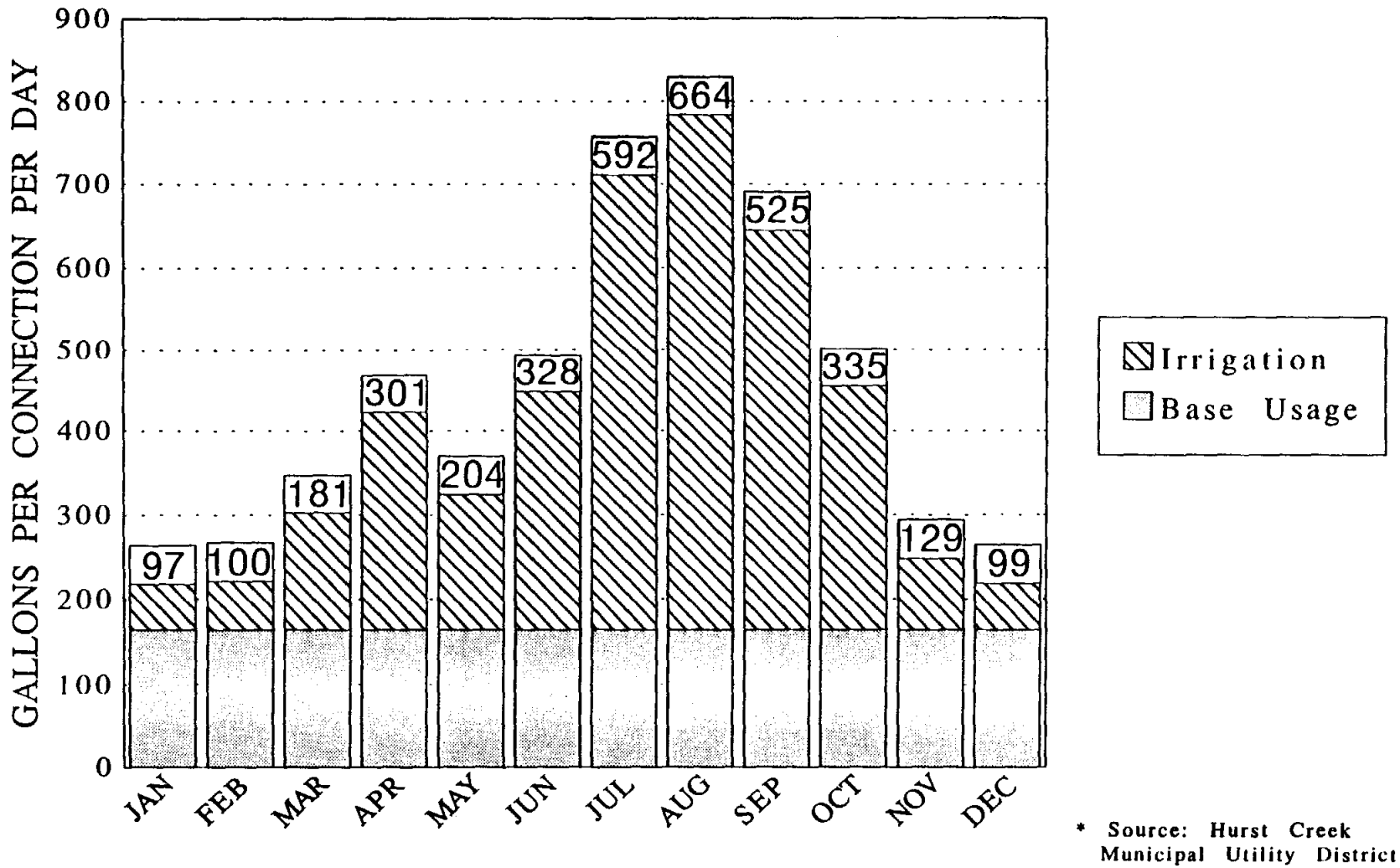
This type of management practice will reduce the amount of storage required; and, since the effluent storage ponds must be lined, this represents a significant cost savings. However, the irrigation of cedar trees will remove land from the developable inventory and will require the installation of an irrigation system.



*Source: Lakeway Municipal Utility District Water Records (September 1992 - June 1994)

FIGURE V-4

AVERAGE DAILY IRRIGATION DEMAND*
LAKEWAY MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY



* Source: Hurst Creek Municipal Utility District

FIGURE V-5

AVERAGE DAILY IRRIGATION DEMAND*
HURST CREEK MUNICIPAL UTILITY DISTRICT
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

REGULATORY REQUIREMENTS FOR EFFLUENT MANAGEMENT ALTERNATIVES

The management and disposal of treated wastewater effluent through land application is controlled by the rules set forth in Chapter 309, Subchapter C "Land Disposal of Sewage Effluent". This subchapter of the Texas Natural Resource Conservation Commission (TNRCC) Permanent Rules contains specific requirements concerning the irrigation activities associated with the management of wastewater effluent. Any reuse activity proposed by a regional reuse utility would need to comply with these provisions if the reuse activity is to be included in a permit as an authorized effluent management technique. If a reuse can not meet these requirements, other effluent management techniques will need to be proposed so that sufficient effluent management capabilities can be demonstrated in the permit.

Reuse activities that do not meet the requirements of Chapter 309 can still be provided with reclaimed water for irrigation purposes. However, the operation of these reuse activities would need to comply with Chapter 310, "Use of Reclaimed Water" of the TNRCC Permanent Rules. The specific requirements included in these two chapters are discussed in the following sections.

Chapter 309 Requirements

The requirement contained in Chapter 309 that may have the largest impact on whether or not a proposed reuse application is acceptable for consideration as an effluent management technique in a wastewater treatment permit is the requirement that the permittee have control over the application of the reclaimed water. In practical terms, in order to have control over the irrigation operations, the permittee must be able to decide whether or not reclaimed water is applied based on the permittee's effluent management needs.

This issue of control is a particularly important consideration for several of the different types of effluent management alternatives previously identified in this Chapter. For example, the use of reclaimed water for the irrigation of residential lawns would not meet the requirements of Chapter 309 if the residents had the ability to refuse or accept the reclaimed water at any time.

The irrigation of parks and common areas around condominium developments are other effluent management alternatives that may be impacted by this requirement.

As a result of these requirements, the irrigation of lawns cannot be considered as an effluent management method. However, the irrigation of residential lawns can be accomplished under the provision of Chapter 310, which is discussed in the next section. For the purposes of this study, the use of reclaimed water for residential lawns will be considered as a secondary use available from a regional reuse utility.

The other significant requirement contained in Chapter 309 concerns the effluent quality requirements established for different types of management techniques. These requirements are set forth in Subchapter A of Chapter 309. This portion of the rules identifies two different classes of effluent management techniques. The first class would include techniques that involve irrigation operations where the public has access to the irrigated area and may potentially be exposed. This class would include the irrigation of areas such as golf courses, residential lawns, parks, and condominiums. The second class would include irrigation operations where the public does not have access to the irrigated land. This class would include irrigation activities such as the proposed cedar tree irrigation. The quality criterion for the first class of effluent management techniques identifies that the effluent must meet secondary treatment levels which are defined by the following quality standards:

pH 6.0 - 9.0
BOD_5 65 mg/l for a single grab

The quality criterion for the second class of effluent management techniques identifies that the effluent must meet primary treatment levels which are defined by the following quality standards:

pH 6.0 - 9.0
BOD_5 100 mg/l for a single grab

Chapter 310 Requirements

For those reuse opportunities that do not meet the requirements of Chapter 309, the regional reuse utility may pursue approval of the activities under Chapter 310. Chapter 310 establishes similar requirements for effluent storage and the irrigation operations. The most significant difference between the two chapters involves the quality requirements. The quality requirements of Chapter 310 for areas with unrestricted access, such as parks, are as follows:

BOD_5	30-day average not to exceed 5 mg/l
Turbidity	30-day average not to exceed 3 nephelometer turbidity units (NTU)
Fecal Coliform	Single grab not to exceed 75 colony forming units (CFU)/100 ml

The quality requirements for areas with restricted access, such as golf courses, are as follows:

BOD_5	30-day average not to exceed 10 mg/l
Turbidity	30-day average not to exceed 5 NTU
Fecal Coliform	Single grab not to exceed 200 CFU/100 ml

REGULATORY REQUIREMENTS FOR STORAGE

Whether effluent is being used for irrigation in accordance with Chapter 309 or Chapter 310, sufficient storage must be provided. These chapters have the same requirements for storage of effluent. The storage facilities must be adequately sized, designed to protect groundwater quality, and located so that surface waters are not impacted. The following sections discuss these issues in more detail.

Storage Pond Sizing

Typically, the quantity of effluent disposed by irrigation is greater during the summer months than during the winter months. This is due to the increased evapotranspiration of crops during

the growing season, an increase in the evaporation rate, and a decrease in rainfall. As a result, most utilities have found it cost effective to provide storage for effluent during the winter months when irrigation demands are decreased and use the stored effluent during the summer months when irrigation demands exceed the quantity of effluent provided by the treatment plant.

The alternative to providing this operational storage would be to secure enough land for irrigation to meet 100 percent of the disposal needs during the winter months. In most cases, this alternative would require an excessive amount of land for irrigation. In addition, it would not totally eliminate the need for storage, since periods of inclement weather will prohibit the application of effluent.

In order to mitigate potential problems due to extended periods of wet weather, the TNRCC has established rules for sizing effluent storage facilities. These requirements are set forth in Chapter 309.20 (b)(3)(B). The required storage is based on a design rainfall year with a return frequency of 25 years. This can be accomplished by analyzing the last 25 years worth of rainfall records to determine the maximum annual rainfall during the period or by examining a longer period and statistically determining the 25-year rainfall frequency. This 25-year rainfall quantity is then distributed throughout the year based on a normal monthly rainfall pattern for the area.

In order to calculate the amount of storage required, a water balance analysis must be conducted. The methodology for these calculations is set forth in Chapter 309. The methodology requires a month-by-month comparison of irrigation demand to quantity of wastewater produced at the permitted capacity. When the production of wastewater exceeds the irrigation demand, this excess must be held in storage. If the production of wastewater exceeds the irrigation demand in successive months, the excesses must be allowed to accumulate in a storage facility. The total amount of storage that is required is the maximum accumulation of effluent calculated for a year with a rainfall return frequency of 25 years.

In addition to the TNRCC rules governing the size of effluent storage ponds, the Cities of Austin and Lakeway both have ordinances that impact the amount of storage required for new

developments that propose utilizing land disposal of its treated effluent. In both cases, the amount of storage required is 100 days at the average wastewater production rate.

While the two city ordinances do not directly apply to the operation of the two municipal utility districts and would likely not apply to a regional reuse utility operator, any new subdivision would need to demonstrate compliance with these rules before receiving plat approval from the appropriate city. In a worst case scenario, it is possible that new developments might have to prove that the utility system providing wastewater service to the development meets this criteria for its entire system. If this is the case, variances from this provision might be required in order to obtain plat approval.

Storage Construction

The primary criteria governing the construction methods used for effluent storage facilities is the requirement to protect groundwater resources in the area. In most instances, where the storage facility is a pond, the pond must be lined to impede the downward migration of effluent. Chapter 317 sets forth the following criteria for liners to be used for all earthen structures proposed for use in domestic wastewater treatment or storage.

- In-situ or placed clay soils having the following qualities may be utilized for pond lining:
  - more than 30% passing a 200-mesh sieve;
  - liquid limit greater than 30%;
  - plasticity index greater than 15; and
  - a minimum thickness of 2 feet.
- A membrane lining with a minimum thickness of 20 mils, and an underdrain leak detection system.
- Other methods with commission approval.

Storage Location

The location of storage facilities must be selected to protect both groundwater and surface water, and to minimize potential negative impacts on adjacent properties. The TNRCC will review all siting issues during the application process for new facilities or existing facilities proposing substantial changes. During this review, the TNRCC may consider the following factors.

1) Active geologic processes such as flooding, erosion, subsidence, submergence, and faulting.

2) Groundwater conditions such as groundwater flowrate, groundwater quality, length of flow path to points of discharge, and aquifer recharge or discharge conditions.

3) Soil conditions such as stratigraphic profile and complexity, hydraulic conductivity of strata, and separation distance from the facility to the aquifer and points of discharge to surface water.

4) Climatological conditions.

In addition, the Cities of Lakeway and Austin have ordinances which control development within the study area. If a storage site is proposed to be located within the corporate city limits of the City of Lakeway, compliance with the City's Zoning Ordinance would be required. This would limit the potential sites to those that could be zoned for this type of use. If a storage site is proposed to be located in either the City of Lakeway or the City of Austin Extraterritorial Jurisdiction, the construction will have to be compliant with the subdivision and watershed ordinances of the appropriate city. It is anticipated that these ordinances may impose limitations on any proposed pond due to limits on cut and fill operations. Both cities limit the amount of excavation or fill to four feet. A variance from this requirement will need to be obtained in order to make a pond feasible.

CHAPTER VI
REGIONAL REUSE UTILITY ALTERNATIVES

The development of a regional reuse utility in the Lakeway area represents a unique opportunity to provide a coordinated approach to the future management of the effluent disposal practices in the area. The implementation of a regional reuse utility will require the establishment of a new entity with defined authorities and responsibilities. These authorities and responsibilities must be defined in long-term contracts with the effluent producers in the area and through negotiations with the Texas Natural Resource Conservation Commission (TNRCC). In addition, significant infrastructure improvements will be required to develop a regional system for projected effluent disposal needs in the study area. These subjects are discussed in the following sections.

INSTITUTIONAL FRAMEWORK

For the purposes of this study, it is assumed that an existing, regional entity, such as the Lower Colorado River Authority (LCRA), or a new entity will operate the regional reuse utility. This entity will contract with the two municipal utility districts (MUDs) to provide effluent management services as well as provide reclaimed water to users. As a result, the regional operator will be required to obtain a permit from the TNRCC for the storage/disposal of wastewater effluent. The MUD permits will be amended to reflect the discharge of 100 percent of their effluent to the regional reuse utility.

It is important to note that the TNRCC has not issued a permit authorizing this type of operation. As a result, the permit conditions that might be imposed are uncertain. However, it is anticipated that the permit for the regional reuse operator would contain quality limits for the water withdrawn from the effluent storage ponds and sent to the effluent disposal sites. As long as the quality limits are based on secondary treatment as identified in Chapter 309, this is not expected to pose a particular problem. However, if irrigation operations authorized under Chapter 310 are proposed, particularly if it is a site with unrestricted access, this provision may require the installation of additional treatment at the effluent storage ponds.

As a result of this change in responsibility, the MUDs will no longer need to own or operate effluent storage or effluent irrigation facilities. It is anticipated that these facilities will be used by the

regional reuse utility operator. Therefore, it is assumed that ownership or control by contract of all effluent storage ponds, effluent pump stations, effluent force mains, irrigation equipment, and property for irrigation currently owned by the MUDs will be transferred to the regional utility. The method used to transfer these assets to the regional utility would need to be defined through a negotiation process.

In addition, the existing contracts between the MUDs and the golf course operators for the use of the golf courses as effluent disposal areas must be assigned to the regional utility operator. The terms under which this transfer occurs will need to be determined through negotiations.

The formal transfer of property and contracts should be linked to the execution of long-term contracts between the regional utility operator and the two MUDs. The contracts should address the legal and financial relationships between the regional utility operator and the two MUDs. In addition, the contracts should address the disposition of the assets obtained by the regional utility should the contracts be terminated or allowed to expire.

The contracts should also address how future planning will be conducted by the regional utility, so that the anticipated growth within the area is accommodated in a timely fashion. This aspect of the relationship has been addressed by other regional utilities by developing steering committees for the regional utilities. A steering committee is made up of representatives of the entities served, as well as the regional utility operator. This committee could include representatives from the two MUDs, LCRA, the City of Lakeway, and the major developers in the area. This committee could then provide guidance to the regional utility operator concerning future needs.

MAJOR FACILITIES REQUIRED

In order to meet the projected effluent disposal needs for the Lakeway area through the year 2020, significant expansions to the existing effluent disposal systems are needed. These improvements include effluent storage ponds and additional irrigation facilities.

The amount of additional storage required will be dependent upon the amount of land that is dedicated for effluent disposal and the amount of winter-time irrigation activities such as the proposed cedar tree irrigation. The amount of additional storage required is determined through water balance analyses of the wettest year in the past 25 years.

A water balance was completed for a number of scenarios with different combinations of turf irrigation and cedar tree irrigation. The water balance calculations are based on total effluent disposal demands in the year 2020 and the evapotranspiration rates for LMUD's Central Plant as presented in the permit application, which was recently approved. The water balance calculations resulted in the determination of the total amount of storage required for the 25-year wet year. The results of these calculations are illustrated in Figure VI-1. In addition, the calculations also determined the amount of raw-water that would be required to meet the peak summer-time turf irrigation demands during an average rainfall year. This information is presented in Figure VI-2. This raw-water demand is a result of the lack of sufficient effluent for turf irrigation during the latter part of the dry season.

The effluent disposal needs of the Lakeway area can be met by any combination of irrigation activity and storage requirement presented in Figures VI-1 and VI-2. However, these options have significantly different cost ramifications. In order to make a selection of the appropriate mixture of irrigation acreage and storage capacity, an opinion of the most probable cost of each component must be made. Once unit costs for each component are evaluated, the costs can be combined for each of the alternative scenarios represented in Figures VI-1 and VI-2.

The preliminary unit cost information developed for each of the effluent disposal components includes costs that might ultimately be reimbursed by developers in the area. However, since the costs will be incurred and passed on to new residents in the area, an attempt to include probable costs in the analysis was made.

In general, the costs associated with effluent disposal operations can be included in one of three categories. These categories include the following:

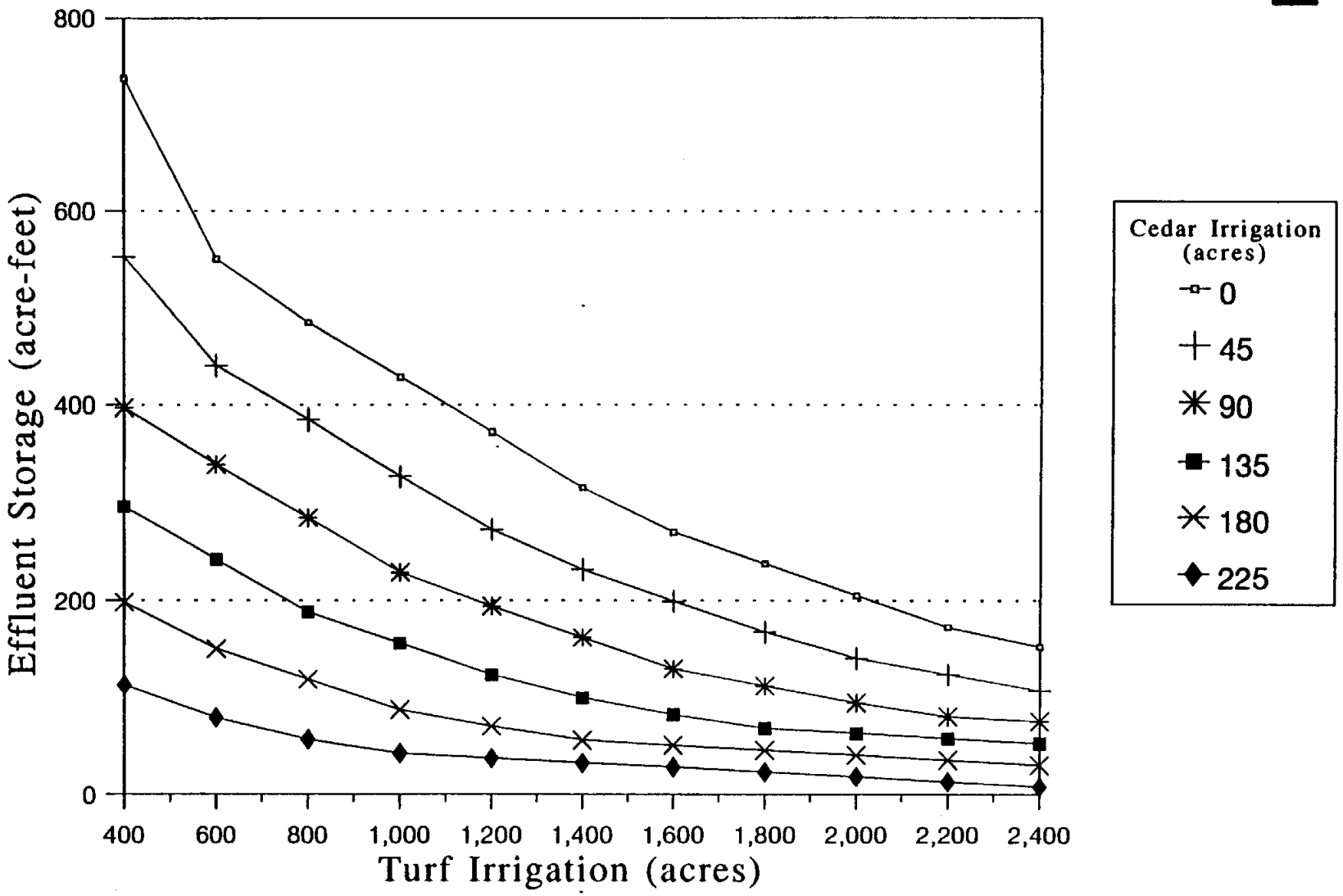


Figure VI-1
Effluent Storage Requirements-2020 Flows
Lakeway Regional Reuse Utility Feasibility Study

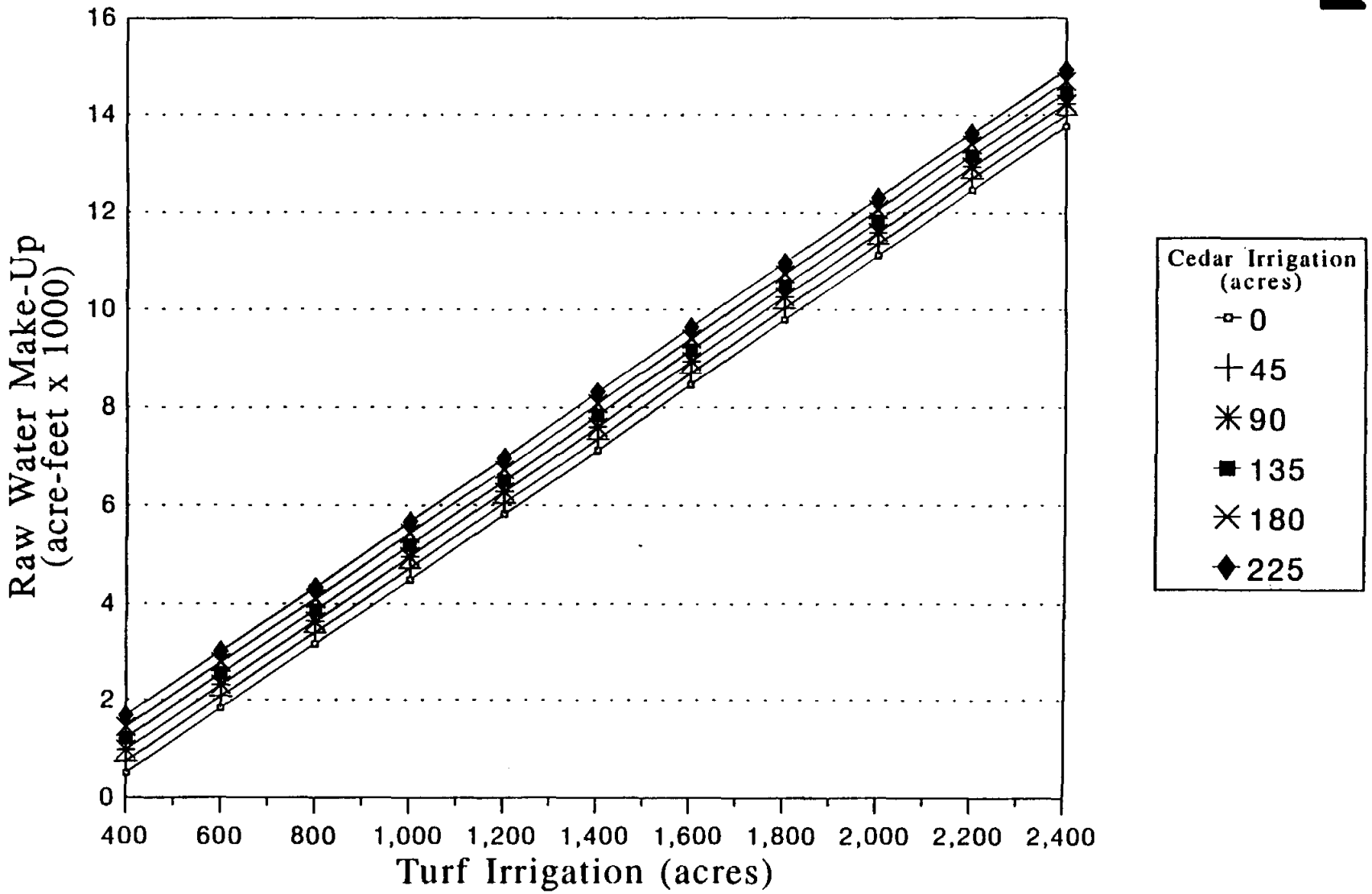


Figure VI-2
Raw Water Make-Up Requirements
Lakeway Regional Reuse Utility Feasibility Study

1. Initial land costs
2. Construction costs
3. Cost of raw water for make-up

General cost information has been included for each component of the effluent disposal operations so that a unit cost can be determined. The unit costs for effluent storage, turf irrigation, and cedar tree irrigation include initial land costs and construction costs for on-site facilities. The cost of transmission lines to convey the effluent from the WWTP to the site was not included since individual sites have not yet been identified. It is important to note that this cost information is very preliminary since information concerning specific site constraints is not available. As a result, conservative values have been selected for the various components. This type of analysis is necessary to determine an appropriate mixture of irrigation acreage versus storage capacity even though the cost information is not complete. The following unit costs were developed for this analysis.

- Effluent Storage = $40,000/acre-foot
- Turf Irrigation = $10,000/acre
- Cedar Tree Irrigation = $23,000/acre
- Raw Water for Make-Up = $105/acre-foot

In order to provide a cost comparison for future effluent disposal alternatives, only those costs for additional facilities required for each alternative was considered. For example, for a future disposal combination of 1000 acres of turf irrigation, 90 acres of cedar tree irrigation, and effluent storage of 220 acre-feet, the future cost is based on these quantities less the existing 400 acres of turf irrigation, 45 acres of cedar tree irrigation, and 64 acre-feet of effluent storage capacity.

The cost of raw water for make-up is a recurring expense. In order to make a valid comparison, it was necessary to convert this annual expenditure to a net present worth value. Once this has been accomplished, a net present worth unit cost for each component can be determined.

The net present worth unit cost for each component was then applied to the quantities calculated through the water balance analysis for a series of scenarios to determine a total present worth cost

for each of the alternative scenarios investigated. The unit costs were only applied to facilities needed in addition to existing facilities. This information is presented in Figure VI-3.

It can be seen from the graph that the least costly alternative would be to maximize the amount of cedar tree irrigation to eliminate the need for additional storage capacity and turf irrigation. It is estimated that 255 acres of cedar irrigation would be needed to achieve this goal. At this level of irrigation, 1,843 acre-feet of raw water would be required annually to meet the peak summer-time irrigation needs.

As previously indicated, the practice of irrigating cedar trees as an alternative to providing storage has been approved on a demonstration basis only. The continued authorization, or the expansion of these activities cannot be taken for granted. As a result, a water balance analysis was also conducted assuming that cedar irrigation would be discontinued. The results of this analysis indicate that the least costly alternative would be to provide 600 acres of turf irrigation and 551 acre-feet of storage. This alternative would require the addition of 200 acres of turf irrigation and 487 acre-feet of storage. The amount of make-up water required annually for this alternative is 1,836 acre-feet.

As an intermediate alternative, if 90 acres of cedar tree irrigation were provided, the least cost alternative would involve 400 acres of turf irrigation and 397 acre-feet of storage. This would require 333 acre-feet of storage and 45 acres of cedar tree irrigation in addition to the existing facilities. However, no additional turf irrigation would be required. The annual amount of raw water required for make-up would be 980 acre-feet. The water balance calculations for this alternative are presented in Appendix D.

The timing of these needs are greatly dependent upon the development of the Lakeway West and Rough Hollow areas. As a result, the major facilities are discussed in the following sections in terms of an immediate improvement plan and an ultimate improvement plan.

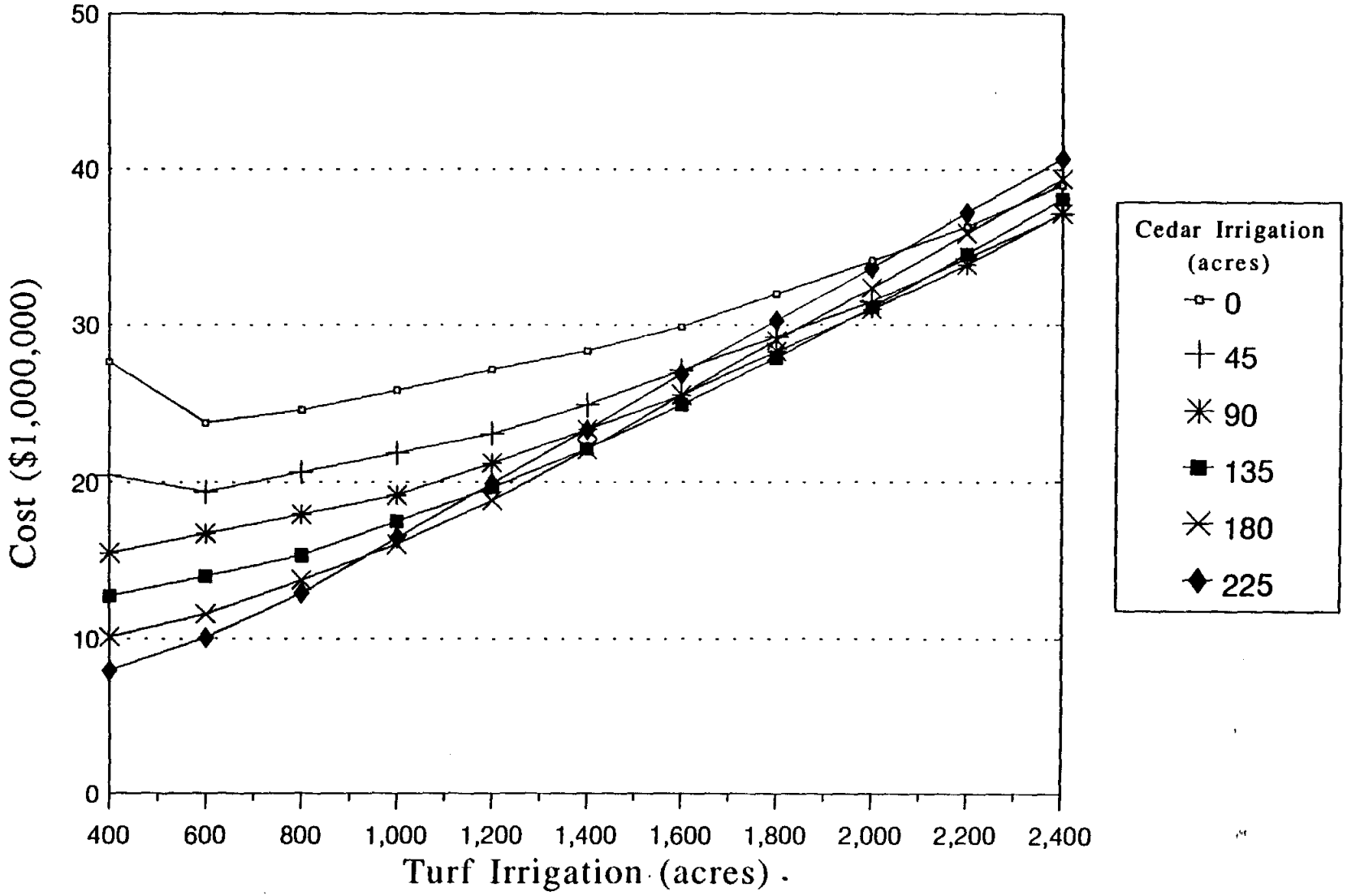


Figure VI-3
Relative System Cost
Lakeway Regional Reuse Utility Feasibility Study

Immediate Improvement Plan

The implementation of a regional reuse utility in the Lakeway area would require the construction of pipelines to link the various effluent disposal operations of the two MUDs. By linking the four wastewater treatment plants in the area with the effluent storage ponds and the various irrigation sites, the regional utility operator would be able to make the best use of the existing infrastructure to meet the existing effluent disposal demands. The following potential benefits could be realized by either Lakeway MUD (LMUD), Hurst Creek MUD (HCMUD), or both.

- A decrease in the amount of raw water used as make-up water for the irrigation of the golf courses.
- A delay in the need to acquire additional area for irrigation.
- A delay in the need to acquire additional effluent storage facilities.
- A better state-permit negotiating position afforded by the flexibility provided by a regional system.

Three alternative routes for pipelines to connect the three separate effluent disposal systems were investigated. These alternatives are illustrated on Figure VI-4. The first alternative represents the minimum amount of pipe that must be constructed to connect the systems. Depending upon the amount of effluent to be transferred, and the timing required, effluent could be transferred between systems under this alternative using the existing pumps. The total amount of pipe required is 4,250 linear feet. The preliminary opinion of probable cost for this alternative is $210,000.

The second alternative includes additional pipelines to connect the systems in a manner that also provides effluent to other areas within the existing development that could be used for irrigation purposes. These areas would include roadway medians, the airstrip, parks, the World of Tennis, and condominium developments. Under this alternative, the regional utility operator would be able to transfer effluent from one system to another with the same provisions identified in Alternative 1. In addition, approximately 175 acres of turf irrigation would be available bringing the total amount of land under irrigation to 575 acres. This alternative would require the installation of approximately

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192,00 linear feet of pipeline. The additional pipeline included in the phase is proposed to be 4-inches in diameter. The preliminary opinion of probable cost for this alternative is $680,000.

The third alternative would provide the pipelines to connect the three systems and provide effluent to other areas for irrigation purposes depending upon their proximity to the existing pipelines and the likelihood that these areas could be utilized as effluent disposal areas. The additional irrigation areas included in this alternative are the median area of Lakeway Blvd., the airstrip, and the World of Tennis. This alternative would provide approximately 5 acres for additional effluent disposal sites bringing the total amount of land under irrigation to 405 acres. The alternative would require the installation of approximately 13,000 linear feet of pipeline. The pipeline included in this alternative, in addition to the pipeline in Alternative 1, is proposed to be 4-inches in diameter. The preliminary opinion of probable cost for this alternative is $490,000.

By combining the operations of the various effluent disposal facilities, developing a regional reuse utility in the area will change the overall effluent disposal capacity. A water balance was completed for each of the three immediate phase alternatives. The results of those calculations indicate that the combined systems would have the capacity to dispose of 0.72 million gallons per day (MGD) under Alternative 1; 0.82 MGD under Alternative 2; and 0.77 MGD under Alternative 3. These capacities reflect the effluent disposal capacity and do not address any possible limitations that may exist in either the wastewater or water treatment capacities.

The combined effluent management capacity of the regional utility is estimated to be less than the summation of the existing capacities of the three separate disposal systems. The apparent loss in capacity is due to the assumption that as a result of the need to amend the existing permits, discharges to Hurst Creek may no longer be allowed, as they are currently allowed in the HCMUD permit. In addition, credit for storage capacity in the ponds on the Hills golf course was not considered. Since HCMUD is authorized to discharge effluent to Hurst Creek, it is not required to maintain a specific storage capacity. Additionally, the fact that the ponds on Hurst Creek are operated at near bank full conditions, the amount of storage available is limited.

If a regional utility can be created while maintaining the authorization to discharge 0.25 MGD, or if the TNRCC will approve the use of the golf course ponds as storage facilities, the total capacity for the combined system would be 0.97, 1.07, and 1.02 MGD respectively. This would be sufficient to meet the disposal needs between the years 2001 and 2005. If the regional utility can maintain the right to discharge 0.65 MGD, in accordance with HCMUD final permit limit, the combined capacities would be 1.37, 1.47, and 1.42 MGD respectively. These capacities would be sufficient to meet the disposal needs between the years 2012 and 2015.

Ultimate Facilities Needs

The ultimate need for additional effluent disposal facilities, assuming that discharges will not be allowed in the future, is dependent upon the amount of cedar tree irrigation incorporated into the ultimate plan. Since the cedar tree irrigation has been approved on a demonstration basis, the future is uncertain. It is conceivable that cedar tree irrigation could be eliminated in the future. It is equally conceivable that cedar tree irrigation could be expanded to the 255 acres required to eliminate the need for additional storage and turf irrigation sites.

Since the future is relatively uncertain, it is recommended that the ultimate facilities needs be based on an estimate of the amount of cedar tree irrigation between the two extremes identified in the previous paragraph. For the purposes of this study, it is assumed that 90 acres of cedar tree irrigation will be incorporated into the final plan. This represents a doubling of the existing authorization.

Effluent Storage Ponds

Lakeway MUD currently owns and operates two effluent storage ponds totalling 62.5 acre-feet. In addition, the MUD maintains an effluent storage tank for temporary storage of effluent with a capacity of 150,000 gallons. HCMUD maintains several on-line ponds on the Hills of Lakeway Golf Course. These ponds do not contain an appreciable amount of effluent storage capacity since they are operated as constant-level ponds for aesthetic reasons. HCMUD also uses a 350,000 gallon tank to store water for irrigation purposes. The two tanks represent an additional 1.5 acre-feet of available storage.

The projected amount of effluent storage required to meet the storage needs in 2020 is 397 acre-feet. Therefore, an additional 333 acre-feet of storage is required. Four alternative locations for storage ponds have been identified and evaluated. These locations are illustrated in Figure VI-5.

Site 1 is located on approximately 135 acres of land located east of Hurst Creek MUD. The tract is bounded by Lohmans Crossing Road on the north and east side, the Hurst Creek MUD boundary on the westside, and undeveloped hill country on the southside. The elevation of the tract ranges from a low of 900 feet to a high of 960 feet.

It is estimated that 333 acre-feet of storage could be constructed on approximately 40 acres of this tract by excavating material to form a levee with an elevation of 945 feet. The pond would resemble an inverted four-sided pyramid with a flat bottom. The surface area would be approximately 20 acres and the pond's average depth would be 20 feet. The opinion of most probable cost of construction of the pond on Site 1 is $13.5 million.

Site 2 is located in the middle of the Lakeway West area in the upper reaches of a draw that drains storm water runoff to Rough Hollow Cove. An earthen dam would need to be constructed across the upper most part of the draw to form a pond. The most efficient pond configuration for this site would most approximate an inverted three-sided pyramid with a flat bottom. Uphill surface runoff would need to be diverted around the pond.

It is estimated that 333 acre-feet of storage could be constructed on approximately 20 acres of this site. The surface area would be approximately 10 acres and the pond's average depth would be 20 feet. The opinion of most probable cost of construction of the pond on Site 2 is $13.3 million. The top of berm elevation would be approximately 860.

Site 3 is located west of the World of Tennis member and guest quarters and north of the Tennis complex. This site would provide close proximity to existing wastewater treatment and irrigation system infrastructure.

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As with Site 2, an earthen dam could be built across the draw to limit the amount of rock excavation. The elevation of the top of the dam would be approximately 900 feet. The triangular shaped surface of the pond would have approximately 10 acres of surface area, with each of the three sides approximately 975 feet in length, and an average depth of 20 feet. The opinion of most probable cost of construction of a pond on Site 3 is $13.3 million.

Site 4 is located approximately 1000 feet west of the Pedernales Electric Cooperative, substation on the southeast border of Lakeway West. This site is in close proximity to HCMUD and in the middle of the north-south axis of Lakeway West.

As with Site 2, an earthen dam could be built across the draw to limit the amount of rock excavation. The elevation of the top of the dam would be approximately 880 feet. The triangular shaped surface of the pond would have approximately 7 acres of surface area, with each of the three sides approximately 835 feet in length, and an average depth of 30 feet. The opinion of most probable cost of construction of a pond on Site 4 is $13.7 million.

Additional Turf Irrigation Sites

As previously discussed additional turf irrigation will not be required until after the year 2020.

However, the provision of additional turf irrigation sites could reduce the overall costs of the effluent management alternatives if the sites can be provided at a lower cost and/or the irrigation operation would not require as much make-up water. For instance, it is possible that developers could provide additional median areas for irrigation purposes at a lower cost because the land must be dedicated as right-of-way for the street anyway. The irrigation demand presented by these median areas would not be as intense as a golf course and therefore would not require as much make-up water.

If the right-of-way throughout a subdivision is used for irrigation purposes, effluent force mains will need to be constructed throughout the subdivision. As a result, the infrastructure necessary to provide reclaimed water to individuals for the irrigation of their lawns would be in place. Service lines with meters could be connected to these effluent lines with minimal additional costs. Secondly, the City

of Lakeway Subdivision Ordinance currently requires that 20 feet of non-paved right-of-way be provided for all categories of streets. If this area is used for irrigation, it would reduce the amount of land to be taken out of the developable inventory for irrigation purposes. Finally, the need to provide make-up water for irrigation purposes in the early stages of development, when effluent production is at its lowest, and during drought conditions would be less for rights-of-way than for either golf courses or parks.

Additional Cedar Irrigation Sites

The LMUD is currently authorized to irrigate 45 acres. It is estimated that an additional 45 acres could be made available for the irrigation of cedar trees adjacent to the existing site. This would meet the total acreage identified for the year 2020. The expansion of this facility would increase the capacity of the regional system to 0.98 MGD, which would meet the needs through the year 2001.

Additional Pumping and Transmission Needs

The initial step in implementing a regional utility would be to link the effluent disposal systems of the two MUDs. This would be accomplished under the Initial Phase discussed in the previous section. Beyond these improvements, effluent pumps and piping would be required to move the effluent to and from the new storage facility and the location of the irrigation sites. Since the location of the wastewater treatment plant to serve Lakeway West and the irrigation sites will not be defined until the development of the Lakeway West area is imminent, it is difficult to determine the transmission facilities needed.

CHAPTER VII
COST ANALYSIS

In order for the implementation of a regional reuse utility to be considered feasible, it must provide a cost-effective means of meeting the area's effluent disposal needs. In determining whether a regional reuse utility is cost-effective, all potential costs and sources of revenue must be considered. The costs to be considered include existing debt retirement costs due to existing infrastructure, future capital costs associated with proposed improvements, and operations and maintenance costs. The potential sources of revenue for a regional reuse utility include charges to the effluent producers for disposal activities, charges to users of the effluent, and credits due to the avoidance of future costs to expand the water treatment capacities. These issues are discussed in more detail in the remainder of this chapter.

OPINION OF PROBABLE COSTS

As previously discussed, the costs of operating the proposed regional reuse utility will fall into one of three categories, existing debt retirement obligations, annual operations and maintenance expenditures, and proposed capital expenditures. Each of these categories will be discussed in terms of both the immediate phase alternatives and the ultimate facilities needs.

Existing Debt Retirement Obligations

Both Lakeway Municipal Utility District (LMUD) and Hurst Creek Municipal Utility District (HCMUD) have spent considerable sums of money developing their respective utility systems. In order to obtain the money necessary to construct the facilities, to provide safe, reliable utility services to their respective customers, both municipal utility districts (MUDs) had to borrow money through the issuance of bonds. The terms of these bond issues require that the MUDs make annual payments to retire the debt incurred. Since the ownership of some of the assets constructed with the borrowed money would change as a result of the implementation of the regional reuse utility, the continuation of debt payments must be addressed. In fact, depending

upon the bond requirements, the debt for these facilities may need to be restructured in light of the change in ownership.

Regardless of the ownership of the facilities or the status of the existing bond covenants, it is anticipated that the existing debt retirement costs will remain unchanged under each of the alternatives evaluated. Since the debt retirement will remain unchanged from the existing conditions, the fulfillment of these debt retirements will not have a bearing on the feasibility of a regional reuse utility and were not incorporated into this analysis.

Operation and Maintenance Costs

The operation and maintenance costs for a regional reuse utility will include the following categories of costs, labor, recurring expenses, power consumption, and routine maintenance work. It is anticipated that the operational costs for a regional reuse utility will not change significantly from the existing operation and maintenance costs. In fact, the future costs may be slightly lower due to economies of scale and the more efficient use of available resources to limit the amount of raw water used for make-up. For the purposes of this analysis, the conservative assumption that operation and maintenance costs will not change will be used.

Future Capital Costs

Opinions of probable future capital costs have been prepared for each of the alternatives investigated. A summary of the probable capital costs is included in Table VII-1. In addition to the opinions of total probable costs, an estimate of the annual debt retirement for several interest rates and terms have been included. Finally, an opinion of the probable cost per 1000 gallons of disposed effluent has been calculated for each alternative.

TABLE VII-1

OPINION OF PROBABLE COSTS
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Item	Immediate Plan Alternative 1	Long-Term Plan[1]
Effluent Storage	$ 0	$ 13,300,000
Turf Irrigation	0	0
Cedar Irrigation	0	1,035,000
Pumping/Piping Improvements	210,000	1,433,500[2]
Total	$ 210,000	$ 15,768,500
Annual Debt Retirement[3]	19,823	1,488,471
Annual Cost/1000 Gallons	$ 0.08[4]	$ 2.13[5]

[1]Assumes 397 acre-feet of storage (333 additional acre-feet) and 90 acres of cedar tree irrigation (45 additional acres).
[2]Provides an allowance equal to 10 percent of other costs.
[3]Annual debt retirement based on 7 percent interest over 20 years.
[4]Based on 0.72 MGD.
[5]Based on 1.912 MGD.

SOURCES OF POTENTIAL REVENUE

Several potential sources of revenue may be available for recovering the cost of constructing the improvements necessary to implement a regional reuse utility. These sources include donations made by the developers, disposal charges to the producers of the effluent, and commodity charges to the users of the effluent. An additional source of cost savings would be the potential deferral of additional water treatment improvements. These issues are discussed in the following sections.

Developer Donations

It is anticipated that the developers of the Rough Hollow and Lakeway West areas may provide substantial contributions toward the construction of the required effluent disposal facilities. These contributions may either take the form of donated land for irrigation or storage facilities, or the contributions may be in the form of providing money for the actual construction of the facilities. In a typical situation, the developer's contribution toward the utility systems must be at least 30 percent. For the purposes of this analysis, it has been assumed that the 30 percent has been provided in the form of treatment plant capacity or collection lines. As a result, credits due to developer contributions will not be assumed.

Commodity Charges to the Effluent Users

The irrigation of landscaped areas is necessary to the growth and continued health of the vegetation. Therefore, the provision of effluent for irrigation purposes meets a need for those individuals or entities that want to maintain landscaped areas. As a result, it is logical that the users of effluent for irrigation purposes should be willing to pay a charge for the use of the effluent. The amount of the charge that individuals will be willing to pay varies considerable based on the circumstances.

The existing golf course operators have a contract with the MUDs to provide water for irrigation purposes free-of-charge. This concession was granted to the developers of the golf courses during negotiations as an offset for the use of the land as an effluent disposal site. It is anticipated that this arrangement will need to continue in the future. In addition, it is anticipated that the developers of the Rough Hollow and Lakeway West areas will want to negotiate similar clauses in contracts for the development of future golf courses. As a result, it is assumed that revenues will not be generated from the sale of effluent to the golf courses.

However, the use of effluent for irrigation purposes in local parks or condominium settings may provide a source of revenues. Currently, the operators of these facilities have demonstrated a willingness to pay potable water rates for irrigation water. If these types of uses are included in the ultimate facilities plan, it is assumed that a viable rate for the use of effluent equal to one-half the current cost of potable water.

Since the irrigation of these areas will have to be controlled by the regional reuse utility, and the regional utility may need to operate the irrigation systems using more water for irrigation than the individuals may want, it will be difficult to establish a rate per volume of water delivered. It would probably be more acceptable to establish a flat monthly rate. In conjunction with the flat rate, a minimum amount of water to be delivered for each month should be established.

As previously indicated, the provision of effluent to individual residences for irrigation purposes will not be a primary objective of the regional reuse utility. However, effluent could be provided to individual residences in accordance with Chapter 310 regulations if dual distribution systems were provided by developers of new subdivisions. It is anticipated that the rates charged to the residences would have to be lower than the rates for potable water.

Two possible alternatives are available for financing the construction of the dual distribution system. First, the developer could construct the system and include its cost in the price of the lots. Under this scenario, the rate differential between potable water and reclaimed water would

need to be great enough to provide the homeowners a return on their investment within a relatively short period.

The second alternative would be for the regional utility to finance the construction of the dual distribution system. Under this scenario, the rates charged by the reuse utility would need to be greater to recover the cost of construction. However, the differential between potable water and the reclaimed water would not need to be as great because the homeowners have not invested in the dual system.

It is anticipated that the cost of reclaimed water would need to be between the cost of raw water and the cost of potable water. The rate must be greater than the cost of raw water because the regional reuse utility will need to purchase additional raw water to meet the additional irrigation demands presented by the residential reuse opportunities. This requirement is a result of the fact that the regional utility must provide sufficient irrigation demands to dispose of all of the effluent produced during the 25-year rainfall event. Since much of this irrigation demand is provided in the form of golf courses, which require consistent irrigation, every gallon of effluent that is diverted from the golf courses to residential uses must be replaced with a gallon of raw water.

If the rate for reclaimed water were set at $0.64/1000 gallons (two times the cost of raw water), then the rate differential between reclaimed water and potable water in LMUD would be $1.86/1000. If the average residence used 60,000 gallons per year for irrigation purposes, the total present worth of the cost savings over a ten-year period, assuming an interest rate of 7 percent, would be approximately $780. The rate differential between reclaimed water and potable water in HCMUD would be $1.23/1000 gallons. If the average residence in HCMUD uses 100,000 gallons per year for irrigation purposes, the total present worth of the savings for a ten-year period, assuming an interest rate of 7 percent, would be approximately $860.

The actual cost of constructing a dual distribution system is dependent upon the land use plan and site constraints. At this time, it is not feasible to estimate the cost of a dual distribution system per residential lot or per acre. However, these calculations would suggest that a

developer could invest up to $780 per resident for a dual distribution system in LMUD, pass the cost to the homeowner and have the homeowner recoup the investment within 10 years. The investment for a dual distribution system in HCMUD could be as much as $860.

In addition to the obvious cost saving benefits to the homeowner, the installation of a dual distribution system would have other potential benefits to a developer. The MUDs may want to consider giving a developer credit for some portion of the cost of a dual distribution system against the capital recovery fee for potable water service. The MUDs may be in a position to benefit from the construction of a dual distribution system as a result of decreased potable water demands. Finally, the installation of a dual distribution system may give a development a competitive advantage over other developments in the area due to the drought resistant nature of the water supply and the relative cost of reclaimed water.

Savings Due to Water Treatment Expansion Deferrals

In many instances when reclaimed water is substituted for potable water, significant cost savings can be realized through the deferral of expansions to the potable water system, particularly the treatment capacity. In the case of the Lakeway Regional Reuse Utility, most of the effluent disposal sites are golf courses constructed to meet the effluent disposal needs of new developments. As a result, the golf courses represent new irrigation demands and not a substitution of reclaimed water for potable water.

The only effluent disposal sites that would constitute a substitution of reclaimed water for potable water would be those parks or condominium settings for which the regional utility were able to obtain control of the irrigation practices. In addition, any residential use of reclaimed water under Chapter 310 would constitute a substitution of reclaimed water for potable water. However, the timing for this type of use is uncertain. In addition, it would be difficult to identify a mechanism to transfer these savings to the regional reuse utility operator. Perhaps the best mechanism to account for this type of savings would be to grant a capital recovery credit to

developers that install dual distribution systems. The amount of credit would be based on the decreased demand that would result from the installation of the dual distribution system.

Disposal Charges to the Effluent Producers

The primary purpose of implementing a regional reuse utility would be to develop an efficient, effective mechanism for the disposal of treated wastewater effluent. Since this is the primary purpose of the regional utility, it is reasonable that charges for the provision of these services be the primary source of revenue for the regional utility.

Based on the assumption that the entire cost of a regional reuse utility would be recovered from charges to the effluent producers, the additional cost of effluent disposal services that would result from the implementation of Alternative 1 in the immediate improvement plan would be approximately $0.08/1000 gallons. The cost of operating the existing effluent storage, effluent pump stations, effluent force mains, and irrigation systems would be in addition to this cost. The additional costs incurred for the facilities required to meet the ultimate disposal needs in the year 2020 in the Lakeway area would be approximately $2.13/1000 gallons.

CHAPTER VIII
CONCLUSIONS AND RECOMMENDATIONS

The Lakeway area is experiencing significant growth. The pace of this growth is expected to continue and intensify over the foreseeable future. In order to continue providing reliable wastewater service to the area, Lakeway Municipal Utility District (LMUD) and Hurst Creek Municipal Utility District (HCMUD) will need to expand their effluent management facilities in the future. Due to state environmental regulations designed to protect the unique environmental character of the area, the expanded effluent management facilities must not discharge to Lake Travis or its tributaries.

In order to assist the two municipal utility districts (MUDs) in their efforts to plan for the continued growth of the area, the Lower Colorado River Authority (LCRA), together with the City of Lakeway, the two MUDs, and the Texas Water Development Board (TWDB) undertook a study to evaluate the feasibility of implementing a regional reuse utility in the Lakeway area. As originally conceived, the regional utility would provide effluent management services to the two MUDs by providing operators of irrigation systems in the area with reclaimed water. By providing reclaimed water to area golf courses, individual residents, and other entities interested in using water for irrigation purposes, the regional reuse utility would be assisting in the safe management of wastewater effluent and aiding in water conservation efforts. In addition to these benefits, by using individual lawn irrigation as a management activity, the amount of land that would need to be set aside from the developable inventory for effluent disposal purposes would be decreased.

However, since the Lakeway area is subject to the state rule prohibiting new or expanded discharges to Lake Travis or its tributaries, the regional reuse utility would have to comply with the land disposal regulations contained in Chapter 309 of the Texas Natural Resource Conservation Commission (TNRCC) Permanent Rules. These rules include the provision that all sites identified as effluent management sites would need to be under the direct control of the regional utility. This provision would exclude the use of individual residences as management sites since the operation of the irrigation systems would be left to the homeowners.

As a result of this provision, the feasibility study of a regional reuse utility focused on the development of a system to provide adequate effluent management facilities. The provision of reclaimed water to individual residences and other entities desiring non-potable water for irrigation was identified as a possible secondary use of a regional reuse utility.

The implementation of a regional utility will require major modifications to the responsibilities for wastewater effluent management in the area. The regional reuse utility operator will be responsible for the management of all wastewater effluent produced by the two MUDs. This responsibility will include the operation and maintenance of all effluent storage facilities, effluent pump stations, effluent force mains, and effluent irrigation operations. Since the regional reuse utility operator will be responsible for the storage and disposal of the effluent, the operator will be required to obtain a permit from the TNRCC. This permit may include provisions prohibiting discharges to surface waters and establishing quality limits for water being withdrawn from the storage reservoirs. In addition, the wastewater treatment permits currently held by the two MUDs would need to be modified to reflect this change in responsibility.

These changes in responsibility would need to be clearly identified in long-term contracts that would need to be negotiated between the regional utility operator and the two MUDs. These contracts should also address the need to transfer existing effluent management facilities owned and/or operated by the two MUDs to the regional utility operator. Finally, the contracts should address the disposition of these assets, and other assets that may be obtained by the regional utility, if the contracts are terminated or allowed to expire.

It is anticipated that a regional reuse utility would be implemented in phases. The initial phase would involve providing the pipeline necessary to link the three existing effluent disposal systems. The opinion of probable cost to accomplish this task is $210,000. The linked systems will have a total capacity to dispose of 0.72 mgd of effluent. The cost per 1000 gallons of effluent disposed is estimated to be $0.08.

The second implementation phase of a regional reuse utility would be to provide additional capacity to meet the growth in the area. It is anticipated that the regional utility will need to provide 333 acre-feet of additional effluent storage capacity, and 45 additional acres of cedar tree irrigation before the year 2020. Many of these improvements will be required in response to the development of the Rough Hollow and Lakeway West areas within LMUD. The opinion of probable costs for these improvements, not including additional wastewater treatment capacity, additional collection system, is approximately $15.8 million. Based on a total wastewater contribution of 1.912 MGD in 2020, these additional facilities represent a cost of $2.13 1000 gallons.

The implementation of a regional reuse utility in the Lakeway area could provide effluent management services for the LMUD and the HCMUD. The provision of services by a regional entity could provide benefits to the two MUDs and their customers through a more efficient use of existing facilities. The efficient utilization of existing facilities could delay the need for one or both of the MUDs to construct additional facilities. The deferral of these costs would provide a significant benefit. However, it is not envisioned that a regional reuse utility will be able to provide effluent management services to the area with less infrastructure than the two MUDs would require if they provided service separately.

In order to realize these potential savings due to project deferrals, the regulatory status of effluent management operations in the area will have to change. Currently, HCMUD maintains the authorization to discharge up to 0.25 MGD of tertiary treated effluent to several ponds located in the middle of the Hills golf course on Hurst Creek. By utilizing this authorized discharge, in combination with the existing effluent management capacity in LMUD, the combined, permitted capacity in the area is 0.94 MGD. If a regional utility were implemented, the authorization to discharge effluent to Hurst Creek may be rescinded. This would actually result in an overall decrease in the disposal capacity of approximately 23 percent.

As a result, unless the right to discharge to Hurst Creek can be assumed by the regional reuse utility, the implementation of a regional reuse utility in the Lakeway area is not considered

feasible at this time. The two MUDs can continue to operate their existing systems as they are without constructing additional facilities, except those identified in permit requirements. If HCMUD were to lose its ability to discharge effluent to Hurst Creek during its next renewal process, the feasibility of implementing a regional utility should be re-evaluated.

Even though the creation of a regional reuse utility does not appear to be feasible at this time, the MUDs can derive some benefit from forming a regional alliance. The two MUDs and other providers of wastewater treatment services in the Lake Travis area face similar challenges in the future. As a result the following recommendations are made.

1) LMUD and HCMUD should continue to operate independently at this time.

2) LMUD and HCMUD should monitor the results obtained from the cedar tree irrigation operation in preparation for the next permit renewal process.

3) LMUD and HCMUD should pursue alternative funding sources for a possible pilot project involving residential irrigation with reclaimed water. Possible sources might include the Texas Water Development Board and research oriented organizations such as the American Water Works Association Research Foundation or the Water Environment Research Foundation.

4) LMUD and HCMUD should investigate other innovative technologies such as the use of constructed wetlands.

5) LMUD should consider requesting amendments to its permit to allow the transfer of effluent between the two disposal systems. A strong case could be made that this is a minor amendment since the effluent disposal locations, rates, or quality limits would not be affected.

6) As an alternative to a permit amendment, LMUD could seek authorization to move effluent from one disposal system to the other under Chapter 310. It would need to be clear in the reuse notification that the combination of effluent applied in accordance with Chapter 309 and 310 would not exceed the application rates identified in the permit.

7) In order to reduce the amount of raw water used to irrigate The Hills Golf Course, LMUD and HCMUD could file a reuse notification to send effluent from LMUD to HCMUD when LMUD has more effluent than is needed for its golf courses.

However, the State may be concerned over the difference in effluent limits and the introduction of this effluent into the HCMUD pond system.

8) LMUD and HCMUD should monitor the efforts currently beginning concerning the revision of Chapter 310 and Chapter 317 of the TNRCC Permanent Rules and provide comments as necessary.

9) As an alternative to Chapter 310 reuse notification, it may be possible to reduce the amount of raw water required for The Hills Golf Course by diverting a portion of raw wastewater from LMUD to HCMUD for treatment on a contract basis for some period of time. This may provide some benefit to LMUD by delaying the need for planning the next capacity expansion and/or allowing development in the Rough Holland Lakeway West areas to be initiated before a new plant is brought on-line.

APPENDIX A

STUDY AREA

APPENDIX B

LAKEWAY HISTORICAL RAINFALL DATA

APPENDIX B

LAKEWAY HISTORICAL RAINFALL DATA
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Rank	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Return Period	Prob-ability[1]
1	1957	0.59	3.06	4.70	10.22	6.93	6.10	1.00	0.00	5.97	9.79	2.93	0.87	52.16	64.0	1.56%
2	1991	7.66	4.01	1.56	4.71	4.11	3.70	1.27	2.33	7.83	1.12	1.07	11.23	50.60	32.0	3.13%
3	1973	3.26	2.04	2.17	3.45	3.53	8.77	4.73	0.56	6.60	10.54	1.23	0.25	47.13	21.3	4.69%
4	1941	1.64	2.98	4.78	6.51	3.64	12.81	3.06	0.00	0.75	7.60	1.23	1.63	46.64	16.0	6.25%
5	1946	4.05	2.22	2.84	7.89	5.42	1.56	1.34	3.52	5.87	1.81	7.88	1.96	46.36	12.8	7.81%
6	1987	0.70	3.51	1.45	0.40	7.31	12.37	2.78	0.92	3.44	0.55	8.00	2.06	43.49	10.7	9.38%
7	1935	1.73	3.76	1.05	2.04	8.68	11.29	1.31	0.25	8.32	1.84	0.84	2.06	43.17	9.1	10.94%
8	1992	3.84	6.48	4.00	1.67	7.72	4.29	1.74	0.68	2.71	0.94	5.34	3.51	42.92	8.0	12.50%
9	1945	3.04	3.84	5.11	4.69	1.67	6.62	1.46	5.99	2.71	3.35	1.46	2.13	42.06	7.1	14.06%
10	1958	3.32	6.23	2.62	4.84	3.47	3.36	3.11	0.71	6.75	5.78	0.86	0.83	41.89	6.4	15.63%
11	1981	1.37	1.55	4.74	1.16	6.23	14.90	1.28	0.36	2.86	5.52	1.67	0.20	41.84	5.8	17.19%
12	1940	0.68	3.63	1.40	6.08	2.01	8.01	0.52	1.93	3.32	5.38	5.03	3.85	41.83	5.3	18.75%
13	1944	5.81	3.79	1.88	0.38	8.54	2.34	0.29	4.68	4.54	0.39	4.51	4.28	41.42	4.9	20.31%
14	1986	0.41	2.57	0.35	0.53	10.98	2.64	0.00	0.96	5.66	8.15	2.39	6.67	41.31	4.6	21.88%
15	1974	2.65	0.71	1.55	1.42	6.92	1.68	0.76	7.69	6.68	4.92	2.70	2.14	39.82	4.3	23.44%
16	1975	0.39	3.07	0.45	3.26	7.59	9.25	4.16	4.69	2.12	2.73	0.40	1.44	39.55	4.0	25.00%
17	1968	8.70	1.60	2.15	2.14	8.21	3.60	2.89	0.77	3.35	0.6	4.91	0.55	39.48	3.8	26.56%
18	1965	4.43	4.94	1.33	2.18	9.45	1.03	0.34	1.38	4.96	3.64	2.63	3.05	39.37	3.6	28.13%
19	1936	0.42	1.66	1.56	0.75	7.71	3.84	8.36	2.49	5.15	2.94	2.28	1.36	38.51	3.4	29.69%
20	1949	4.27	2.29	2.30	7.89	0.79	4.09	1.77	2.48	3.69	4.89	0.01	2.93	37.40	3.2	31.25%

[1]Probability that rainfall totals for a year will exceed the rainfall total for that year.

Source: Texas Natural Resource Information System
EarthInfo National Climatic Data Center

APPENDIX B
(continued)

LAKEWAY HISTORICAL RAINFALL DATA
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Rank	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Return Period	Prob-ability[1]
21	1961	1.37	4.73	0.69	0.11	0.97	13.29	7.63	0.42	3.61	1.02	2.80	0.66	37.29	3.0	32.81%
22	1960	1.11	2.30	1.41	1.15	0.77	4.95	2.19	2.72	1.65	13.74	1.88	2.95	36.82	2.9	34.38%
23	1980	1.63	1.92	4.13	4.59	6.97	0.87	0.02	0.71	7.38	4.13	3.22	1.18	36.75	2.8	35.94%
24	1942	0.08	1.42	0.68	7.53	1.94	2.59	3.35	2.26	7.95	5.74	1.96	1.11	36.60	2.7	37.50%
25	1959	0.45	2.24	0.24	4.97	1.57	3.84	3.17	5.02	4.28	6.67	1.93	1.53	35.92	2.6	39.06%
26	1976	0.48	0.22	1.86	8.80	5.04	3.16	3.50	1.30	2.25	4.97	2.31	1.86	35.75	2.5	40.63%
27	1993	3.71	2.60	3.85	3.95	3.21	7.83	0.00	0.00	4.39	3.57	1.41	1.20	35.72	2.4	42.19%
27	1930	2.17	1.66	2.15	0.85	7.96	1.86	0.22	1.79	2.95	9.01	1.73	2.77	35.10	2.4	42.19%
28	1962	0.60	0.61	1.22	4.61	1.00	9.09	0.00	4.99	4.66	4.54	0.91	2.51	34.76	2.3	43.75%
29	1983	1.95	3.23	4.62	0.06	4.42	4.03	2.23	5.66	2.09	3.56	2.02	0.42	34.29	2.2	45.31%
30	1964	2.77	1.43	2.00	1.68	1.77	8.66	0.59	2.19	6.10	3.98	2.43	0.64	34.24	2.1	46.88%
31	1967	0.27	1.48	1.12	5.07	3.18	0.00	1.04	3.85	5.60	4.75	4.34	2.50	33.21	2.1	48.44%
32	1937	2.61	0.12	3.74	0.72	3.19	4.56	0.63	4.46	2.17	3.43	3.59	3.77	32.98	2.0	50.00%
33	1985	1.43	4.93	1.80	1.78	2.71	5.52	1.56	0.00	3.25	4.99	4.83	0.00	32.80	1.9	51.56%
34	1934	9.52	2.09	3.92	5.05	1.66	0.23	0.72	0.48	1.05	0.03	5.17	2.69	32.62	1.9	53.13%
35	1990	0.87	2.82	4.03	2.66	3.35	1.14	5.94	1.32	2.19	2.92	4.15	1.11	32.50	1.8	54.69%
36	1979	4.54	2.81	3.26	4.39	3.25	1.96	3.42	2.62	1.32	0.97	1.02	2.73	32.29	1.8	56.25%
37	1982	0.70	1.80	1.15	4.44	5.51	4.92	0.10	1.84	1.71	2.59	5.44	1.75	31.95	1.7	57.81%
38	1931	4.63	5.49	3.61	5.74	0.55	3.06	2.49	1.94	0.02	0.17	1.08	3.07	31.84	1.7	59.38%

[1]Probability that rainfall totals for a year will exceed the rainfall total for that year.
Source: Texas Natural Resource Information System
EarthInfo National Climatic Data Center

APPENDIX B
(continued)

LAKEWAY HISTORICAL RAINFALL DATA
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Rank	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Return Period	Prob-ability[1]
39	1969	0.42	3.42	2.69	3.30	2.70	1.66	1.00	5.29	1.60	4.93	1.15	3.59	31.75	1.6	60.94%
40	1932	6.46	2.95	2.21	2.67	1.05	2.19	1.40	5.20	3.96	0.11	1.25	1.97	31.41	1.6	62.50%
41	1933	5.49	2.16	1.68	1.48	3.43	0.48	6.27	0.97	3.02	3.40	0.67	0.90	29.97	1.6	64.06%
42	1984	1.15	0.66	2.15	0.17	2.01	2.11	1.73	0.00	0.77	13.49	1.60	4.09	29.93	1.5	65.63%
43	1951	0.55	2.88	3.83	1.19	3.32	7.14	0.17	2.17	6.27	1.04	1.05	0.25	29.86	1.5	67.19%
44	1953	0.68	1.29	1.78	5.36	1.78	1.85	0.46	2.20	2.92	7.30	0.38	3.83	29.81	1.5	68.75%
45	1970	1.49	5.53	3.55	1.38	7.81	0.59	0.34	0.95	6.57	0.98	0.00	0.18	29.37	1.4	70.31%
46	1972	2.28	0.55	0.41	2.06	7.87	2.18	0.78	1.57	1.05	6.37	3.68	0.35	29.15	1.4	71.88%
47	1952	0.27	1.69	2.31	5.80	3.87	2.19	0.63	0.00	3.20	0.00	5.32	2.28	27.54	1.4	73.44%
48	1989	4.60	0.97	2.39	1.50	7.94	3.23	0.15	1.47	0.54	2.93	1.43	0.22	27.37	1.3	75.00%
49	1950	0.80	3.69	0.82	8.64	3.96	2.30	0.66	0.62	4.68	0.66	0.03	0.00	26.87	1.3	76.56%
50	1938	3.85	2.65	1.61	4.41	3.10	3.69	1.22	0.66	2.79	0.27	0.59	1.27	26.10	1.3	78.13%
51	1978	1.20	2.12	1.30	2.75	3.00	2.00	1.75	3.63	2.54	0.42	4.84	0.24	25.79	1.3	79.69%
52	1966	1.70	2.99	0.51	4.29	2.96	1.78	0.43	6.49	3.16	0.67	0.11	0.63	25.72	1.2	81.25%
53	1943	0.86	0.44	2.42	3.00	5.09	1.48	3.55	0.96	3.24	0.37	1.72	1.03	24.16	1.2	82.81%
54	1971	0.04	0.66	0.06	0.97	1.27	0.74	3.42	5.73	1.38	3.66	2.91	3.30	24.14	1.2	84.38%
55	1977	1.79	2.39	1.51	7.43	1.85	1.04	0.31	1.02	0.74	1.74	2.63	0.13	22.58	1.2	85.94%
56	1955	2.01	4.06	0.85	0.86	4.25	3.03	1.83	2.01	1.30	0.10	1.39	0.73	22.44	1.1	87.50%
57	1939	2.40	1.43	1.07	2.14	2.81	1.16	3.24	1.70	1.61	1.81	2.24	0.58	22.18	1.1	89.06%

[1]Probability that rainfall totals for a year will exceed the rainfall total for that year.
Source: Texas Natural Resource Information System
EarthInfo National Climatic Data Center

APPENDIX B
(continued)

LAKEWAY HISTORICAL RAINFALL DATA
LAKEWAY REGIONAL REUSE UTILITY FEASIBILITY STUDY

Rank	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Return Period	Prob-ability[1]
58	1947	3.89	0.42	3.37	2.56	3.30	0.13	1.98	2.22	0.07	0.02	2.05	1.37	21.38	1.1	90.63%
59	1948	0.99	2.64	1.39	1.92	4.23	1.45	1.92	0.28	1.22	1.99	1.33	1.21	20.56	1.1	92.19%
60	1988	0.30	1.38	1.64	0.91	3.61	2.79	2.34	2.35	0.44	1.65	0.00	1.72	19.13	1.1	93.75%
61	1963	0.63	2.76	0.23	3.46	1.25	2.44	0.53	0.92	1.47	0.87	1.56	1.03	17.14	1.0	95.31%
62	1956	1.78	1.70	0.27	0.64	2.94	1.09	0.10	1.27	0.09	0.94	2.11	2.00	14.92	1.0	96.88%
63	1954	1.09	0.27	0.28	1.90	2.71	0.79	0.77	1.19	0.80	0.99	0.35	0.44	11.58	1.0	98.44%
1930-93 avg		2.3	2.5	2.1	3.3	4.2	4.0	1.8	2.1	3.3	3.4	2.3	1.9	33.3		
25-Year		3.6	4.0	3.1	5.5	6.9	3.9	2.9	4.0	4.3	4.4	3.1	2.6	48.3		

[1]Probability that rainfall totals for a year will exceed the rainfall total for that year.
Source: Texas Natural Resource Information System
EarthInfo National Climatic Data Center

APPENDIX C

WATER CONSERVATION EFFORTS

SUMMARY OF WATER CONSERVATION AND DROUGHT CONTINGENCY PLANS FOR THE LAKEWAY REGIONAL REUSE STUDY AREA

The Lower Colorado River Authority (LCRA) requires all wholesale water customers to develop water conservation and drought contingency plans. The Lakeway Municipal Utility District (MUD), Hurst Creek MUD and Travis County Water Control Improvement District (WCID) 17 have developed plans that have been approved by both the LCRA as well as the Texas Water Development Board (TWDB). The following paragraphs summarize the efforts of the utilities to develop and implement these plans.

Lakeway MUD

Lakeway MUD's water conservation plan has been developed to meet the following goals:

1. improve raw water utilization to 90%;

2. improve efficiency of raw water to treated water billed to 87% and reduce internal usage from 4.4% to 3.0%; and

3. reduce customer consumption of treated water throughout the year with special emphasis on a 10% reduction per connection during peak periods.

In FY 89, the accountability of raw water to treated water billed and used was 82% and the efficiency to treated water billed was 77.4%. Since that time, the District has taken the following steps:

1. continued leak detection studies

2. continued a structured meter maintenance and change-out program

3. continued a program to detect faulty meters by investigating unusual readings observed during billing, and

4. continued a program to minimize the internal use of water.

The following strategies have been implemented to meet the District's third goal of reducing peak water use by 10%.

Rates: The District adopted water conservation rates in 1990. Customers pay $2.50 per 1000 gallons for the first 50,000 and $3.50 per 1000 gallons about 50,000 gallons. Customers are billed bimonthly.

Communications: The District sends fliers to its customers on water conservation tips throughout the year. A public service announcement is submitted to the Lake Travis View every summer reminding them of the summer conservation charge. New customers receive a packet containing conservation materials.

Xeriscape landscaping: The District installed a Xeriscape garden in front of their office in 1991. The LCRA held a workshop on Xeriscape at the garden.

Plumbing Code: The District's plumbing code was revised in 1991 to reflect the state plumbing code standards for low flow showerheads, faucets and toilets.

Plumbing retrofit: The District, in partnership with the LIRA, distributed low-flow showerheads, aerators and toilet dams at no cost to customers.

Reuse: All of the District's treated effluent is used to irrigate two golf courses and plans are underway to irrigate 50 acres or juniper forrest.

Miscellaneous: The District encourages and recognizes individuals or groups that accomplish significant and measurable conservation. High volume users are identified and contacted to determine areas of possible savings.

Drought Contingency Plan: The District's drought contingency plan includes measures for mild, moderate and extreme conditions. Both education and enforcement provisions are included in the plan. The plan follows a five day watering schedule identical to the City of Austin's plan.

Hurst Creek MUD

The Hurst Creek MUD has sufficient water system capacity to meet the residential and commercial needs of the District for many years to come. Therefore the goals of the water conservation program are primarily to achieve resource conservation. These goals include:

1. long-term reductions in overall water demand

2. reductions in the magnitude of seasonal peak demands

3. reductions in wastewater flow volume and associated treatment and disposal costs.

The following activities are currently being performed to encourage water conservation.

Education: The District distributes water conservation literature to customers on a regular basis. New customers are provided with a packet on water conservation.

Rates: The District has a uniform rate structure in which the cost of water remains consistent regardless of the quantity consumed.

Universal metering: All water users are metered. One inch meters and larger are inspected yearly and 1 inch and smaller meters are inspected every ten years.

Leak detection and repair: The District conducts ongoing leak detection and repair to keep unaccounted for water to less than 15%.

Reuse: Effluent from the District's wastewater treatment facilities is used to irrigate the Hills of Lakeway golf course within the District's boundaries.

Drought Contingency Plan: The District has developed drought contingency measures for mild and severe conditions. Education and implementation measures are addressed in the plan. The District is currently working on enforcement provisions for the drought plan.

Travis County WCID #17

Travis County WCID #17 has no stated conservation goals. However, the District has implemented several conservation measures.

Public Education: The District has developed a water conservation packet for all new water customers. The District also periodically mails out new brochures emphasizing new or innovated means for conserving water and develops news articles targeting household water use.

Plumbing Retrofit: In 1992, the WCID offered water conserving plumbing devices to their water customers. LCRA provided the equipment.

Plumbing Code: The WCID adopted the City of Austin Plumbing Code which requires the use of water conserving plumbing fixtures similar to the Texas state code. The WCID adopted this code in 1990, two years before the state code took affect.

Water Rates: The WCID currently uses an increasing block rate with a minimum charge for water service.

Universal metering: All water users are metered. One inch meters and larger are inspected yearly and 1 inch and smaller meters are inspected every ten years.

Leak detection and repair: The WCID's current leak detection program consists of following up on leaks reported by customers and meter readers, continual checking and servicing of production, pumping and storage facilities and a quick response by staff to reported problems.

Drought Contingency Plan: The WCID's drought contingency plan includes measures for mild, moderate and extreme conditions. Both education and enforcement provisions are included in the plan. The plan follows a five day watering schedule identical to the City of Austin's plan.

APPENDIX D

WATER BALANCE CALCULATIONS

TABLE 1
LAKEWAY REGIONAL REUSE UTILITY STUDY
TURF IRRIGATION WATER BALANCE
2020 COMBINED WASTEWATER LOADS
inches/acre of irrigation land

FILE NAME: LAKEWAY
JOB NO.: 551-0100
ENGINEER: SJC

DATE: 02/16/95
TIME: 08:28 AM

VARIABLES:				
	1)	HYDROLOGIC SOIL GROUP	C	
	2)	CURVE NUMBER	74	
	3)	Ce - ELECTRICAL CONDUCTANCE OF EFFLUENT	1200	
	4)	Ci - MAX. ALLOW. CONDUCTANCE OF SOIL	5000	BASED ON RYE GRASS
	5)	A - AREA TO BE IRRIGATED	400	ACRES
	6)	a - SURFACE AREA OF RESERVOIR	12.6	ACRES
	7)	q - MINIMUM PRECIPITATION TO PRODUCE RUNOFF	0.7	INCHES
	8)	Q - TOTAL WASTEWATER LOADS	1.912	MGD

MONTH (1)	AVERAGE PRECIP. (2)	AVERAGE RUNOFF (3)	AVERAGE INFILT. RAINFALL (4)	EVAPOTRANS-PIRATION (5)	REQUIRED LEACHING (6)	TOTAL WATER NEEDS (5)+(6) (7)	EFFLUENT NEEDED IN ROOT ZONE (7)-(4) (8)	EVAPORATION FROM RESVR. SURFACE ADJ PER ACRE OF IRRIGATED LAND (4%) (9)	EFFLUENT TO BE APPLIED TO LAND (8)/0.85 (10)	CONSUMPTION FROM RESERVOIR (9)+(10) (11)	CONSUMPTION (ac-ft)
Jan.	2.30	0.50	1.80	2.40	0.19	2.59	0.79	0.05	0.93	0.98	86.31
Feb.	2.50	0.61	1.89	3.00	0.35	3.35	1.46	0.07	1.72	1.78	111.67
Mar.	2.10	0.40	1.70	4.90	1.01	5.91	4.21	0.12	4.95	5.07	196.99
Apr.	3.30	1.10	2.20	5.90	1.17	7.07	4.87	0.16	5.73	5.89	235.66
May	4.20	1.74	2.46	7.10	1.47	8.57	6.11	0.19	7.19	7.38	285.56
Jun.	4.00	1.60	2.40	8.30	1.86	10.16	7.76	0.23	9.13	9.35	338.73
Jul.	1.80	0.26	1.54	9.00	2.36	11.36	9.82	0.23	11.55	11.78	378.54
Aug.	2.10	0.40	1.70	8.60	2.18	10.78	9.08	0.23	10.68	10.90	359.27
Sep.	3.30	1.10	2.20	6.50	1.36	7.86	5.66	0.17	6.66	6.84	261.97
Oct.	3.40	1.17	2.23	4.90	0.84	5.74	3.52	0.14	4.14	4.27	191.45
Nov.	2.30	0.50	1.80	3.10	0.41	3.51	1.71	0.09	2.01	2.10	117.01
Dec.	1.90	0.30	1.60	2.40	0.25	2.65	1.06	0.07	1.25	1.31	88.47
	33.2	9.69	23.51	66.10	13.45	79.55	56.04	1.74	65.92	67.66	2651.62

TABLE 2
LAKEWAY REGIONAL REUSE UTILITY STUDY
CEDAR TREE IRRIGATION WATER BALANCE
2020 COMBINED WASTEWATER LOADS
inches/acre of irrigation land

FILE NAME: LAKEWAY
JOB NO.: 551-0100
ENGINEER: SJC

DATE: 02/16/95
TIME: 08:28 AM

VARIABLES:				
	1)	HYDROLOGIC SOIL GROUP	C	
	2)	CURVE NUMBER	73	
	3)	Ce - ELECTRICAL CONDUCTANCE OF EFFLUENT	1200	
	4)	Ci - MAX. ALLOW. CONDUCTANCE OF SOIL	10000	BASED ON RYE GRASS
	5)	A - AREA TO BE IRRIGATED	90	ACRES
	6)	a - SURFACE AREA OF RESERVOIR	12.6	ACRES
	7)	q - MINIMUM PRECIPITATION TO PRODUCE RUNOFF	0.7	INCHES
	8)	Q - TOTAL WASTEWATER LOADS	1.44	MGD

MONTH (1)	AVERAGE PRECIP. (2)	AVERAGE RUNOFF (3)	AVERAGE INFILT. RAINFALL (4)	EVAPOTRANS-PIRATION (5)	REQUIRED LEACHING (6)	TOTAL WATER NEEDS (5)+(6) (7)	EFFLUENT NEEDED IN ROOT ZONE (7)-(4) (8)	EVAPORATION FROM RESVR. SURFACE ADJ PER ACRE OF IRRIGATED LAND (4%) (9)	EFFLUENT TO BE APPLIED TO LAND (8)/0.85 (10)	CONSUMPTION FROM RESERVOIR (9)+(10) (11)	CONSUMPTION (ac-ft)
Jan.	2.07	0.50	1.57	7.38	0.79	8.17	6.60	0.00	7.77	7.77	61.29
Feb.	2.43	0.61	1.82	8.23	0.87	9.10	7.28	0.00	8.57	8.57	68.28
Mar.	1.91	0.40	1.51	12.77	1.54	14.31	12.79	0.00	15.05	15.05	107.29
Apr.	2.99	1.10	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	3.96	1.74	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun.	3.60	1.60	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul.	1.79	0.26	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug.	1.98	0.40	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep.	3.19	1.10	2.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct.	3.05	1.17	1.88	11.81	1.35	13.16	11.29	0.00	13.28	13.28	98.73
Nov.	2.26	0.50	1.76	8.73	0.95	9.68	7.92	0.00	9.32	9.32	72.60
Dec.	1.99	0.30	1.69	7.53	0.80	8.33	6.64	0.00	7.81	7.81	62.45
	31.22	9.69	21.53	56.45	6.30	62.75	52.52	0.00	61.79	61.79	470.65

TABLE 3
LAKEWAY REGIONAL REUSE UTILITY STUDY
EFFLUENT STORAGE VOLUME REQUIREMENT
2020 COMBINED WASTEWATER LOADS
inches/acre of irrigation land

VARIABLES:	1)	HYDROLOGIC SOIL GROUP	C	
	2)	CURVE NUMBER	74	
	3)	Ce - ELECTRICAL CONDUCTANCE OF EFFLUENT	1200	
	4)	Ci - MAX. ALLOW. CONDUCTANCE OF SOIL	5000	BASED ON RYE GRASS
	5)	A - AREA TO BE IRRIGATED	400	ACRES
	6)	a - SURFACE AREA OF RESERVOIR	12.6	ACRES
	7)	q - MINIMUM PRECIPITATION TO PRODUCE RUNOFF	0.7	INCHES
	8)	Q - TOTAL WASTEWATER LOADS	1.912	MGD

MONTH (12)	EFFLUENT RECEIVED FOR APPLICATION OR STORAGE (13)	RAINFALL WORST YEAR IN PAST 25 YEARS (14)	RUNOFF WORST YEAR IN PAST 25 YEARS (15)	INFILTRATION RAINFALL (14)-(15) (16)	AVAILABLE WATER (13)+(16) (17)	NET 25 YEAR LOW LAKE EVAPORATION PER ACRE OF LAND (18)	STORAGE (19)	ACCUMULATED STORAGE (20)
Jan.	178.49	3.60	1.31	93.53	272.02	0.03	123.54	300.70
Feb.	178.49	4.00	1.60	98.15	276.64	0.02	96.06	396.77
Mar.	178.49	3.10	0.97	86.88	265.37	0.13	-43.19	353.57
Apr.	178.49	5.50	2.77	91.03	269.52	0.14	29.32	382.90
May	178.49	6.90	3.96	98.17	276.65	0.11	-12.68	370.21
Jun.	178.49	3.90	1.52	79.22	257.71	0.24	-89.09	281.13
Jul.	178.49	2.90	0.85	68.49	246.97	0.33	-142.40	138.73
Aug.	178.49	4.00	1.60	80.12	258.61	0.33	-111.75	26.98
Sep.	178.49	4.30	1.82	82.67	261.16	0.28	-10.13	16.84
Oct.	178.49	4.40	1.90	102.26	280.74	0.17	-15.24	0.00
Nov.	178.49	3.10	0.97	86.88	265.37	0.11	72.23	72.23
Dec.	178.49	2.60	0.67	79.00	257.49	0.05	104.93	177.16
	2141.86	48.3	19.92	1046.40	3188.26	1.93		

Required storage = 397 acre*feet

LAKEWAY AREA RECLAIMED WATER REGIONAL REUSE UTILITY FEASIBILITY STUDY

CONTRACT # 94-483-044 (May 1995)

(3) Large Scale Map located in the Official file, may copied upon request

Potential Effluent Management Sites Figure V-1

Immediate Improvement Plan Figure VI-4

Storage pond Sites VI-5

Appendix A Study Area

Please Contact Research and Planning Fund Grants Management Division at (512) 463-7926