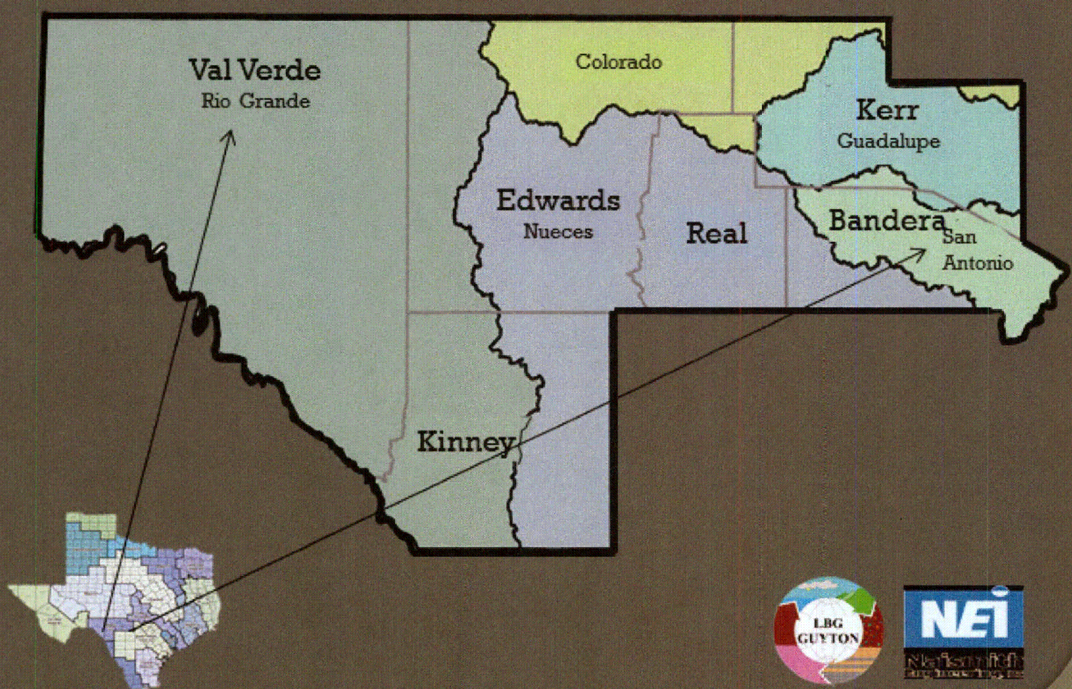
# Plateau Region Water Plan

January 2016

Prepared By
Plateau Region Water Planning Group

Prepared For
Texas Water Development Board



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Prepared by

Jennifer Herrera
Environmental Scientist
LBG-Guyton Associates

John B. Ashworth, P.G.
Senior Consultant
LBG-Guyton Associates

Tom L. Brown
Intergovernmental Affairs Manager
Naismith Engineering, Inc.

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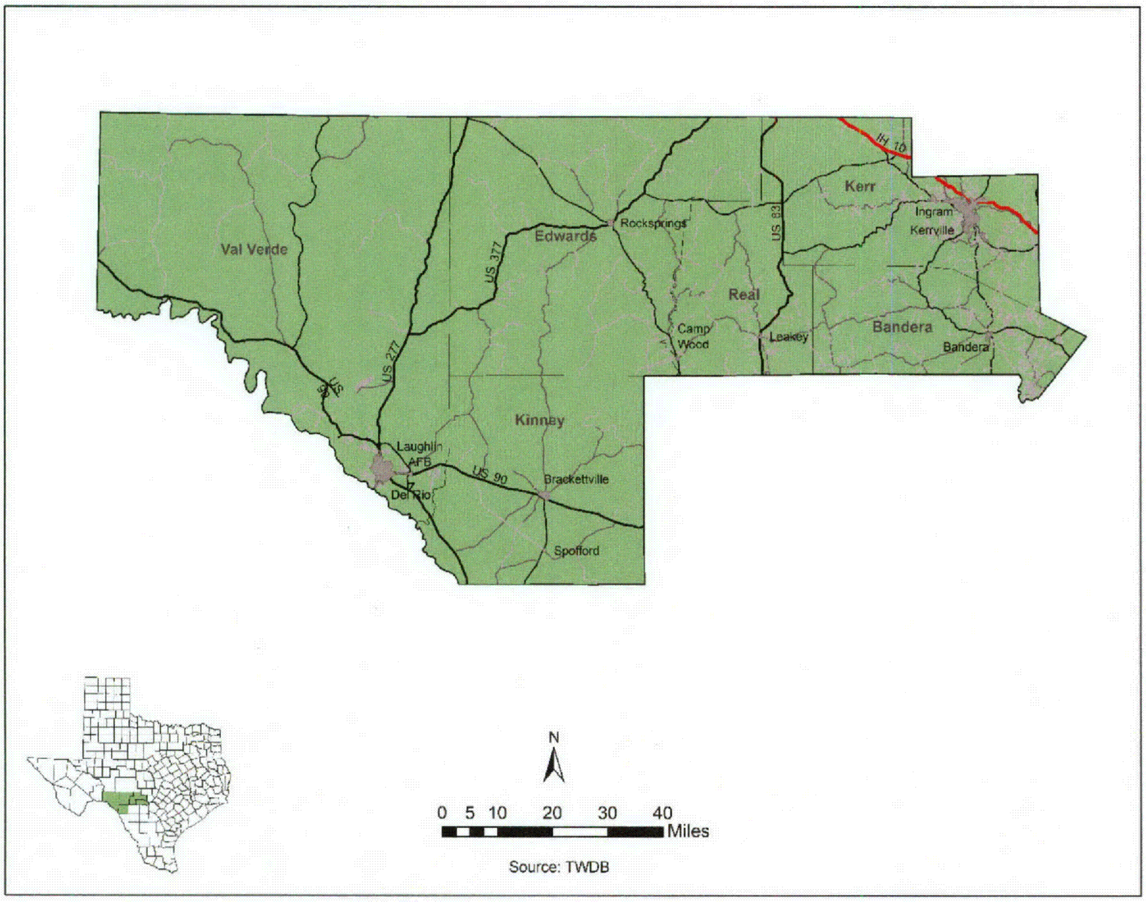
Executive Summary

# EXECUTIVE SUMMARY

Located along the southern boundary of the Edwards Plateau, the Plateau Water Planning Region (Region J) stretches from the Central Texas Hill Country westward to the Rio Grande and consists of Bandera, Edwards, Kerr, Kinney, Real and Val Verde Counties (Figure ES-1). Tourism, hunting, ranching, agribusiness, government and military activities support the regional economy. The beauty of the Hill Country, the solitude of the forested canyons and plateau grasslands, and the gateway to Mexico all support a major tourist and recreational trade. Natural resources of the Region include both terrestrial and aquatic habitats that boast some of the best scenic drives, beautiful vistas, river rafting, and hunting and fishing in Texas.

**Figure ES-1. Plateau Region Water Planning Area Map**




In January of 2011, the third round of regional water planning was concluded with the adoption of the *2011 Plateau Region Water Plan*. It is understood that this *Plan* is not a static *Plan* but rather is intended to be revised as conditions change. For this reason, the current *2016 Plateau Region Water Plan* put forth in this document is not a new *Plan*, but rather an evolutionary modification of the preceding *Plan*. Only those parts of the original *Plan* that require updating, and there are many, have been revised.

The purpose of the *Plateau Region Water Plan* is to provide a document that water planners and water users can reference for long- and short-term water management recommendations. Equally important, this

*Plan* serves as an educational tool to enlighten all citizens to the importance of properly managing and conserving the pristine water resources of this Region. The *2016 Plateau Region Water Plan* follows an identical format as the *Plans* prepared by the other 15 water planning regions in the State as mandated by the Texas Legislature and overseen by the Texas Water Development Board. The *Plan* provides an evaluation of current and future water demands for all water-use categories, and water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed an entity's ability to supply that need, alternative strategies are considered to meet the potential water shortages. Water management strategies are also presented that reflects an entity's desire to upgrade their water supply system. In all cases, conservation practices are first considered in managing water supplies.

Because our understanding of current and future water demand and supply sources is constantly changing, it is intended for this *Regional Water Plan* to be revised every five years or sooner if deemed necessary. This *Plan* fully recognizes and protects existing water rights, water contracts, and option agreements, and there are no known conflicts between this *Plan* and plans prepared for other regions.

The following summary tables are provided at the end of this Executive Summary:

Table ES-1. Population Projection and Water Demand Summary

Table ES-2. Identified Water Need Summary

Table ES-3. Second-Tier Identified Water Need Summary

Table ES-4. WUG Unmet Needs Summary

Table ES-5. Recommended Water Management Strategy Roll-Up Summary

Table ES-6. Alternative Water Management Strategy Summary

# POPULATION AND WATER DEMAND

The U.S. Census Bureau performed a census count in 2010, which provides the base year for future population projections. Although the Plateau Water Planning Group (PWPG) accepts the 2010 census count, members express concern that the census does not recognize the significant seasonal population increase that occurs in these counties as the area draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting properties. Therefore, an emphasis is made in this *Plan*, especially for the rural counties, to recognize a need for more water than is justified simply from the population-derived water-demand estimates.

The Plateau Region covers 9,252 square miles and contains a projected year-2020 population of 141,476 (Table ES-1). The mostly rural nature of this Region is reflected in its population density of 15.3 (in 2020) people per square mile, which is significantly less than the State average of 72 people per square mile. Approximately 45 percent of the total population of the area is located in the two largest cities, Del Rio and Kerrville. In the year 2020, Del Rio, including the population of Laughlin Air Force Base, is projected to have 39,839 residents and Kerrville with 23,319. The projected year-2020 populations of other major communities in the Region are: Bandera (1,045); Rocksprings (841); Brackettville and Fort Clark Springs (2,996); and Camp Wood (698) and are presented in Figure ES-2. These population estimates do not include a significant transient (tourist, hunting, recreation, etc.) population that has a resulting significant impact on overall water supply demand in the Region.

Total population of the six counties is expected to increase by 52 percent from the projected year-2020 census count of 141,476 to 184,595 by 2070. The greatest percentage increase in population is projected to occur in Val Verde County, which is expected to grow from a projected year-2020 population of 54,694 to 82,161 by the year 2070, an increase of 50 percent. Bandera County (30 percent) and Kerr County (15 percent) are also anticipating growth. Population in the rural counties of Edwards, Kinney and Real is expected to remain relatively constant over the 50-year planning period, however the transient population will likely increase.

Total projected water consumptive use in the Plateau Region in the year 2020 is 39,802 acre-feet (Table ES-1). The largest category of projected demand is municipal (18,637 acre-feet), followed by irrigation (10,929 acre-feet), livestock (2,926 acre-feet), mining (355 acre-feet), and manufacturing (25 acre-feet) as illustrated in Figure ES-3. Municipal and irrigation combined represent 74 percent of all water used in the Region. The forecasted total demand for water needed in the Region will increase from the year 2020 by 44,937 acre-feet (13 percent) by the year 2070. Municipal and County-Other water demand in the Plateau Region is projected to increase from a year-2020 level of 25,567 acre-feet to 31,315 acre-feet by the year 2070.

The largest center of municipal demand in the Region is the City of Del Rio in Val Verde County, where 10,645 acre-feet of water is projected to be used in 2020 to supply the residents and businesses within the City. Fifty-three percent of the Region's total municipal water use occurs in Val Verde County. The City of Del Rio is the only entity in the Plateau Region that is designated as a wholesale water provider. In addition to its own use, the City provides water to Laughlin Air Force Base and subdivisions outside of the City.

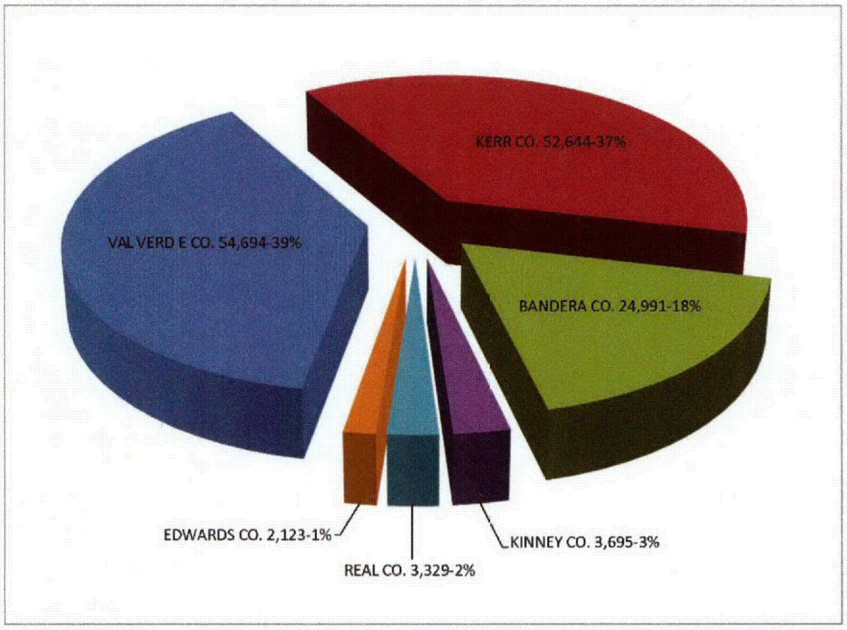



**Figure ES-2. Year 2020 Projected Population**

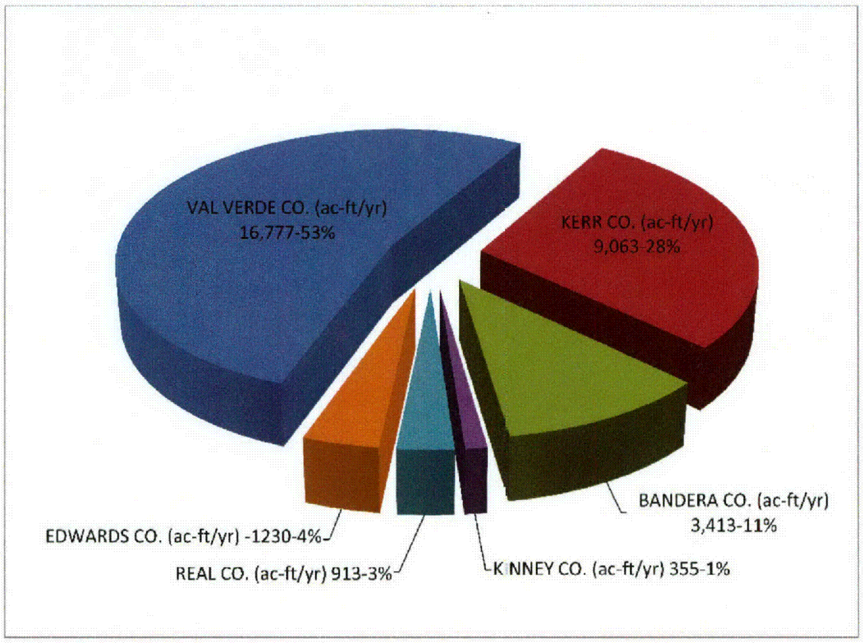



**Figure ES-3. Year 2020 Projected Water Demand by County**

The Upper Guadalupe River Authority (UGRA) anticipates becoming a wholesale water provider in coming years with the intent to provide conjunctive water-supply sources to meet the needs of Kerr County citizens that will not be served by the City of Kerrville. The use of water for manufacturing purposes only occurs in Kerr County.

Most irrigation that occurs in the Plateau Region is for the watering of pastures and hay fields. Because of the typically rocky and uneven terrain throughout much of the Region, irrigation of commercial row crops is minimal other than in Kinney County. Kinney County has the highest irrigation water use (62 percent of the Region's total) and is the only county in which irrigation use is greater than municipal use. On a regional basis, water used for irrigation is projected to decline slightly over the 50-year planning horizon; from the year-2020 level of 10,929 acre-feet to 10,282 acre- feet by 2070. However, as any irrigator can attest, climate, water availability, and the market play key roles in how much water is actually applied on a year-by-year basis.

Environmental and recreational water use in the Plateau Region is recognized as being an important consideration as it relates to the natural community in which the residents of this Region share and appreciate. In addition, for rural counties, tourism activities centered around the natural resources offer perhaps the best hope for modest economic growth to areas that have seen a long decline in traditional economic activities such as agriculture.

# WATER SUPPLY RESOURCES

Water supply sources in the Plateau Region include groundwater from six aquifers (149,614 acre-feet in 2020), and surface water within five river basins (19,994 acre-feet in 2020) (Chapter 3, Table 3-2). Reuse of existing supplies is also considered a water supply source. Water supply availability under drought-of-record conditions is considered in the planning process to insure that water demands can be met under the worst of circumstances. In the consideration of available water supply sources, this *Plan* fully recognizes and protects existing water rights, water contracts, and option agreements.

Within the Plateau Region, the TWDB recognizes three major aquifers [the Trinity, the Edwards-Trinity (Plateau), and the Edwards (Balcones Fault Zone)] as illustrated in Figure ES-4. For this *Plan*, the Austin Chalk Aquifer in Kinney County, and the Frio and Nueces River Alluvium Aquifers in Edwards and Real Counties are also identified as groundwater sources. Groundwater conservation districts in Bandera, Kerr, Kinney, Real and Edwards Counties provide for local management control of the groundwater resources in their respective districts. Over much of the Region, water levels generally fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions. Discharge from the aquifers occurs naturally through springs and seeps, and artificially by pumping from wells. Some discharge also occurs through leakage from one aquifer to another and through natural down-gradient subsurface flow out of the Region.

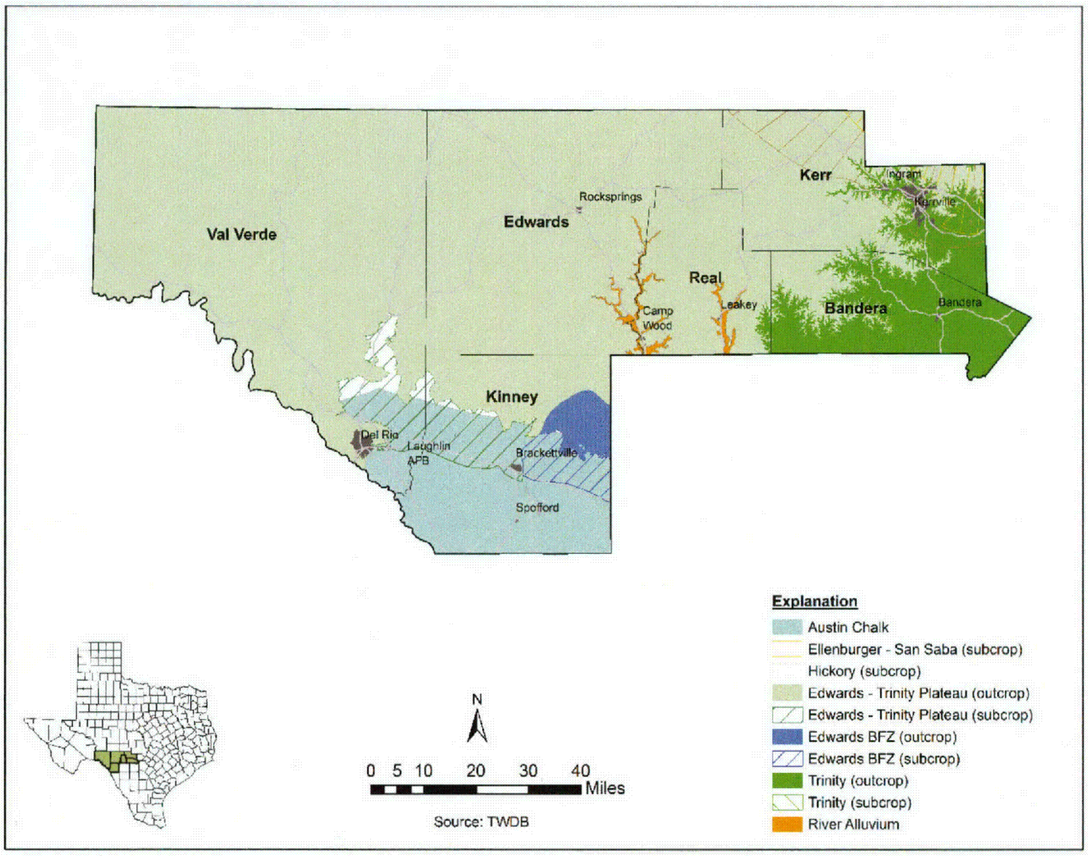



**Figure ES-4. Groundwater Sources**

Base flow to the many rivers and streams that flow through the Plateau Region is principally generated from the numerous springs that issue from rock formations that form the major aquifers. It is thus recognized that sustaining flow in these important rivers and streams is highly dependent on maintaining an appropriate water level in the aquifer systems that feed the supporting springs. With the sustainability of local water supplies and the economic welfare of the Region in mind, the PWPG thus defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. The PWPG also acknowledges that groundwater conservation districts have regulatory authority over permitted withdrawals.

The volumetric availability of groundwater for this *2016 Plan* is based on TWDB provided Modeled Available Groundwater (MAG) as developed through the Groundwater Management Area process. Aquifers recognized in this *Plan* that are not included in the GAM-MAG process are termed "non-relevant" and "other aquifer". Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods, with include the following:

The counties that comprise the Plateau Region contain the headwaters of the Guadalupe, San Antonio, Medina, Sabinal, Frio, Nueces, and West Nueces rivers; and tributaries to the Colorado River and Rio Grande such as the Pecos, Devils, and South Llano rivers. Flow in these rivers and streams is critical to the Plateau Region in that it provides municipal drinking water, supplies irrigation and livestock needs, maintains environmental habitats, and supports a thriving ecological and recreational tourist economy. Water users downstream of the Plateau Region (Regions K, L, and M) likewise have a stake in maintaining and protecting river flows.

Although rather limited during severe drought conditions, surface-water supplies in the Region are important (Figure ES-5). The Cities of Kerrville and Del Rio currently use surface water from the Guadalupe River and from San Felipe Springs, respectively. Camp Wood in Real County is supplied from Old Faithful Spring located on a tributary to the Nueces River. For surface-water supplies, drought-of-record conditions relate to the quantity of water available to meet existing permits from the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio rivers and their tributaries as estimated by Run 3 of the TCEQ Water Availability Models (WAMs).

Water recycling, or reuse, is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation or industrial processes, and potentially for public consumption. The Cities of Kerrville and Camp Wood have active water reuse programs.

The PWPG recognizes the important ecological water supply function that all springs perform in the Region. Springs create and maintain base flow to rivers, contribute to the esthetic and recreational value of land, and are significant sources of water for wild game and aquatic species. Water issuing from springs forms wetlands that attract migratory birds and other fowl that inhabit the Region throughout the year. The spring wetlands host numerous terrestrial and aquatic species, some of which are recognized as threatened and endangered.

The PWPG has identified three "Major Springs" that are important for their municipal water supply contribution. The fourth largest spring system in Texas, San Felipe Springs, discharges to San Felipe Creek east of Del Rio and provides municipal drinking water for the City, as well as irrigation use downstream. Las Moras Springs in Kinney County is of historical significance for its importance as a supply source on early travel routes and military fortifications. Today, Las Moras Springs supports the

Fort Clark Springs community and is hydrologically associated with the same aquifer system that serves Fort Clark Springs MUD and the City of Brackettville. The third major spring is Old Faithful in Real County, which is the drinking-water supply source for the City of Camp Wood. Although only three springs are identified as "Major Springs", the PWPG recognizes that all springs in the Region are important and are deserving of natural resource protection.

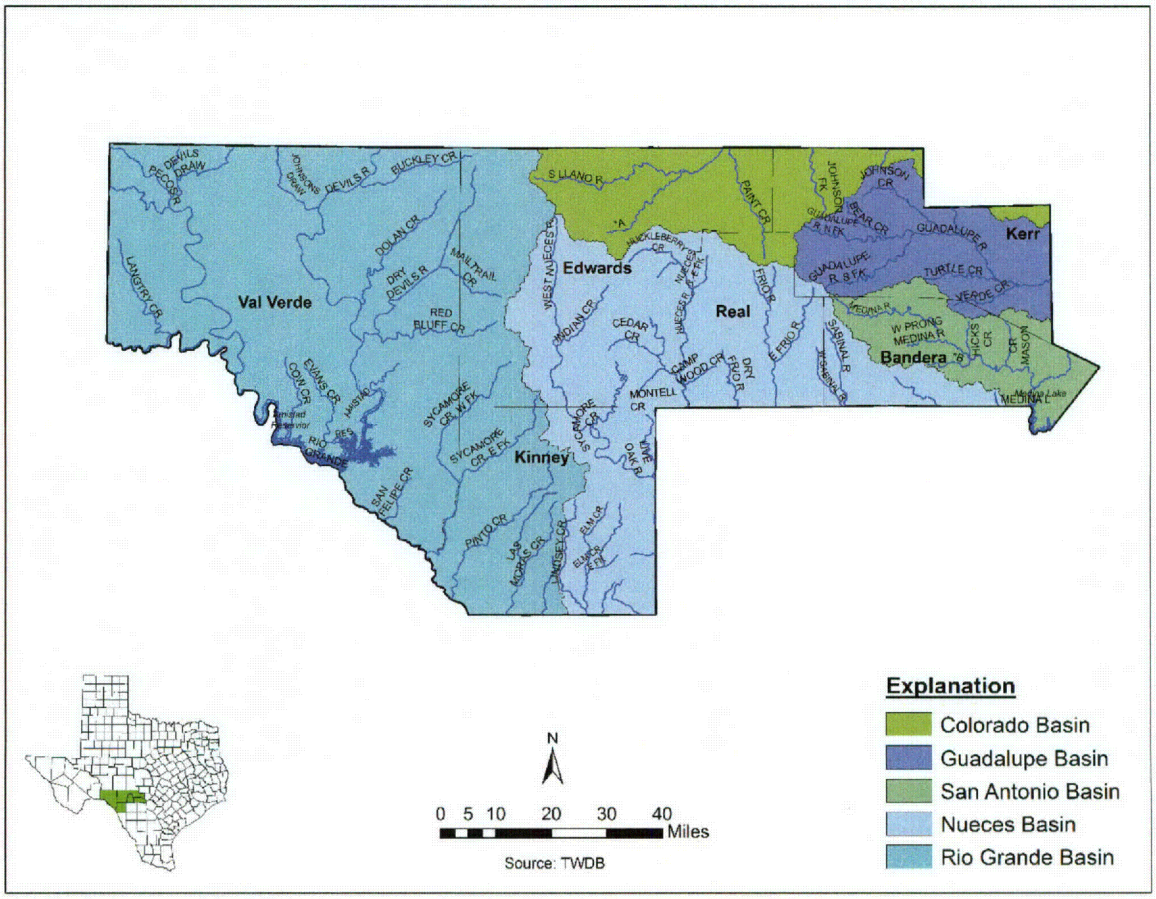



**Figure ES-5. Surface Water Sources**

# WATER MANAGEMENT STRATEGIES

A major component of this *Plan* is to identify municipalities and water-use categories that may, in times of severe drought, be unable to meet expected water-supply needs based on today's ability to access, treat, and distribute the supply. Recommended alternatives, or water management strategies, to meet anticipated drought-induced shortages are presented for consideration. It should be acknowledged that the PWPG has no authority to mandate that any recommended strategy be implemented, and that it is the individual entity's initiative to act on needed changes.

Tables ES-2 and ES-4 list projected water supply shortages within the Region under drought-of-record conditions based on no new infrastructure development. A secondary water needs analysis for all water user groups and wholesale water providers for which conservation or direct reuse water management strategies are recommended is provided in Table ES-3. This secondary water needs analysis calculates the water needs that would remain after assuming all recommended conservation and reuse water management strategies are fully implemented. Tables ES-5 and ES-6 provide a listing of all recommended and alternative water management strategies in this *Plan* that if implemented may assist in meeting supply shortages. Additional strategies are recommended for other entities that have no projected supply shortage, but have desired projects to be considered for funding. Conservation and water-loss strategies are also recommended where appropriate. Total capital cost to implement the recommended strategies is $146,202,577.

A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. Recreation activities involve human interaction with the outdoor environment and are often directly dependent on water resources. It is recognized that the maintenance of the regional environmental community's water supply needs serves to enhance the lives of citizens of the Plateau Region as well as the tens of thousands of annual visitors to this Region.

The implementation of water management strategies recommended in Chapter 5 of this Regional *Plan* is not expected to have any impact on native water quality. In particular, primary and secondary safe drinking water standards, which are the key parameters of water quality identified by the PWPG as important to the use of the water resource, are not compromised by the implementation of the strategies. Also, no recommended strategies involve moving water from a rural location for use in an urban area.

# WATER QUALITY

Water quality plays an important role in determining the suitability of water supplies to meet current and future water needs. Primary and secondary safe drinking water standards are the key parameters of water quality identified by the PWPG as important to the use of water resources and are used for comparisons of water quality data. The reservoirs within the Plateau Region - Amistad Reservoir and Medina Lake - are some of the clearest (most transparent) water bodies in the State of Texas. Amistad Reservoir is the third clearest water body in Texas and Medina Lake is the fifth clearest.

Groundwater resources in the Plateau Region are generally potable, although between five and ten percent of the groundwater is brackish. Groundwater quality problems are generally related to naturally high concentrations of total dissolved solids (TDS) or to the occurrence of elevated concentrations of individual dissolved constituents. High concentrations of TDS are primarily the result of the lack of sufficient recharge and restricted circulation. Together, these retard the flushing action of fresh water moving through the aquifers.

Water quality is generally good throughout the Plateau Region; however, a few specific water quality issues are of concern.

- Increase in urban runoff generally comes with an increase in impervious cover in populated areas. Urbanization also causes increased pollutant loads, including sediment, chemicals from motor vehicles, pesticides/herbicides/fertilizers from gardens and lawns, viruses/bacteria/ nutrients from human and animal wastes including septic systems, heavy metals from a variety of sources, and higher temperatures of the runoff.
- Increasing population has also manifested itself in the fragmentation of larger properties. With the advent of fragmentation comes the proliferation of new wells being drilled to serve individual properties. Each new well thus becomes another potential conduit for surface contamination to reach the underlying aquifer system.
- Vehicular traffic in streambeds disrupts streamflow, damages plants and animals living in these areas, damages channels and erodes banks, and decreases water quality by increasing the turbidity of the water in these rivers and streams.
- The constituent of most concern is nitrate, which was found above the primary maximum contaminant level in a number of water-sample analyses from the Edwards (BFZ) Aquifer and the Austin Chalk Aquifer in Kinney County. Historically, the primary contribution to poor groundwater quality occurs in wells that do not have adequately cemented casing.
- Poorer groundwater quality in the Region is generally from two sources, evaporite beds in the Glen Rose limestone and from surface contamination, both of which can be prevented by proper well construction. Also of concern are above normal levels of radioactivity that have been detected in sand sequences of the Glen Rose and Hensell Formations.

# WATER CONSERVATION AND DROUGHT CONTINGENCY

Water conservation and drought contingency planning are two of the most important components of water supply management. Recognizing their potential contribution, setting realistic goals, and aggressively enforcing their implementation may significantly extend the time when new supplies and associated infrastructure are needed. Water conservation are those practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling or reuse of water so that a water supply is made available for future or alternative uses. Water conservation strategies and recommendations are discussed in Chapter 5, Section 5.3.

Although residents of the Plateau Region are generally accustomed to highly variable climatic conditions, the relatively low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions.

Drought contingency plans provide a structured response that is intended to minimize the damaging effects caused by water shortage conditions. A common feature of drought contingency plans is a structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply or water demand conditions intensify. This measured or gradual approach allows for timely and appropriate action as a water shortage develops. The onset and termination of each implementation stage should be defined by specific "triggering" criteria. Triggering criteria are intended to ensure that timely action is taken in response to a developing situation and that the response is appropriate to the level of severity of the situation. Chapter 7 provides a detailed discussion on drought impact and preparedness in the Plateau Region.

# PROTECTION OF WATER, AGRIGUCLUTRAL AND NATURAL RESOURCES

The long-term protection of the Plateau Region's water resources, agricultural resources, and natural resources is an important component of this *2016* update of the *Plateau Region Water Plan*. Long-term water resources protection occurs in the conservative methodology of estimating water supply availability, evaluation of water management strategies for potential threats to water resources, the recommendation of water conservation strategies, and regional recommendations pertaining to water conservation and drought management practices. When enacted, the conservation practices will diminish water demand, the drought management practices will extend supplies over stress periods, and land management practices (land stewardship) will potentially increase aquifer recharge and stream base flow conditions.

Agricultural resources are protected in this *Plan*. There is no current movement of water from agricultural areas in the Region for use in urban areas; and there are no recommended strategies in this *Plan* that involve moving water from rural locations. Also, non-agricultural strategies include an analysis of potential impact to agricultural interests.

The protection of natural resources as intended in this *Plan* is closely linked with the protection of water resources as discussed above. The methodology adopted to assess groundwater source availability is based on not significantly impacting spring flows that contribute to base flows in area rivers. Thus, the intention to protect surface flows is directly related to those natural resources that are dependent on surface water sources for their existence.

Environmental impacts were evaluated in the consideration of strategies to meet water-supply deficits. Of prime consideration was whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to animals and plants that naturally inhabit the area under consideration. Although no specific "ecologically unique river and stream segments" are recommended in this *Plan*, the PWPG is very explicit in acknowledging the importance of all springs and stream segments for their significance as wildlife habitat.

# POLICY RECOMMENDATIONS

Water-supply resources intended to meet the future needs of all water-use categories in the Plateau Region are recognized to be limited in comparison to resources available in many other parts of the State. A conscientious effort to maintain an awareness of existing conditions and anticipate future water needs is recognized by the PWPG as being the foundation of continued regional water planning. In support of this belief, the PWPG is providing specific recommendations in this *Plan* that address:

- Watershed Management Practices
- Riparian Stewardship
- Conservation Management of State-Owned Lands
- Rainwater Harvesting as an Alternative Source of Water
- Conservation and Drought Planning
- Headwaters GCD Access to Groundwater under State-Owned Land
- Val Verde County Groundwater Management
- GCD Management of Brackish Groundwater
- Recharge Structures
- Transient Population Impact on Water Demand
- Better Methodologies for Estimating Population and Water Demand
- County-Other Demand Distribution
- Irrigation Surveys
- Peak-Use Management
- MAG Availability Alternative
- Regional Planning Coordination
- Training for New Regional Water Planning Group Members
- Require Participation of State Agencies Involved with the Planning Process
- Needed Studies and Data

The PWPG encourages the continued public process of developing region-based water plans. Copies of the *2016 Plateau Region Water Plan* are accessible in county courthouses, public libraries, and through the PWPG website at http://www.ugra.org/waterdevelopment.html. The *Plan* is also accessible through the Texas Water Development Board web site: http://www.twdb.state.tx.us/.

**EXECUTIVE SUMMARY TABLES**

**Table ES-1. Population Projection and Water Demand – Summary**
**(Acre-feet per year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **Municipal** | | | | | | |
| Population | 74,436 | 78,340 | 81,619 | 84,839 | 87,637 | 90,235 |
| Demands | 18,637 | 19,309 | 19,921 | 20,621 | 21,297 | 21,958 |
| Existing Supplies | 35,158 | 35,158 | 35,158 | 35,158 | 35,158 | 35,158 |
| Needs* | (3,456) | (3,527) | (3,541) | (3,599) | (3,667) | (3,727) |
| **County-Other** | | | | | | |
| Population | 67,040 | 75,408 | 81,380 | 86,306 | 90,590 | 94,360 |
| Demands | 6,930 | 7,565 | 8,031 | 8,475 | 8,930 | 9,357 |
| Existing Supplies | 14,164 | 14,164 | 14,164 | 14,164 | 14,164 | 14,164 |
| Needs* | (6) | (241) | (384) | (434) | (476) | (501) |
| **Manufacturing** | | | | | | |
| Demands | 25 | 27 | 29 | 30 | 32 | 34 |
| Existing Supplies | 34 | 34 | 34 | 34 | 34 | 34 |
| Needs* | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining** | | | | | | |
| Demands | 355 | 418 | 448 | 414 | 392 | 380 |
| Existing Supplies | 381 | 381 | 381 | 381 | 381 | 381 |
| Needs* | (38) | (98) | (112) | (76) | (47) | (43) |
| **Livestock** | | | | | | |
| Demands | 2,926 | 2,926 | 2,926 | 2,926 | 2,926 | 2,926 |
| Existing Supplies | 2,928 | 2,928 | 2,928 | 2,928 | 2,928 | 2,928 |
| Needs* | (214) | (214) | (214) | (214) | (214) | (214) |
| **Irrigation** | | | | | | |
| Demands | 10,929 | 10,788 | 10,654 | 10,521 | 10,394 | 10,282 |
| Existing Supplies | 15,544 | 15,544 | 15,544 | 15,544 | 15,544 | 15,544 |
| Needs* | (143) | (143) | (142) | (142) | (141) | (141) |
| **Region Totals** | | | | | | |
| Population | 141,476 | 153,748 | 162,999 | 171,145 | 178,227 | 184,595 |
| Demands | 39,802 | 41,033 | 42,009 | 42,987 | 43,971 | 44,937 |
| Existing Supplies | 68,209 | 68,209 | 68,209 | 68,209 | 68,209 | 68,209 |
| Needs* | (3,857) | (4,223) | (4,393) | (4,465 | (4,545) | (4,626) |

**Table ES-2. Identified Water Need Summary**
**(Acre-feet per year)**

| County | WUG/WWP | Source Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bandera | Irrigation | San Antonio | 129 | 129 | 129 | 129 | 129 | 129 |
| | Livestock | Guadalupe | 12 | 12 | 12 | 12 | 12 | 12 |
| | Livestock | San Antonio | 1 | 1 | 1 | 1 | 1 | 1 |
| Edwards | Rocksprings | Nueces | 98 | 96 | 94 | 94 | 94 | 94 |
| | Livestock | Nueces | 16 | 16 | 16 | 16 | 16 | 16 |
| | Mining | Rio Grande | 22 | 22 | 22 | 22 | 22 | 22 |
| Kerr | Kerrville | Guadalupe | 3,194 | 3,263 | 3,281 | 3,334 | 3,396 | 3,450 |
| | Loma Vista WS | Guadalupe | 30 | 37 | 38 | 44 | 51 | 57 |
| | County Other | Colorado | 5 | 5 | 5 | 5 | 6 | 7 |
| | County Other | Nueces | 1 | 1 | 1 | 1 | 1 | 1 |
| | Livestock | Colorado | 106 | 106 | 106 | 106 | 106 | 106 |
| | Livestock | Nueces | 6 | 6 | 6 | 6 | 6 | 6 |
| | Livestock | San Antonio | 18 | 18 | 18 | 18 | 18 | 18 |
| | Irrigation | San Antonio | 14 | 14 | 13 | 13 | 12 | 12 |
| | Mining | Colorado | 12 | 13 | 17 | 17 | 19 | 21 |
| Kinney | Livestock | Rio Grande | 22 | 22 | 22 | 22 | 22 | 22 |
| Real | Camp Wood | Nueces | 134 | 131 | 128 | 127 | 126 | 126 |
| | Livestock | Nueces | 33 | 33 | 33 | 33 | 33 | 33 |
| Val Verde | Mining | Rio Grande | 4 | 63 | 73 | 37 | 6 | 0 |

**Table ES-3. Second-Tier Identified Water Need Summary**
**(Acre-Feet per Year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Municipal | 3,304 | 3,375 | 3,389 | 3,447 | 3,515 | 3,575 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Manufacturing | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 38 | 98 | 112 | 76 | 47 | 43 |
| Livestock | 214 | 214 | 214 | 214 | 214 | 214 |
| Irrigation | 143 | 143 | 142 | 142 | 141 | 141 |

**Table ES-4. WUG Unmet Needs Summary**
**(Acre-Feet per Year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Municipal | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Manufacturing | 0 | 2 | 4 | 5 | 7 | 9 |
| Mining | 47 | 50 | 66 | 68 | 75 | 82 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 375 | 350 | 326 | 301 | 279 | 258 |

**Table ES-5. Recommended and Alternate Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Bandera | City of Bandera | San Antonio | Reuse treated wastewater effluent for irrigation use | J-1 | 310 | 310 | 310 | 310 | 310 | 310 | $450,000 |
| Bandera | City of Bandera | San Antonio | Promote, design & install rainwater harvesting systems | J-2 | 1 | 1 | 1 | 1 | 1 | 1 | $56,000 |
| Bandera | City of Bandera | San Antonio | Additional Lower Trinity well and lay necessary pipeline | J-4 | 323 | 323 | 323 | 323 | 323 | 323 | $2,284,000 |
| Bandera | City of Bandera | San Antonio | Additional Middle Trinity wells within City water infrastructure | J-5 | 161 | 161 | 161 | 161 | 161 | 161 | $779,000 |
| Bandera | Bandera County Other | San Antonio | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | 1 | 1 | 1 | 1 | 1 | 1 | $163,000 |
| Bandera | Bandera County Other | San Antonio | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | 1 | 1 | 1 | 1 | 1 | 1 | $463,000 |
| Bandera | Bandera County Other | San Antonio | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | 1 | 1 | 1 | 1 | 1 | 1 | $447,000 |
| Bandera | Bandera County Other | San Antonio | Vegetative Management | J-9 | 2,314 | 2,314 | 2,314 | 2,314 | 2,314 | 2,314 | $0 |
| Bandera | Bandera County Other | San Antonio | Additional well for Pebble Beach Subdivision | J-10 | 161 | 161 | 161 | 161 | 161 | 161 | $3,717,000 |
| Bandera | Bandera County Other | San Antonio | Additional wells to provide emergency supply to VFD | J-11 | 189 | 189 | 189 | 189 | 189 | 189 | $2,824,000 |
| Bandera | Bandera County Other | San Antonio | Additional wells to help Medina Lake area | J-12 | 27 | 27 | 27 | 27 | 27 | 27 | $1,377,000 |
| Bandera | * Bandera County Irrigation | Nueces | Additional groundwater wells | J-13 | 130 | 130 | 130 | 130 | 130 | 130 | $244,000 |
| Bandera | * Bandera County Livestock | San Antonio | Additional groundwater well | J-14 | 20 | 20 | 20 | 20 | 20 | 20 | $103,000 |
| Edwards | * City of Rocksprings | Colorado | Water loss audit and main-line repair | J-15 | 1 | 1 | 1 | 1 | 1 | 1 | $129,000 |
| Edwards | * City of Rocksprings | Colorado | Additional groundwater well | J-16 | 121 | 121 | 121 | 121 | 121 | 121 | $650,000 |
| Edwards | Edwards County Other | Nueces | Water loss audit and main-line repair for Barksdale WSC | J-17 | 1 | 1 | 1 | 1 | 1 | 1 | $203,000 |
| Edwards | Edwards County Other | Nueces | Additional well in the Nueces River Alluvium Aquifer | J-18 | 54 | 54 | 54 | 54 | 54 | 54 | $114,000 |
| Edwards | Edwards County Other | Nueces | Vegetative Management | J-19 | 145 | 145 | 145 | 145 | 145 | 145 | $0 |
| Edwards | * Edwards County Livestock | Nueces | Additional groundwater wells | J-20 | 20 | 20 | 20 | 20 | 20 | 20 | $105,000 |
| Edwards | * Edwards County Mining | Rio Grande | Additional groundwater wells | J-21 | 30 | 30 | 30 | 30 | 30 | 30 | $109,000 |

**Table ES-5. (Continued) Recommended and Alternate Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Kerr | * City of Kerrville | Guadalupe | Increase wastewater reuse | J-22 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $23,000,000 |
| | | | Water loss audit and main-line repair | J-23 | 147 | 147 | 147 | 147 | 147 | 147 | $9,339,000 |
| | | | Purchase water from UGRA | J-24 | | 3,840 | 3,840 | 3,840 | 5,450 | 5450 | $4,103,791 |
| | | | Increased water treatment and ASR capacity | J-25 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 3360 | $11,543,000 |
| | * Loma Vista WSC | Guadalupe | Conservation: Public information | J-26 | 4 | 4 | 4 | 4 | 4 | 4 | $0 |
| | | | Additional groundwater well | J-27 | 57 | 57 | 57 | 57 | 57 | 57 | $728,000 |
| | * Kerr County Other | Guadalupe | Water loss audit and main-line repair for Center Point WWW | J-28 | 1 | 1 | 1 | 1 | 1 | 1 | $33,000 |
| | | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | 1 | 1 | 1 | 1 | 1 | 1 | $138,000 |
| | | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | 1 | 1 | 1 | 1 | 1 | 1 | $99,000 |
| | | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | 1 | 1 | 1 | 1 | 1 | 1 | $102,000 |
| | | | Conservation: Public information | J-32 | 15 | 15 | 15 | 16 | 16 | 16 | $0 |
| | | | Vegetative management (UGRA) | J-33 | 218 | 218 | 218 | 218 | 218 | 218 | $0 |
| | | | UGRA Acquisition of Surface Water Rights | J-34 | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | 1029 | $1,087,367 |
| | | | KCCC Acquisition of Surface Water Rights | J-35 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | $6,342,000 |
| | | | Construction of an Off-Channel Surface Water Storage | J-36 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,534,303 |
| | | | Construction of surface water treatment plant facilities and distribution lines (CCP-UGRA) | J-37 | 149 | 149 | 149 | 149 | 149 | 149 | $25,581,000 |
| | | | ASR facility (CCP-UGRA) | J-38 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $1,258,000 |
| | | | Well field for dense, rural areas (CCP-UGRA) | J-39 | 860 | 860 | 860 | 860 | 860 | 860 | $4,357,000 |
| | | | Desalination plant (CCP-UGRA) | J-40 | 860 | 860 | 860 | 860 | 860 | 860 | $14,539,000 |
| | | | Construction of an Ellenburger Aquifer water supply well (CCP-UGRA) | J-41 | 108 | 108 | 108 | 108 | 108 | 108 | $567,000 |
| | Kerr County Irrigation | San Antonio | Additional groundwater well | J-42 | 20 | 20 | 20 | 20 | 20 | 20 | $78,000 |
| | * Kerr County Livestock | Colorado | Additional groundwater wells | J-43 | 108 | 108 | 108 | 108 | 108 | 108 | $667,000 |
| | * Kerr County Livestock | Guadalupe | Additional groundwater wells | J-44 | 20 | 20 | 20 | 20 | 20 | 20 | $190,000 |
| | * Kerr County Livestock | San Antonio | Additional groundwater well | J-45 | 20 | 20 | 20 | 20 | 20 | 20 | $65,000 |
| | * Kerr County Mining | Guadalupe | Additional groundwater well | J-46 | 30 | 30 | 30 | 30 | 30 | 30 | $132,000 |

**Table ES-5. (Continued) Recommended and Alternate Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Kinney | City of Brackettville | Rio Grande | Water loss audit and main-line repair | J-47 | 58 | 58 | 58 | 58 | 58 | 58 | $1,116 |
| | | | Increase supply to Spoford with new water line | J-48 | 3 | 3 | 3 | 3 | 3 | 3 | $751,000 |
| | | | Increase storage facility | J-49 | 3 | 3 | 3 | 3 | 3 | 3 | $288,000 |
| | Fort Clark Springs MUD | Rio Grande | Increase storage facility | J-50 | 620 | 620 | 620 | 620 | 620 | 620 | $1,033,000 |
| | Kinney County Other | | Vegetative Management | J-51 | 145 | 145 | 145 | 145 | 145 | 145 | $0 |
| | * Kinney County Livestock | Rio Grande | Additional groundwater wells | J-52 | 22 | 22 | 22 | 22 | 22 | 22 | $55,000 |
| Real | * City of Camp Wood | Nueces | Conservation: Public information | J-53 | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | | | Additional groundwater wells | J-54 | 172 | 172 | 172 | 172 | 172 | 172 | $1,887,000 |
| | City of Leakey (Real County Other) | Nueces | Water loss audit and main-line repair | J-55 | 1 | 1 | 1 | 1 | 1 | 1 | $52,000 |
| | | | Additional groundwater well | J-56 | 91 | 91 | 91 | 91 | 91 | 91 | $156,000 |
| | | | Develop interconnections between wells within the City | J-57 | 81 | 81 | 81 | 81 | 81 | 81 | $200,000 |
| | Real County Other | | Water loss audit and main-line repair for Real WSC | J-58 | 2 | 2 | 2 | 2 | 2 | 2 | $199,000 |
| | | | Vegetative Management | J-59 | 145 | 145 | 145 | 145 | 145 | 145 | $0 |
| | | | Additional well for Oakmont Saddle WSC | J-60 | 54 | 54 | 54 | 54 | 54 | 54 | $420,000 |
| | * Real County Livestock | Nueces | Additional groundwater wells | J-61 | 40 | 40 | 40 | 40 | 40 | 40 | $74,000 |
| Val Verde | City of Del Rio | Rio Grande | Water loss audit and main-line repair | J-62 | 119 | 119 | 119 | 119 | 119 | 119 | $8,673,000 |
| | | | Renovate, drill & equip new well, connect to distribution system | J-63 | 850 | 850 | 850 | 850 | 850 | 850 | $2,937,000 |
| | | | Water treatment plant expansion | J-64 | | 943 | 943 | 943 | 943 | 943 | $1,841,000 |
| | | | Develop a wastewater reuse program | J-65 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $1,700,000 |
| | Val Verde County Other | | Vegetative Management | J-66 | 145 | 145 | 145 | 145 | 145 | 145 | $0 |
| | * Val Verde County Mining | Rio Grande | Additional groundwater well | J-67 | 80 | 80 | 80 | 80 | 80 | 80 | $235,000 |
| ***2016 ALTERNATE WATER MANAGEMENT STRATEGY*** | | | | | | | | | | | |
| Bandera | City of Bandera | San Antonio | Surface water acquisition, treatment and ASR | J-3 | 0 | 0 | 3,100 | 3,100 | 3,100 | 3,100 | $29,450,000 |

**Table ES-6. Alternative Water Management Strategy Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Bandera | City of Bandera | San Antonio | Surface water acquisition, treatment and ASR | J-3 | 0 | 0 | 3,100 | 3,100 | 3,100 | 3,100 | $29,450,000 |

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# Water User Group (WUG) Category Summary

| REGION J | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **MUNICIPAL** | | | | | | |
| POPULATION | 74,436 | 78,340 | 81,619 | 84,839 | 87,637 | 90,235 |
| DEMANDS (acre-feet per year) | 18,637 | 19,309 | 19,921 | 20,621 | 21,297 | 21,958 |
| EXISTING SUPPLIES (acre-feet per year) | 35,158 | 35,158 | 35,158 | 35,158 | 35,158 | 35,158 |
| NEEDS (acre-feet per year)* | (3,456) | (3,527) | (3,541) | (3,599) | (3,667) | (3,727) |
| **COUNTY-OTHER** | | | | | | |
| POPULATION | 67,040 | 75,408 | 81,380 | 86,306 | 90,590 | 94,360 |
| DEMANDS (acre-feet per year) | 6,930 | 7,565 | 8,031 | 8,475 | 8,930 | 9,357 |
| EXISTING SUPPLIES (acre-feet per year) | 14,164 | 14,164 | 14,164 | 14,164 | 14,164 | 14,164 |
| NEEDS (acre-feet per year)* | (6) | (241) | (384) | (434) | (476) | (501) |
| **MANUFACTURING** | | | | | | |
| DEMANDS (acre-feet per year) | 25 | 27 | 29 | 30 | 32 | 34 |
| EXISTING SUPPLIES (acre-feet per year) | 34 | 34 | 34 | 34 | 34 | 34 |
| NEEDS (acre-feet per year)* | 0 | 0 | 0 | 0 | 0 | 0 |
| **MINING** | | | | | | |
| DEMANDS (acre-feet per year) | 355 | 418 | 448 | 414 | 392 | 380 |
| EXISTING SUPPLIES (acre-feet per year) | 381 | 381 | 381 | 381 | 381 | 381 |
| NEEDS (acre-feet per year)* | (38) | (98) | (112) | (76) | (47) | (43) |
| **LIVESTOCK** | | | | | | |
| DEMANDS (acre-feet per year) | 2,926 | 2,926 | 2,926 | 2,926 | 2,926 | 2,926 |
| EXISTING SUPPLIES (acre-feet per year) | 2,928 | 2,928 | 2,928 | 2,928 | 2,928 | 2,928 |
| NEEDS (acre-feet per year)* | (214) | (214) | (214) | (214) | (214) | (214) |
| **IRRIGATION** | | | | | | |
| DEMANDS (acre-feet per year) | 10,929 | 10,788 | 10,654 | 10,521 | 10,394 | 10,282 |
| EXISTING SUPPLIES (acre-feet per year) | 15,544 | 15,544 | 15,544 | 15,544 | 15,544 | 15,544 |
| NEEDS (acre-feet per year)* | (143) | (143) | (142) | (142) | (141) | (141) |
| **REGION TOTALS** | | | | | | |
| POPULATION | 141,476 | 153,748 | 162,999 | 171,145 | 178,227 | 184,595 |
| DEMANDS (acre-feet per year) | 39,802 | 41,033 | 42,009 | 42,987 | 43,971 | 44,937 |
| EXISTING SUPPLIES (acre-feet per year) | 68,209 | 68,209 | 68,209 | 68,209 | 68,209 | 68,209 |
| NEEDS (acre-feet per year)* | (3,857) | (4,223) | (4,393) | (4,465) | (4,545) | (4,626) |

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Category Summary report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

# Water User Group (WUG) Second-Tier Identified Water Need

| REGION J | WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR) | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| **BANDERA COUNTY** | | | | | | |
| **GUADALUPE BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 12 | 12 | 12 | 12 | 12 | 12 |
| **NUECES BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **SAN ANTONIO BASIN** | | | | | | |
| BANDERA | 0 | 0 | 0 | 0 | 0 | 0 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 1 | 1 | 1 | 1 | 1 | 1 |
| IRRIGATION | 129 | 129 | 129 | 129 | 129 | 129 |
| **EDWARDS COUNTY** | | | | | | |
| **COLORADO BASIN** | | | | | | |
| ROCKSPRINGS | 0 | 0 | 0 | 0 | 0 | 0 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **NUECES BASIN** | | | | | | |
| ROCKSPRINGS | 98 | 96 | 94 | 94 | 94 | 94 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 16 | 16 | 16 | 16 | 16 | 16 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **RIO GRANDE BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 22 | 22 | 22 | 22 | 22 | 22 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **KERR COUNTY** | | | | | | |
| **COLORADO BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 12 | 13 | 17 | 17 | 19 | 21 |
| LIVESTOCK | 106 | 106 | 106 | 106 | 106 | 106 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **GUADALUPE BASIN** | | | | | | |
| INGRAM | 0 | 0 | 0 | 0 | 0 | 0 |
| KERRVILLE | 3,047 | 3,116 | 3,134 | 3,187 | 3,249 | 3,303 |
| LOMA VISTA WATER SYSTEM | 26 | 33 | 34 | 40 | 47 | 53 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MANUFACTURING | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **NUECES BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 6 | 6 | 6 | 6 | 6 | 6 |

## Water User Group (WUG) Second-Tier Identified Water Need

| REGION J | WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR) | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| **KERR COUNTY** | | | | | | |
| **SAN ANTONIO BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 18 | 18 | 18 | 18 | 18 | 18 |
| IRRIGATION | 14 | 14 | 13 | 13 | 12 | 12 |
| **KINNEY COUNTY** | | | | | | |
| **NUECES BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **RIO GRANDE BASIN** | | | | | | |
| BRACKETTVILLE | 0 | 0 | 0 | 0 | 0 | 0 |
| FORT CLARK SPRINGS MUD | 0 | 0 | 0 | 0 | 0 | 0 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 22 | 22 | 22 | 22 | 22 | 22 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **REAL COUNTY** | | | | | | |
| **COLORADO BASIN** | | | | | | |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **NUECES BASIN** | | | | | | |
| CAMP WOOD | 133 | 130 | 127 | 126 | 125 | 125 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| LIVESTOCK | 33 | 33 | 33 | 33 | 33 | 33 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |
| **VAL VERDE COUNTY** | | | | | | |
| **RIO GRANDE BASIN** | | | | | | |
| DEL RIO | 0 | 0 | 0 | 0 | 0 | 0 |
| LAUGHLIN AFB | 0 | 0 | 0 | 0 | 0 | 0 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 4 | 63 | 73 | 37 | 6 | 0 |
| LIVESTOCK | 0 | 0 | 0 | 0 | 0 | 0 |
| IRRIGATION | 0 | 0 | 0 | 0 | 0 | 0 |

***Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.**

# Water User Group (WUG) Second-Tier Identified Water Need Summary

## REGION J

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| MUNICIPAL | 3,304 | 3,375 | 3,389 | 3,447 | 3,515 | 3,575 |
| COUNTY-OTHER | 0 | 0 | 0 | 0 | 0 | 0 |
| MANUFACTURING | 0 | 0 | 0 | 0 | 0 | 0 |
| MINING | 38 | 98 | 112 | 76 | 47 | 43 |
| LIVESTOCK | 214 | 214 | 214 | 214 | 214 | 214 |
| IRRIGATION | 143 | 143 | 142 | 142 | 141 | 141 |

*Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.

# Recommended Water User Group (WUG) Water Management Strategies (WMS)

## WUG Entity Primary Region: J

| WUG Entity Name | WMS Sponsor Region | WMS Name | Source Name | Water Management Strategy Supplies 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | Unit Cost 2020 | Unit Cost 2070 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BANDERA | J | CITY OF BANDERA - ADDITIONAL GROUNDWATER WELL AND NECESSARY PIPELINE | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 323 | 323 | 323 | 323 | 323 | 323 | $920 | $328 |
| BANDERA | J | CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 161 | 161 | 161 | 161 | 161 | 161 | $460 | $56 |
| BANDERA | J | CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $5000 | $0 |
| BANDERA | J | CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION USE | J \| DIRECT REUSE | 310 | 310 | 310 | 310 | 310 | 310 | $138 | $58 |
| BRACKETTVILLE | J | CITY OF BRACKETTVILLE - INCREASE SUPPLY TO SPOFFORD WITH NEW WATER LINE | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| KINNEY COUNTY | 3 | 3 | 3 | 3 | 3 | 3 | $22333 | $1333 |
| BRACKETTVILLE | J | CITY OF BRACKETTVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 58 | 58 | 58 | 58 | 58 | 58 | $19 | $19 |
| CAMP WOOD | J | CITY OF CAMP WOOD - ADDITIONAL GROUNDWATER WELLS | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| REAL COUNTY | 172 | 172 | 172 | 172 | 172 | 172 | $1570 | $651 |
| CAMP WOOD | J | CITY OF CAMP WOOD - CONSERVATION PUBLIC INFORMATION | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $910 | $910 |
| NTY-OTHER, ANDERA | J | BANDERA CO. FWSD #1 - ADDITIONAL WELL FOR PEBBLE BEACH SUBDIVISION | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 161 | 161 | 161 | 161 | 161 | 161 | $613000 | $302000 |
| COUNTY-OTHER, BANDERA | J | BANDERA COUNTY FWSD #1 - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $15000 | $1000 |
| COUNTY-OTHER, BANDERA | J | BANDERA RIVER RANCH #1 - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $42000 | $3000 |
| COUNTY-OTHER, BANDERA | J | BCRAGD - ADDITIONAL WELLS TO HELP MEDINA LAKE AREA | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 27 | 27 | 27 | 27 | 27 | 27 | $6148 | $1889 |
| COUNTY-OTHER, BANDERA | J | BCRAGD - ADDITIONAL WELLS TO PROVIDE EMERGENCY SUPPLY TO VFD | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 189 | 189 | 189 | 189 | 189 | 189 | $1497 | $249 |
| COUNTY-OTHER, BANDERA | J | BCRAGD - VEGETATIVE MANAGEMENT | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| COUNTY-OTHER, BANDERA | J | DROUGHT MANAGEMENT (BCRAGD) | DEMAND REDUCTION | 496 | 551 | 580 | 590 | 598 | 603 | $0 | $0 |
| COUNTY-OTHER, BANDERA | J | MEDINA WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $40000 | $3000 |
| COUNTY-OTHER, EDWARDS | J | BARKSDALE WSC - ADDITIONAL GROUNDWATER WELL | J \| NUECES RIVER ALLUVIUM AQUIFER \| EDWARDS COUNTY | 54 | 54 | 54 | 54 | 54 | 54 | $21000 | $11000 |
| COUNTY-OTHER, EDWARDS | J | BARKSDALE WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $18000 | $1000 |
| COUNTY-OTHER, EDWARDS | J | EDWARDS COUNTY OTHER - VEGETATIVE MANAGEMENT - ARUNDO DONAX | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| COUNTY-OTHER, KERR | J | CCP/UGRA - ELLENBURGER AQUIFER WATER SUPPLY WELL | J \| ELLENBURGER AQUIFER FRESH/BRACKISH \| KERR COUNTY | 108 | 108 | 108 | 108 | 108 | 108 | $648 | $213 |
| NTY-OTHER, KERR | J | CCP/UGRA - WELL FIELD FOR DENSE, RURAL AREAS | J \| TRINITY AQUIFER FRESH/BRACKISH \| KERR COUNTY | 994 | 994 | 994 | 994 | 994 | 994 | $610 | $186 |
| COUNTY-OTHER, KERR | J | CENTER POINT WWW - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $3000 | $0 |

# Recommended Water User Group (WUG) Water Management Strategies (WMS)

| WUG Entity Name | WMS Sponsor Region | WMS Name | Source Name | Water Management Strategy Supplies 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | Unit Cost 2020 | Unit C[illegible] 2[illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COUNTY-OTHER, KERR | J | EKC/UGRA - ACQUISITION OF SURFACE WATER RIGHTS | J \| GUADALUPE RUN-OF-RIVER | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | $1057 | $0 |
| COUNTY-OTHER, KERR | J | EKC/UGRA - ASR FACILITY | J \| TRINITY AQUIFER ASR FRESH/BRACKISH \| KERR COUNTY | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $101 | $93 |
| COUNTY-OTHER, KERR | J | EKC/UGRA - CONSTRUCTION OF AN OFF-CHANNEL SURFACE WATER STORAGE | J \| GUADALUPE RIVER OFF-CHANNEL LAKE/RESERVOIR | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $621 | $621 |
| COUNTY-OTHER, KERR | J | EKC/UGRA - CONSTRUCTION OF SURFACE WATER TREATMENT FACILITIES AND DISTRIBUTION LINES | J \| GUADALUPE RUN-OF-RIVER | 15 | 15 | 15 | 15 | 15 | 15 | $16725 | $2356 |
| COUNTY-OTHER, KERR | J | HILLS AND DALES WWW - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $13000 | $1000 |
| COUNTY-OTHER, KERR | J | KERR COUNTY OTHER - VEGETATIVE MANAGEMENT - ASHE JUNIPER | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| COUNTY-OTHER, KERR | J | MUNICIPAL AND COUNTY OTHER CONSERVATION FOR UGRA | DEMAND REDUCTION | 15 | 15 | 15 | 16 | 16 | 16 | $402 | $429 |
| COUNTY-OTHER, KERR | J | RUSTIC HILLS WATER - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $9000 | $1000 |
| COUNTY-OTHER, KERR | J | VERDE PARK ESTATES WWW - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $10000 | $1000 |
| COUNTY-OTHER, KINNEY | J | KINNEY COUNTY OTHER - VEGETATIVE MANAGEMENT - ARUNDO DONAX | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| COUNTY-OTHER, REAL | J | CITY OF LEAKEY - ADDITIONAL GROUNDWATER WELL | J \| NUECES RIVER ALLUVIUM AQUIFER \| REAL COUNTY | 91 | 91 | 91 | 91 | 91 | 91 | $275 | $132 |
| COUNTY-OTHER, REAL | J | CITY OF LEAKEY - INTERCONNECTIONS BETWEEN WELLS | J \| NUECES RIVER ALLUVIUM AQUIFER \| REAL COUNTY | 81 | 81 | 81 | 81 | 81 | 81 | $222 | $12 |
| COUNTY-OTHER, REAL | J | CITY OF LEAKEY - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $4000 | $0 |
| COUNTY-OTHER, REAL | J | OAKMONT SADDLE WSC - ADDITIONAL GROUNDWATER WELL | J \| NUECES RIVER ALLUVIUM AQUIFER \| REAL COUNTY | 54 | 54 | 54 | 54 | 54 | 54 | $704 | $56 |
| COUNTY-OTHER, REAL | J | REAL COUNTY OTHER - VEGETATIVE MANAGMENT (ARUNDO DONAX) | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| COUNTY-OTHER, REAL | J | REAL WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 2 | 2 | 2 | 2 | 2 | 2 | $9000 | $500 |
| COUNTY-OTHER, VAL VERDE | J | VAL VERDE COUNTY OTHER - VEGETATIVE MANAGEMENT (ARUNDO DONAX) | DEMAND REDUCTION | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| DEL RIO | J | CITY OF DEL RIO - DEVELOP A WASTEWATER REUSE PROGRAM | J \| RIO GRANDE RUN-OF-RIVER | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $49 | $3 |
| DEL RIO | J | CITY OF DEL RIO - RENOVATE, DRILL & EQUIP NEW WELL, CONNECT TO DISTRIBUTION SYSTEM | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| VAL VERDE COUNTY | 850 | 850 | 850 | 850 | 850 | 850 | $389 | $100 |
| DEL RIO | J | CITY OF DEL RIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 119 | 119 | 119 | 119 | 119 | 119 | $6555 | $454 |
| DEL RIO | J | CITY OF DEL RIO - WATER TREATMENT PLANT EXPANSION | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| VAL VERDE COUNTY | 943 | 943 | 943 | 943 | 943 | 943 | $0 | $279 |
| FORT CLARK SPRINGS MUD | J | FORT CLARK SPRINGS MUD - INCREASE STORAGE FACILITY | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| KINNEY COUNTY | 620 | 620 | 620 | 620 | 620 | 620 | $150 | $11 |
| IRRIGATION, BANDERA | J | BANDERA COUNTY IRRIGATION - ADDITIONAL GROUNDWATER WELLS | J \| TRINITY AQUIFER FRESH/BRACKISH \| BANDERA COUNTY | 130 | 130 | 130 | 130 | 130 | 130 | $238 | [illegible] |
| IRRIGATION, KERR | J | KERR COUNTY IRRIGATION - ADDITIONAL GROUNDWATER WELL | J \| TRINITY AQUIFER \| KERR COUNTY | 20 | 20 | 20 | 20 | 20 | 20 | $450 | $100 |

# Recommended Water User Group (WUG) Water Management Strategies (WMS)

| WUG Entity Name | WMS Sponsor Region | WMS Name | Source Name | Water Management Strategy Supplies 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | Unit Cost 2020 | Unit Cost 2070 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KERRVILLE | J | CITY OF KERRVILLE - INCREASE WASTEWATER REUSE | J \| GUADALUPE RUN-OF-RIVER | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $439 | $57 |
| KERRVILLE | J | CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY | J \| TRINITY AQUIFER ASR \| KERR COUNTY | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | $531 | $243 |
| KERRVILLE | J | CITY OF KERRVILLE - PURCHASE WATER FROM UGRA | J \| GUADALUPE RUN-OF-RIVER | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| KERRVILLE | J | CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 147 | 147 | 147 | 147 | 147 | 147 | $5714 | $395 |
| LIVESTOCK, BANDERA | J | BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| BANDERA COUNTY | 20 | 20 | 20 | 20 | 20 | 20 | $550 | $100 |
| LIVESTOCK, EDWARDS | J | EDWARDS COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| EDWARDS COUNTY | 20 | 20 | 20 | 20 | 20 | 20 | $550 | $100 |
| LIVESTOCK, KERR | J | KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL | J \| TRINITY AQUIFER \| KERR COUNTY | 20 | 20 | 20 | 20 | 20 | 20 | $300 | $50 |
| LIVESTOCK, KERR | J | KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| KERR COUNTY | 108 | 108 | 108 | 108 | 108 | 108 | $611 | $93 |
| LIVESTOCK, KERR | J | KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS - GUADALUPE RIVER BASIN | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| KERR COUNTY | 20 | 20 | 20 | 20 | 20 | 20 | $900 | $100 |
| LIVESTOCK, KINNEY | J | KINNEY COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS | J \| AUSTIN CHALK AQUIFER BRACKISH \| KINNEY COUNTY | 22 | 22 | 22 | 22 | 22 | 22 | $227 | $0 |
| [illegible]STOCK, REAL | J | REAL COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| REAL COUNTY | 40 | 40 | 40 | 40 | 40 | 40 | $200 | $50 |
| LOMA VISTA WATER SYSTEM | J | LOMA VISTA WSC - ADDITIONAL GROUNDWATER WELL | J \| TRINITY AQUIFER FRESH/BRACKISH \| KERR COUNTY | 57 | 57 | 57 | 57 | 57 | 57 | $1464 | $375 |
| LOMA VISTA WATER SYSTEM | J | LOMA VISTA WSC - CONSERVATION PUBLIC INFORMATION | DEMAND REDUCTION | 4 | 4 | 4 | 4 | 4 | 4 | $552 | $552 |
| MINING, EDWARDS | J | EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELLS | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| EDWARDS COUNTY | 30 | 30 | 30 | 30 | 30 | 30 | $400 | $100 |
| MINING, KERR | J | KERR COUNTY MINING - ADDITIONAL GROUNDWATER WELL | J \| TRINITY AQUIFER FRESH/BRACKISH \| KERR COUNTY | 30 | 30 | 30 | 30 | 30 | 30 | $500 | $133 |
| MINING, VAL VERDE | J | VAL VERDE COUNTY MINING - ADDITIONAL GROUNDWATER WELL | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| VAL VERDE COUNTY | 80 | 80 | 80 | 80 | 80 | 80 | $312 | $63 |
| ROCKSPRINGS | J | CITY OF ROCKSPRINGS - ADDITIONAL GROUNDWATER WELL | J \| EDWARDS-TRINITY-PLATEAU AQUIFER \| EDWARDS COUNTY | 121 | 121 | 121 | 121 | 121 | 121 | $595 | $149 |
| ROCKSPRINGS | J | CITY OF ROCKSPRINGS - WATER LOSS AUDIT AND MAIN-LINE REPAIR | DEMAND REDUCTION | 1 | 1 | 1 | 1 | 1 | 1 | $12000 | $1000 |
| | | | **Region J Total RecommendedWMS Supplies** | 21,494 | 21,549 | 21,578 | 21,589 | 21,597 | 21,602 | | |

# Alternative Water User Group (WUG) Water Management Strategies (WMS)

## WUG Entity Primary Region: J

| WUG Entity Name | WMS Sponsor Region | WMS Name | Source Name | Water Management Strategy Supplies 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | Unit Cost 2020 | Unit Cost 2070 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BANDERA | J | CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR | J \| TRINITY AQUIFER ASR FRESH/BRACKISH \| BANDERA COUNTY | 500 | 500 | 1,000 | 1,000 | 1,500 | 1,500 | $4948 | $7 |
| | | | | | | | | | | | |
| Region J Total Alternative WMS Supplies | | | | 500 | 500 | 1,000 | 1,000 | 1,500 | 1,500 | | |

# Alternative Projects Associated with Water Management Strategies

## Project Sponsor Region: J

| Sponsor Name | Is Sponsor a WWP? | Project Name | Project Description | Capital Cost | Online Decade |
|---|---|---|---|---|---|
| | | | Region J Total Alternative Capital Cost | | |

*Projects with a capital cost of zero are excluded from the report list.

# Water User Group (WUG) Management Supply Factor

| REGION J | WUG MANAGEMENT SUPPLY FACTOR | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| BANDERA | 7.6 | 6.8 | 6.5 | 6.3 | 6.2 | 6.2 |
| BRACKETTVILLE | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| CAMP WOOD | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 |
| COUNTY-OTHER, BANDERA | 1.4 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 |
| COUNTY-OTHER, EDWARDS | 4.3 | 4.5 | 4.7 | 4.7 | 4.8 | 4.8 |
| COUNTY-OTHER, KERR | 4.8 | 4.7 | 4.7 | 4.6 | 4.5 | 4.4 |
| COUNTY-OTHER, KINNEY | 3.1 | 3.1 | 3.2 | 3.2 | 3.2 | 3.2 |
| COUNTY-OTHER, REAL | 4.8 | 5.0 | 5.1 | 5.2 | 5.2 | 5.2 |
| COUNTY-OTHER, VAL VERDE | 2.3 | 2.0 | 1.7 | 1.5 | 1.4 | 1.2 |
| DEL RIO | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 |
| FORT CLARK SPRINGS MUD | 3.2 | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 |
| INGRAM | 3.3 | 3.5 | 3.6 | 3.6 | 3.6 | 3.6 |
| IRRIGATION, BANDERA | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| IRRIGATION, EDWARDS | 2.0 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
| IRRIGATION, KERR | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| IRRIGATION, KINNEY | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| IRRIGATION, REAL | 9.9 | 10.4 | 10.8 | 11.3 | 11.9 | 12.4 |
| IRRIGATION, VAL VERDE | 1.1 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 |
| KERRVILLE | 2.2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.0 |
| LAUGHLIN AFB | 2.3 | 2.1 | 1.9 | 1.8 | 1.8 | 1.8 |
| LIVESTOCK, BANDERA | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| LIVESTOCK, EDWARDS | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| LIVESTOCK, KERR | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| LIVESTOCK, KINNEY | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| LIVESTOCK, REAL | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| LIVESTOCK, VAL VERDE | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| LOMA VISTA WATER SYSTEM | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 |
| MANUFACTURING, KERR | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 |
| MINING, EDWARDS | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| MINING, KERR | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 |
| MINING, VAL VERDE | 1.4 | 1.1 | 1.0 | 1.2 | 1.4 | 1.6 |
| ROCKSPRINGS | 3.5 | 3.6 | 3.7 | 3.7 | 3.7 | 3.7 |

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. To calculate the Management Supply Factor for each WUG as a whole, not split by region-county-basin the combined total of existing and future supply is divided by the total projected demand.

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# CHAPTER 1

# PLATEAU REGION DESCRIPTION

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# 1 PLATEAU REGION

Located along the southern boundary of the Texas Edwards Plateau, the six-county Plateau Water Planning Region stretches from the Central Texas Hill Country westward to the Rio Grande. Under land grants issued by Mexico and later by the Republic of Texas in the early 1800s, European immigrants (predominantly German) and transient settlers from the southern United States colonized this rugged land formally occupied for centuries by Native Americans. These first immigrants and those to follow settled small towns along many of the spring-fed streams that crossed the area and from these way stations spread out to establish farms and ranches throughout the Region. Even today, the area retains much of its original cowboy frontier and German heritage. Chapter 1 that follows is a broad introduction to this Region and the water supply challenges it faces. The Region's economic health and quality of life concerns, including the aquatic environment and recreational opportunities, are dependent on a sustainable water supply that is equitably managed.

# 1.1 WATER PLANNING AND MANAGEMENT

## 1.1.1 Regional Water Planning

In January of 2011, the third round of regional water planning was concluded with the adoption of the *2011 Plateau Region Water Plan*. It is understood that this *Plan* is not a static plan but rather is intended to be revised as conditions change. For this reason, the current *2016 Plateau Region Water Plan* put forth in this document is not a new *Plan*, but rather an evolutionary modification of the preceding *Plans*. Only those parts of the previous *Plan* that required updating, and there were many, have been revised.

Previous planning periods included interim projects designated by the Plateau Water Planning Group (PWPG) to evaluate specific water supply availability and management issues. These reports can be accessed on the Upper Guadalupe River Authority website at http://www.ugra.org/waterdevelopment.html.

**Table 1-1. Interim Planning Project Reports**

| Interim Planning Project Reports | Date |
|---|---|
| Ground-Water Resources of the Edwards Aquifer in the Del Rio Area, Texas | 2001 |
| The Lower Trinity Aquifer of Bandera and Kerr Counties, Texas | 2001 |
| Springs of Kinney and Val Verde Counties | 2005 |
| Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County, Texas | 2005 |
| Installation of Groundwater Monitoring Equipment in Designated Wells in the Plateau Planning Region | 2005 |
| Water Rights Analysis and ASR Feasibility in Kerr County | 2009 |
| ASR Feasibility in Bandera County | 2009 |
| Groundwater Data Acquisition in Edwards, Kinney and Val Verde Counties, Texas | 2010 |
| Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area | 2010 |
| Occurrence of Significant River Alluvium Aquifers in the Plateau Region | 2010 |

The purpose of the *2016 Plateau Region Water Plan* is to provide a document that water planners and users can reference for long- and short-term water management recommendations. Equally important, this *Plan* serves as an educational tool to enlighten all citizens as to the importance of properly managing and conserving the delicate water resources of this pristine Region. Chapter 1 presents a broad overview of the Region and many of the key issues that must be addressed as part of any attempt to develop a comprehensive water management plan that is acceptable and beneficial to those who reside here.

The Plateau Region Planning Group is a voluntary association comprised of voting and non-voting members whom represent a minimum of 11 water use categories. Since 1997, the PWPG has been involved in a wide range of projects, programs and the development of the *Regional Water Plan*.

The *2016 Plateau Region Water Plan* follows an identical format as the plans prepared by the other 15 water planning regions in the State as mandated by the Texas Legislature and overseen by the Texas Water Development Board (TWDB). The *Plan* provides an evaluation of current and future water demands for all water-use categories, and evaluates water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed available supplies, management strategies are considered to meet the potential water shortages. Because our understanding of current and future water demand and supply sources are constantly changing, it is intended for this *Plan* to be revised every five years or sooner if deemed necessary.

In the development of this *Plan* it was essential to coordinate planning efforts with adjacent regions (Regions E, F, K, L and M) to insure that there were no conflicting strategies pertaining to shared or transferred water-supply sources. This coordination resulted in there being no known conflicts between this *Plan* and plans prepared for other regions.

Water-supply availability under drought-of-record conditions is considered in the planning process to insure that water demands can be met under the worst of circumstances. Recommendations of the Drought Preparedness Council are considered in this *Plan*.

For surface water supplies, drought-of-record conditions relate to the quantity of water available to meet existing permits from the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio rivers and their tributaries as estimated by Run 3 of the Texas Commission on Environmental Quality (TCEQ) - Water Availability Models (WAM). This *Plan* has no impact on navigation on these surface-water courses.

The availability of groundwater during drought-of-record conditions is based primarily on Modeled Available Groundwater (MAG) declarations based on Groundwater Management Area (GMA) "desired future conditions". The GMA process is described in greater detail in Section 1.1.5 of this chapter. Chapter 3 contains a detailed analysis of water supply availability in the Region.

This *Plan* continues to benefit from environmental data on the more prominent watercourses in the Region as provided by the Texas Parks & Wildlife Department. This data was useful in the assessment and consideration of environmental flow needs, springs, and ecologically significant stream segments.

This *2016 Plateau Region Water Plan* fully recognizes and protects existing water rights, water contracts, and option agreements. The PWPG strongly encourages all entities to participate in the planning process so that their specific concerns can be recognized and addressed. The PWPG also encourages the participation of Groundwater Conservation Districts and recognizes their management plans and rules.

Water quality is recognized as an important component in this 50-year water plan. Water supplies can be diminished or made more costly to prepare for distribution if water quality is compromised. To insure that this *Plan* fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water-supply availability estimates (Chapter 3), water management strategies and water quality impacts (Chapter 5), and policy recommendations (Chapter 8).

Also considered in the above segments of the *Plan* were the Water Quality Management Plans (WQMPs) of TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB). TCEQ's WQMP is tied to the State's water quality assessments that identify and direct planning for implementation measure that control and/or prevent priority water quality problems. Elements contained in the WQMP include effluent limitations of wastewater facilities, total maximum daily loads, nonpoint source management controls, identification of designated management agencies, and groundwater and source water protection planning. TSSWCB's WQMP is a site-specific plan developed through and approved by Soil and Water Conservation Districts for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measure, and technologies.

In the year 2010, the U.S. Census Bureau performed a census count, which provides the base year for future population projections in the Region. Although the PWPG accepts the 2010 census count, members express concern that the census does not recognize the significant seasonal population increase that occurs in these counties as the area draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting homes and cabins. Therefore, an emphasis is being made in this planning document, especially in the rural counties, to recognize a need for more water than is justified simply from the population-derived water demand quantities.

### 1.1.2 State Water Plan

The Texas Water Development Board adopted *Water for Texas 2012* as the official *Texas State Water Plan*. The Texas Water Code directs the TWDB to periodically update this comprehensive water plan, which is used as a guide to State water policy. The *2012 State Water Plan* is the third water plan to incorporate water management and policy decisions made at the regional level as expressed in the 16 approved regional water plans. The segment of the *State Plan* that addresses the Plateau Region highlight:

- Additional supply needed in 2060 – 2,389 acre-feet per year
- Recommended water management strategy volume in 2060 – 23,010 acre-feet per year
- Total capital cost - $55 million
- Conservation accounts for 3 percent of 2060 strategy volume
- Brush control strategy supply not available during drought of record conditions
- Aquifer Storage and Recovery accounts for 21 percent of 2060 strategy volume

### 1.1.3 Local Water Management Plans

The Plateau Region often experiences periods of limited rainfall, especially compared with more humid areas in the eastern part of the State. Although residents of the Region are generally accustomed to these conditions, the low rainfall and accompanying high evaporation underscore the necessity of developing plans to manage resources responsibly and to respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions. The following entities have developed water management and drought contingency plans:

- City of Del Rio
- City of Brackettville
- City of Kerrville
- Fort Clark Municipal Utility District
- Headwaters Groundwater Conservation District
- City of Bandera
- Bandera County River Authority and Groundwater District

- Wiedenfeld Water Works
- Kinney County Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District
- City of Leakey
- City of Camp Wood

### 1.1.4 Groundwater Conservation Districts

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts, which are charged with managing groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected or appointed board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states in part, "Groundwater Conservation Districts created as provided by this chapter are the State's preferred method of groundwater management." Four districts are currently in operation within the Plateau Region (Figure 1-1); their management goals are discussed in further detail in Chapter 5.

- Bandera County River Authority and Groundwater District
- Headwaters Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District
- Kinney County Groundwater Conservation District

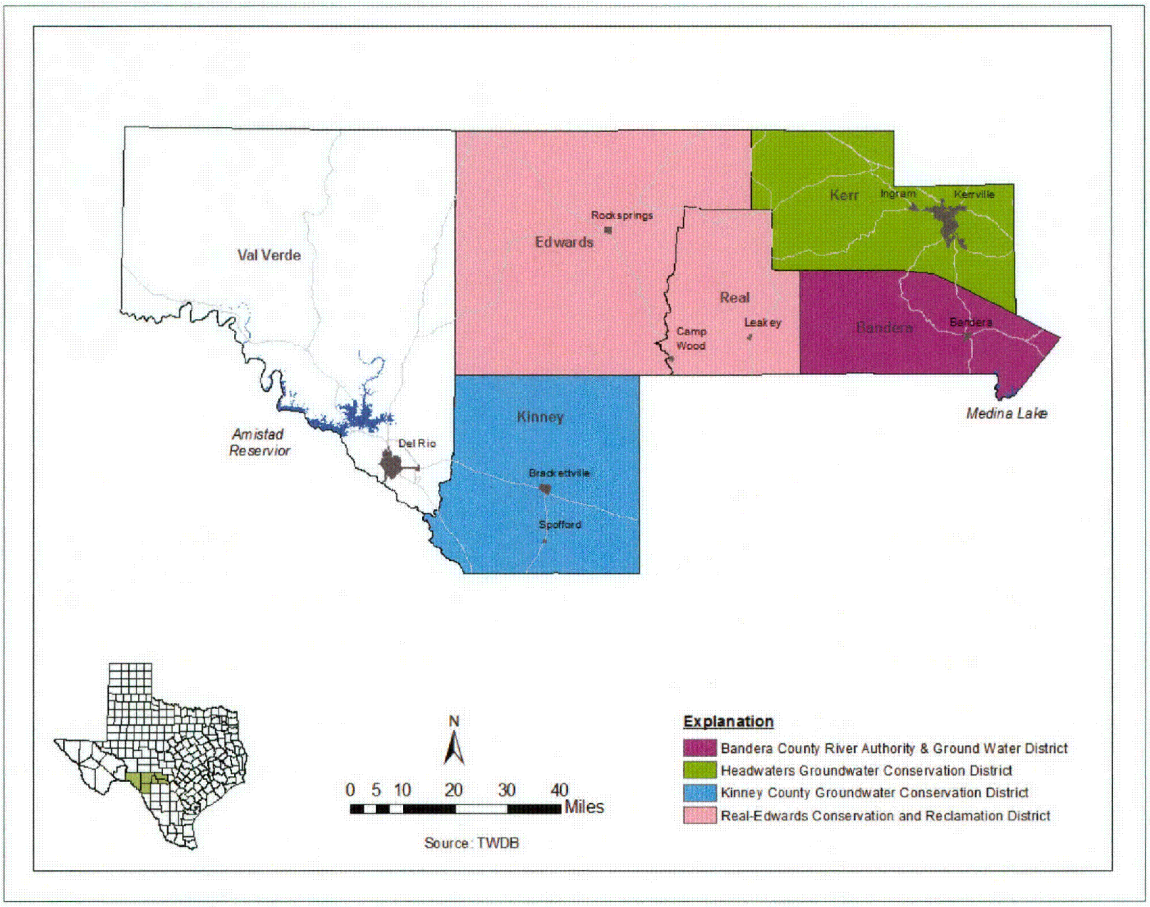


**Figure 1-1. Groundwater Conservation Districts**

### 1.1.5 Groundwater Management Areas

In recent sessions, the Texas Legislature has redefined the manner in which groundwater is to be managed (http://www.twdb.texas.gov/groundwater/management_areas/index.asp) Senate Bill 2 of the 77th Texas Legislature (2001) authorized:

- The TWDB to designate Groundwater Management Areas that would include all major and minor aquifers of the State.
- Required Groundwater Conservation Districts to share groundwater plans with other districts in the Groundwater Management Area.
- Allowed a Groundwater Conservation District to call for joint planning among districts in a Groundwater Management Area.

The objective was to delineate areas considered suitable for management of groundwater resources. A Groundwater Management Area (GMA) should ideally coincide with the boundaries of a groundwater reservoir (aquifer) or a subdivision of a groundwater reservoir, but it may also be defined by other factors, including the boundaries of political subdivisions. In December 2002, the TWDB designated 16 GMAs covering the entire State (http://www.twdb.texas.gov/mapping/index.asp).

In 2005, the Legislature once again changed the direction of groundwater management. The new requirements, codified in Texas Water Code Chapter 36.108, required joint planning in management areas among Groundwater Conservation Districts. The new requirements direct that,

*"Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area."*

*Desired future conditions* are a description of aquifers at some time in the future. This description is a precursor to developing a volumetric number called *managed available groundwater*. The TWDB is responsible for providing each Groundwater Conservation District and Regional Water Planning Group, located wholly or partly in the management area, with *modeled available groundwater*. Once the *modeled available groundwater* is determined, the districts begin issuing groundwater withdrawal permits to support the *desired future condition* of the aquifer up to the total amount of *modeled available groundwater*. These permits express *desired future conditions* by only allowing withdrawals that will support the conditions established by the GMA. Regional water plans must also incorporate the *modeled available groundwater* for each aquifer within their regions. GMA *desired future conditions* are thus recognized as the conservative means of sustainably preserving groundwater supplies for use by future generations.

The counties of the Plateau Region are included in three GMAs:

- GMA 7 includes Edwards, Kinney (partial), Real and Val Verde
- GMA 9 includes Bandera and Kerr
- GMA 10 includes Kinney (partial)

*Desired future conditions* have been adopted for specified aquifers in these GMAs, and, therefore, this *2016 Plateau Region Water Plan* includes a significant revision to all groundwater source availability estimates based on *modeled availability groundwater* volumes generated from the GMA process.

### 1.1.6 Hill Country Priority Groundwater Management Area

A portion of the Plateau Region (Bandera and Kerr Counties) is included in the initial Hill Country Priority Groundwater Management Area (PGMA). The PGMA process is initiated by the TCEQ, who designates a PGMA when an area is experiencing critical groundwater problems, or is expected to do so within 25 years. These problems include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, or contamination of groundwater supplies. Once an area is designated a PGMA, landowners have two years to create a Groundwater Conservation District (GCD). Otherwise, the TCEQ is required to create a GCD or to recommend that the area be added to an existing district. The TWDB works with the TCEQ to produce a legislative report every two years on the status of PGMAs in the state. The PGMA process is completely independent of the current Groundwater Management Area (GMA) process and each process has different goals. The goal of the PGMA process is to establish GCDs in these designated areas so that there will be a management entity to address the identified groundwater issues. PGMAs are still relevant as long as there remain portions within these designated areas without GCDs. The Plateau Region's portion of the Hill Country PGMA (Bandera & Kerr Counties) now has established GCDs. A statewide map of the declared PGMA areas is available at: http://www.tceq.state.tx.us/assets/public/permitting/watersupply/groundwater/maps/pgma_areas.pdf.

# 1.2 REGIONAL GEOGRAPHIC SETTING

## 1.2.1 Plateau Region

The Plateau Region encompasses six counties in the west-central part of the State of Texas, stretching from the headwaters of the Guadalupe and San Antonio rivers in the Central Texas Hill Country westward to Del Rio and the Rio Grande international border (Figure 1-2). With a total area of 9,252 square miles ($mi^2$), the Plateau Region represents 3.5 percent of the total area of the State and includes the counties of Bandera (792$mi^2$), Edwards (2,120$mi^2$), Kerr (1,106$mi^2$), Kinney (1,364$mi^2$), Real (700$mi^2$), and Val Verde (3,171$mi^2$).

## 1.2.2 Physiography

The Plateau Region lies along the southern edge of the Edwards Plateau and is bounded on the east by the Central Texas Hill Country and on the west by the Rio Grande international border. The Balcones escarpment generally forms the southern boundary of the Plateau Region. The escarpment is a steep topographic feature that traces the path of a major fault system that formed more than 10 million years ago. The escarpment separates the more resistant rocks of the Edwards Plateau to the north from softer and more easily erodible rocks to the south. Erosion by streams has cut steep canyons into the thick limestone beds of the Edwards Plateau.

Its rolling prairies, steep canyons, and the large number of spring-fed perennially flowing streams characterize the Region. The uplands are fairly level, but the landscape of the stream valleys is very hilly with steep canyons that provide rapid drainage. Upland soils are dark alkaline clays and clay loams; the river valley soils are gravelly and light colored. Some cultivation takes place in the deep, dark-gray or brown loams and clays of the river bottoms and to a greater extent over the broad flat farming belt of Kinney County. The major soil-management concerns are brush control, low fertility and excess lime.

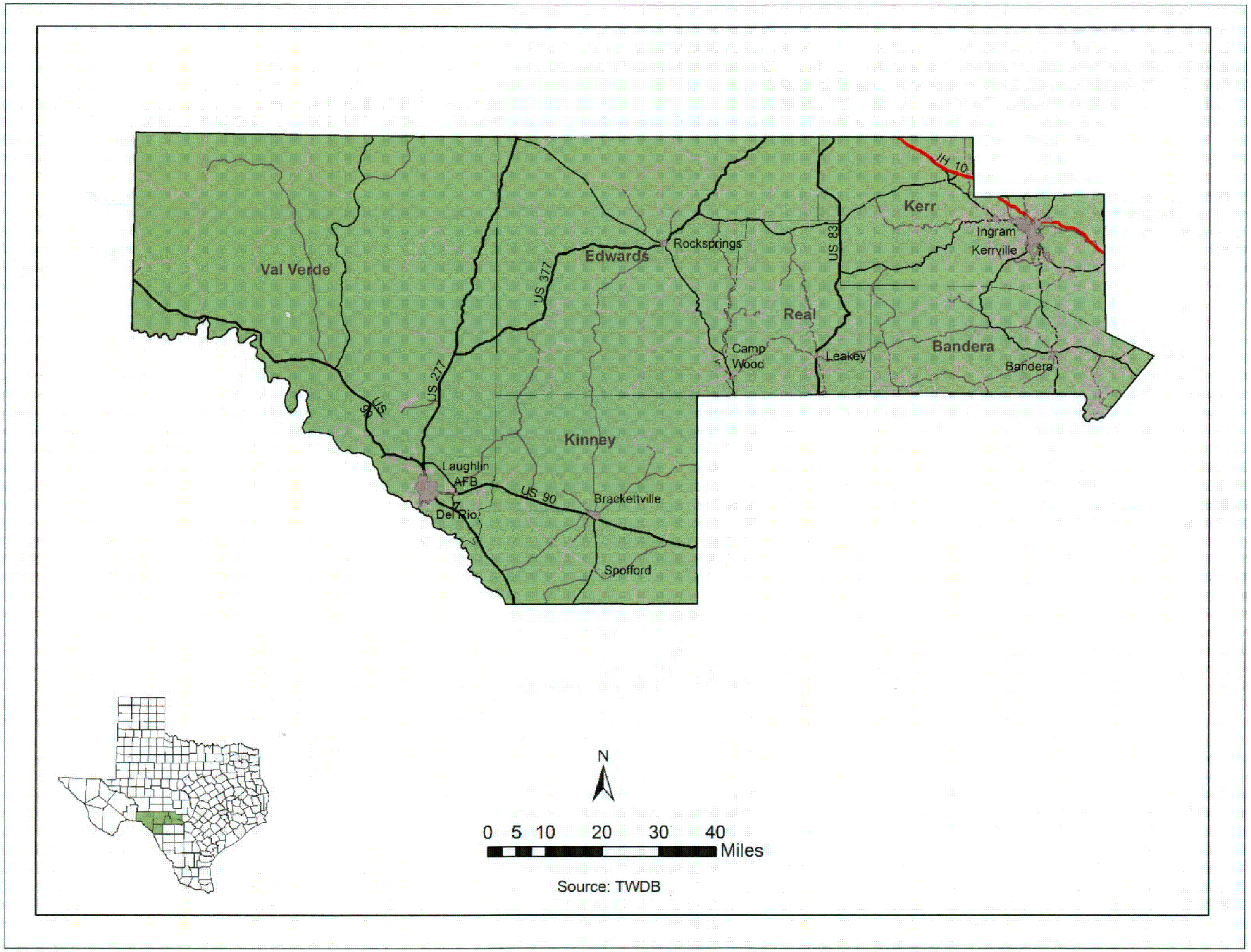


**Figure 1-2. Location of the Plateau Region**

### 1.2.3 Population and Regional Economy

The projected year-2020 population in the Plateau Region is 141,476 (Figure 1-3). The population density of the Region is 15.3 people per square mile, which is much less than the state average of 72 people per square mile. Current and projected future population of the Region is discussed in detail in Chapter 2.

Approximately 45 percent of the total population of the Region is located in the two largest cities, Del Rio and Kerrville. In the year 2020, Del Rio, including the population of Laughlin Air Force Base, is projected to have 39,839 residents and Kerrville with 23,319. The projected year-2020 populations of other major communities in the Region are: Bandera (1,045); Rocksprings (1,254); Brackettville and Fort Clark Springs (2,996); and Camp Wood (698). These population estimates do not include a significant transient (tourist, hunting, recreation, etc.) population that has a resulting significant impact on overall water supply demand in the Region.

The regional economy is based primarily on tourism, hunting, ranching agribusiness and government. The beauty of the Hill Country, the solitude of the forested canyons and plateau grasslands, and the gateway to Mexico all support a major tourist trade. Agribusiness is predominantly associated with the raising of sheep, goats, beef cattle and exotic game throughout the Region. Apple orchards in Bandera County, oil and gas production and mohair production in Edwards and Real Counties, medical services and manufacturing in Kerr County, irrigated cotton, hay and wheat in Kinney County, and a military base and trade with Mexico in Val Verde County all contribute largely to the Region's overall economy.

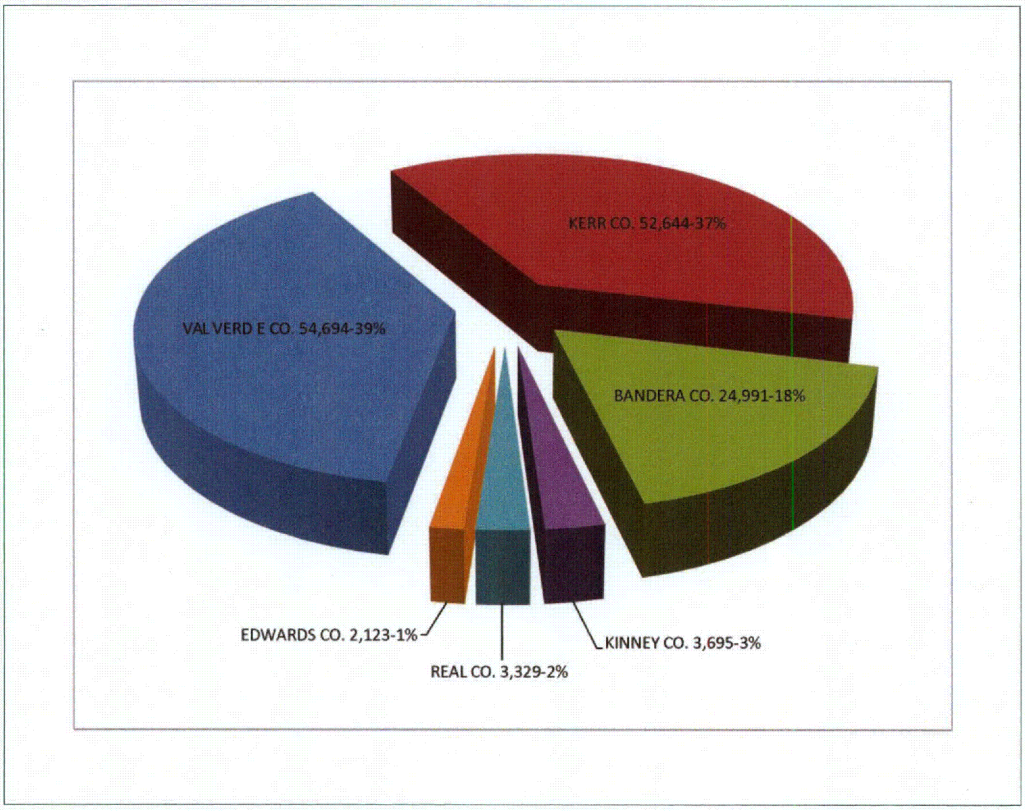


**Figure 1-3. Year 2020 Projected Population**

### 1.2.4 Land Use

Land use in the six-county Region is divided into seven categories (Figure 1-4):

- Urban (or developed)
- Agricultural (cultivated)
- Range
- Forest
- Water
- Wetlands
- Barren

Urban lands are the location of cities and towns that make up less than one percent of the Region's total land area. Agricultural lands are identified as areas that support the cultivation of crops. These lands, which potentially involve extensive irrigation, also occupy less than one percent of the Region. Together, urban and agricultural lands comprise the two most significant areas of water consumption in the Plateau Region.

Rangeland is defined as all areas that are either associated with or are suitable for livestock production. Although this is the largest category of land use in areal extent in the Region, rangeland accounts for one of the smallest sources of water demand. Forestland is limited to areas where topography and climate support the growth of native trees. Areas designated as either water or wetlands are associated with the rivers and their tributaries. Barren lands are defined as undeveloped areas with little potential for use as agricultural land, rangeland or forestland.

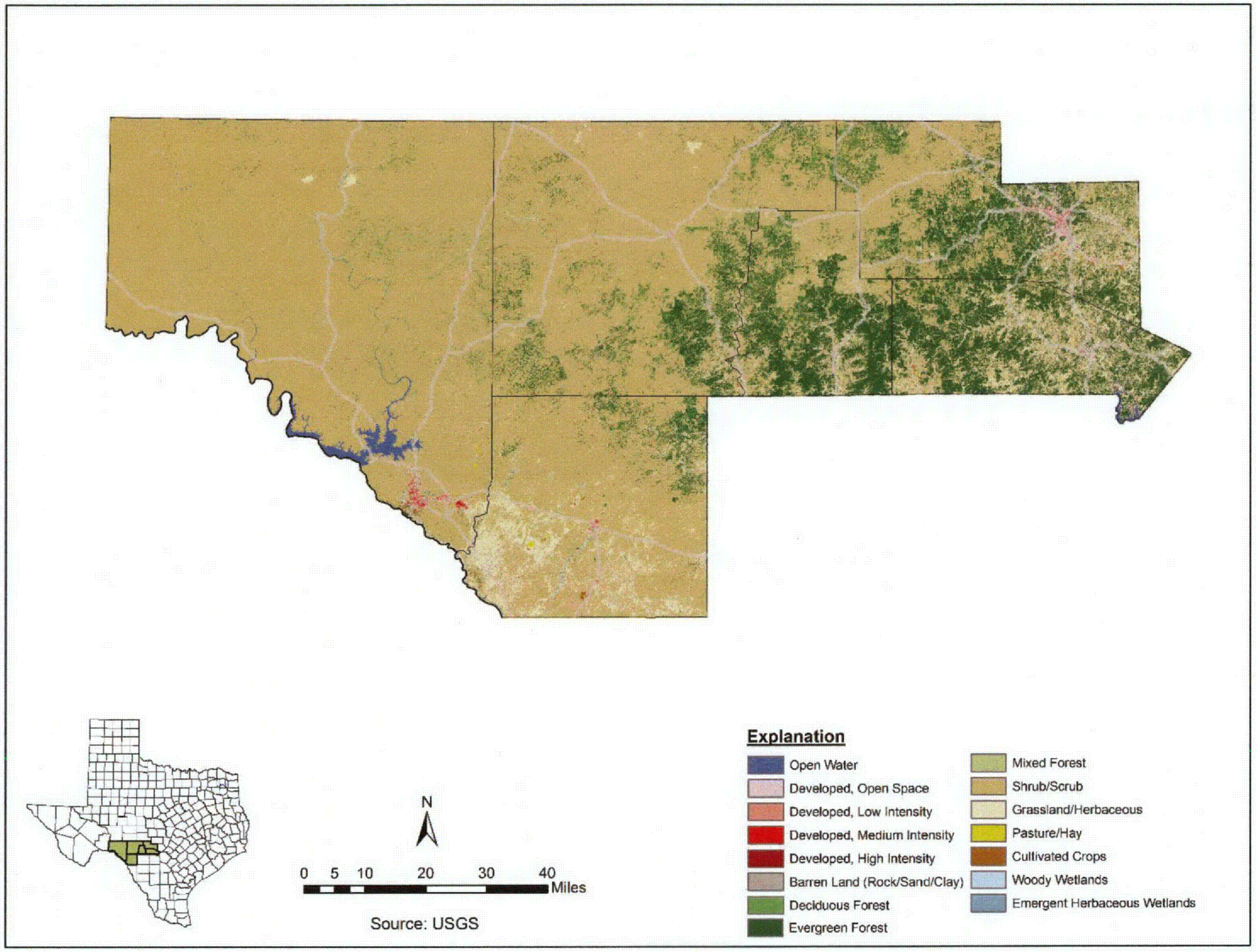


**Figure 1-4. Land Use**

### 1.2.5 Climate and Drought

The climate of the Plateau Region is semi-arid to arid as precipitation decreases westward across the Region. The average for the Edwards Plateau is 25 inches. Figure 1-5 illustrates the variability with respect to the six counties of the Region. Precipitation decreases from approximately 33 inches in the easternmost reaches of Bandera and Kerr Counties to less than 18 inches in western Val Verde County (National Weather Service). Net lake evaporation (Figure 1-6) increases from 58 inches in Bandera and Kerr Counties to about 78 inches in western Val Verde County (TWDB). Net lake evaporation is the difference between total evaporation from a lake and total precipitation. Figure 1-7 illustrates average monthly rainfall recorded at selected stations.

Long periods of below-normal rainfall may have severe impacts on groundwater recharge, spring flow, and stream flow. The effects of low rainfall over long periods of time are most readily reflected in the form of decreased spring flow and stream flow. Under these conditions, the lack of rainfall leads to reduced recharge to aquifers and to lower water levels in wells. As water levels fall in aquifers in drought-stricken areas, the volume of water discharging from important water-supply related springs may diminish to the point that communities reliant on spring water, such as Camp Wood in Real County, may experience an insufficient water supply to meet its full needs. Landowners who are dependent on spring-fed stream flow may also find insufficient volumes of surface water needed to support irrigation or other farming and ranching activities. The direct linkage between precipitation and water levels in aquifers of the Plateau Region is indicated by hydrograph records of wells that show rapid increases in water levels as a response to local rainstorms.

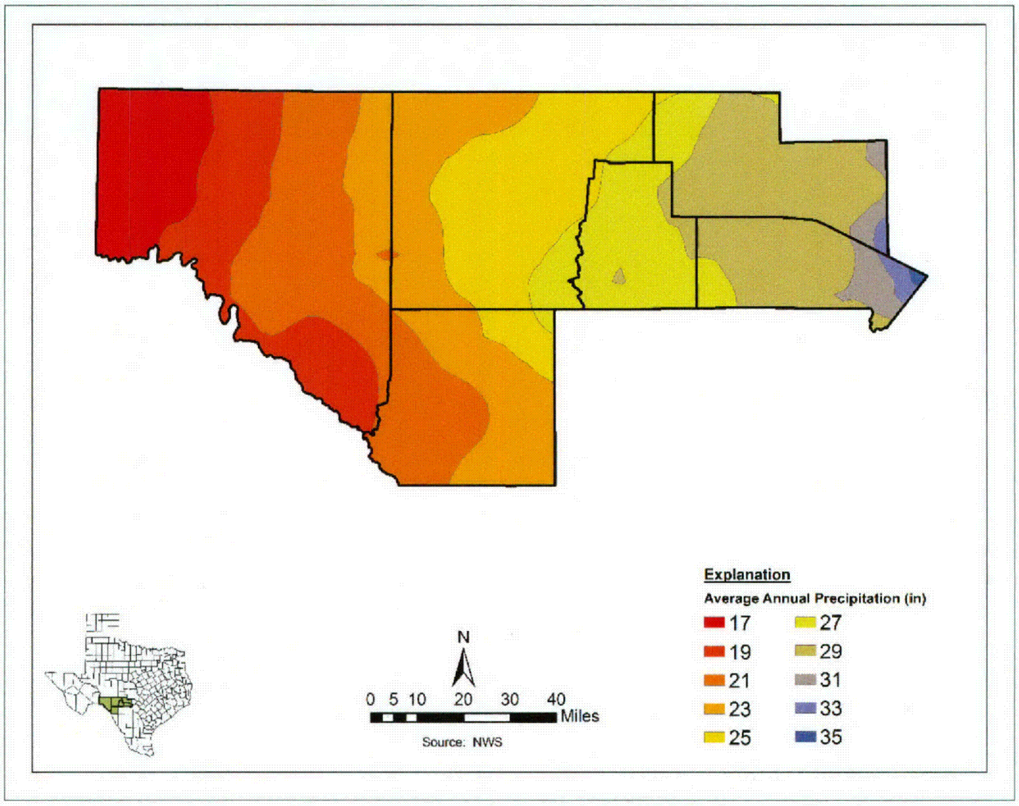


**Figure 1-5. Variation of Precipitation**

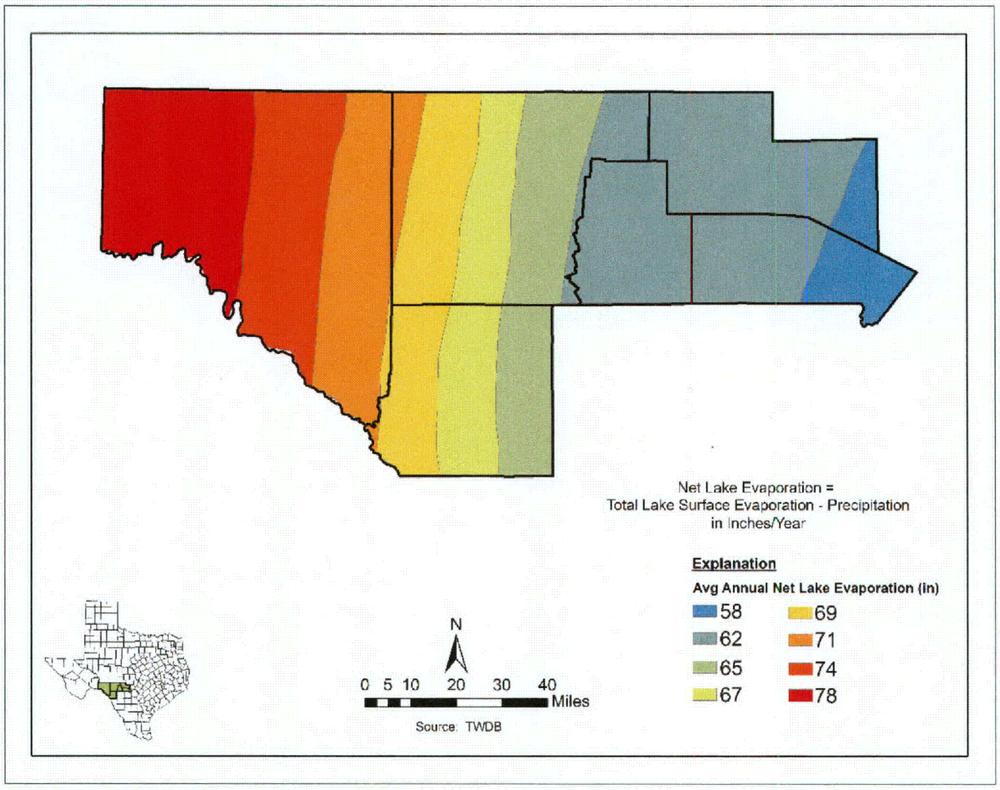


**Figure 1-6. Net Lake Evaporation**


**Figure 1-7. Average Monthly Rainfall for Selected Stations**

Drought conditions are assumed in the planning process to insure that adequate infrastructure and planning is in place under severe water shortage conditions. Drought in the Plateau Region is discussed in detail in Chapter 7 of this *Plan*. Drought in the Plateau Region can be defined in the following operational definitions:

**Meteorologic drought** is defined as an interval of time, usually over a period of months or years, during which precipitation cumulatively falls short of the expected supply.

**Agricultural drought** is defined as that condition when rainfall and soil moisture are insufficient to support the healthy growth of crops and to prevent extreme crop stress. It may also be defined as a deficiency in the amount of precipitation required to support livestock and other farming or ranching operations.

**Hydrologic drought** is a long-term condition of abnormally dry weather that ultimately leads to the depletion of surface water and groundwater supplies, the drying up of lakes and reservoirs, and the reduction or cessation of springflow or streamflow.

Comparing the 1950s Drought of Record (DOR) and the current drought can be accomplished by using historic precipitation, stream flow records, spring discharges and water level measurements in wells for locations that have accumulated data measurements since the 1940s, which is discussed further in Chapter 7 Section 7.2. For the purpose of this planning cycle, the drought of the 1950s is declared the DOR. However, it is the intent of the current *2016 Plan*, to illustrate in Chapter 7 that although the 1950s drought is the Historic Drought of Record, the current drought is of major significance. Although it is impossible at this time to determine whether or not the current drought will become the new DOR, further evaluations will be made in future planning cycles to continuously assess the Region's drought conditions.

### 1.2.6 Native Vegetation and Ecology

A biotic province is a considerable and continuous geographic area that is characterized by the occurrence of one or more ecologic associations that differ, at least in proportional area covered, from the associations of adjacent provinces. In general, biotic provinces are characterized by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography and soil. Most of the Plateau Region has been classified as belonging to the "Balconian" Biotic Province, but small portions of Val Verde and Kinney Counties also lie within the "Tamaulipan" and "Chihuahuan" Biotic Provinces (Figure 1-8). In the 1800s, the area was predominantly savannas of tall native grasses with occasional stands of Live Oak and Spanish Oak. Largely because of the suppression of prairie fires in the last century, most of the area has become blanketed by Ashe Juniper (commonly referred to as "Cedar"), which once was primarily found within steep canyon lands. Another infestation of tree species found in the area is that of Mesquite. Infestation of trees may reduce the quantity and quality of water from watersheds, as well as reduce the diversity of plant species beneath the trees' canopies.

Cypress trees line the banks of many of the rivers and are known to reduce flows in the streams during their active season. Other species of trees that are generally found are Post Oak, Elm, Hackberry, Cottonwood, Sycamore and Willow. Native grass species include Little and Big Bluestem, Indian Grass, Sideoat Grama and Texas Winter Grass. Some of the introduced species of grass include Coastal

Bermuda, Plains Lovegrass, Klein Grass and King Ranch Bluestem. In the western portion of the Region, a varying growth of prickly pear, other cactus species, sage, and other brushy species predominate.

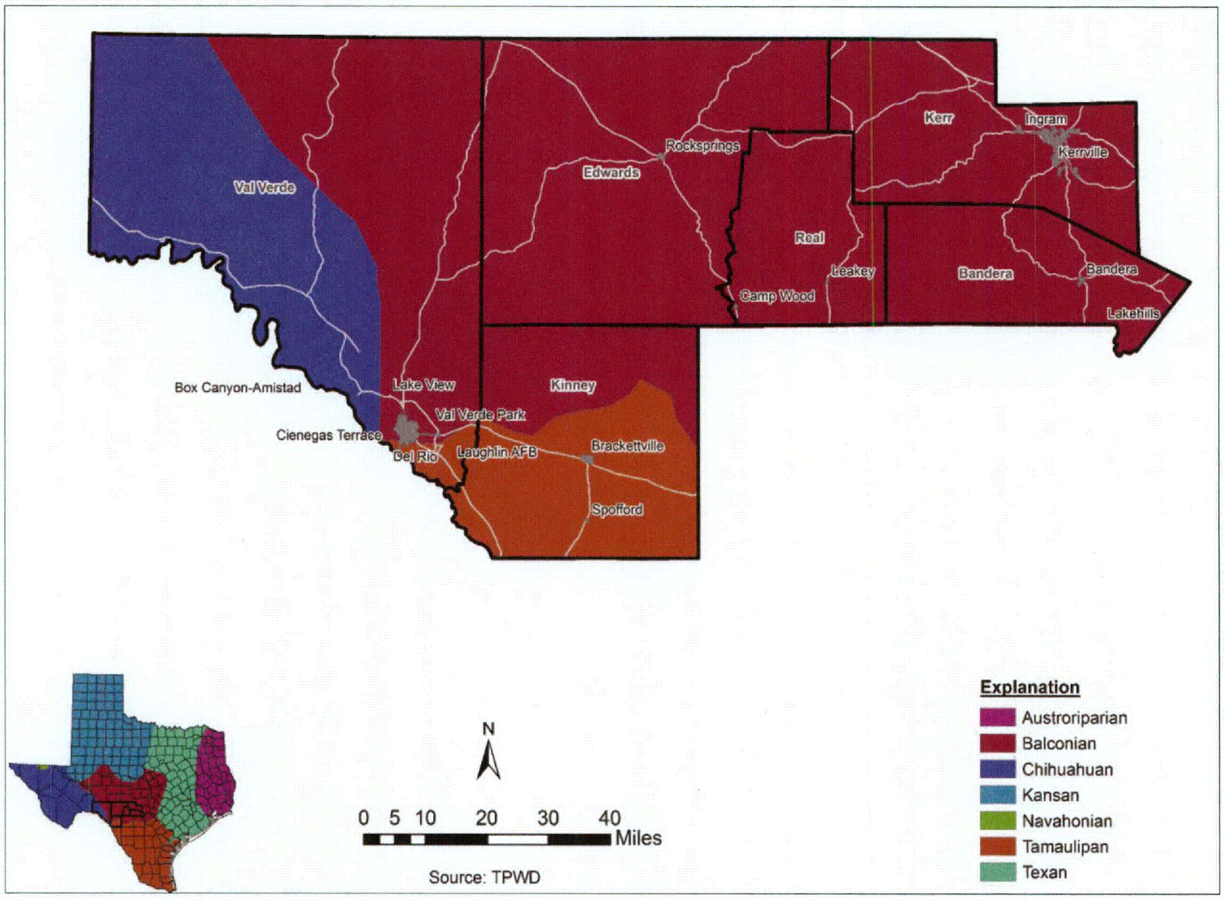


**Figure 1-8. Biotic Provinces**

### 1.2.7 Agricultural and Natural Resources

Agricultural resources in the Region include beef cattle, sheep, goat, and exotic game animals. Apple and pecan orchards, along with hay, are grown in the eastern part of the Region. Kinney County, with its extensive irrigated lands in the western half of the county, account for twice the amount of water used for irrigation as the rest of the Region combined.

The natural resources of the Region include both terrestrial and aquatic habitats that boast some of the best scenic drives and vistas, river rafting, and hunting and fishing in Texas. Natural resources also include the great diversity of plant and animal wildlife that inhabit these environments. Texas Parks and Wildlife Department maintains a comprehensive source of information on State and Federally listed rare, threatened, and endangered plants and animals (http://www.tpwd.state.tx.us/huntwild/wild/species/endang/index.phtml).

Understandably, both local residents and tourists make use of these resources in their enjoyment of numerous public parks, dude ranches, resorts, recreational vehicle parks, and camping facilities. The following protected sites located within the Plateau Region depend upon adequate water to supply both environmental and recreational needs:

- Lost Maples State Natural area
- Hill Country State Natural Area
- Devils River State Natural Area
- Seminole Canyon State Historic Park
- Dolan Falls Ranch Preserve (Nature Conservancy)
- Devils Sinkhole State Natural Area
- Kickapoo Cavern State Park
- Kerrville-Schreiner Park
- Heart of the Hills Fisheries Science Center
- Amistad National Recreation Area
- Love Creek Preserve
- Bandera Canyonlands

As part of the Healthy Watersheds Initiative under the Clean Water Act, the Llano River Field Station at Texas Tech University in Junction is preparing a Watershed Protection Plan (WWP) for the Upper Llano River Watershed, which includes the North and South Llano Rivers. The South Llano River Watershed contains portions of Edward, Kerr, and Real counties, all within the Plateau Region planning area. The implementation of the Upper Llano River WPP is slated to begin in 2016. Implementation efforts will focus on procuring funding from a wide variety of sources to achieve stakeholder goals developed for the Plan. These goals include the control of invasive species (Giant Cane/*Arundo donax* and Elephant Ears/*Colocasia esculenta)* in the watershed and management of encroaching woody species (specifically *Ashe-juniper* and mesquite) through removal of 9,000 acres annually in the watershed.

Both agricultural and natural resources water-supply needs are directly influenced by the quantity and quality of water available primarily in rivers and tributaries that flow through the Region and to a lesser extent on impounded lakes, ponds and tanks. With the exception of the Rio Grande, much of the drainage basins for the headwater of local rivers lie within Plateau Region counties. Springflow emanating from bedrock aquifers, particularly the Edwards-Trinity (Plateau) Aquifer, create the base flow of these streams. As such, these headwater areas are particularly susceptible to drought conditions as the water table naturally drops and springflow diminishes.

Agricultural activities in the Region that rely on surface water are designed to accommodate the intermittent nature of the supply. In most cases, this means that agricultural water supply needs will be supplemented by groundwater sources, or that irrigation activities will cease until river supplies are replenished. Both plant and animal species endemic to this Region have developed a tolerance for the intermittent nature of surface water availability; however, significantly long drought conditions can have a sever effect on these species. Riparian water needs for birding habitat is particularly critical.

Of recognized importance to the water planning process is the concern of the impact that future development of water supplies might have on preexisting conditions in the Region. Water- supply management strategies developed in Chapter 5 of this *Plan* include an evaluation of each strategy's impact on agricultural, natural resources, and environmental concerns(see Tables 5-2 and 5-4, and Appendix 5B).

The only potential impacts to agricultural are identified with the possible change in water rights use from agricultural use to municipal use of Guadalupe River flows in Kerr County. As these strategies only potentially change the use of the water and not the volume of diversion, there is no significant impact to natural resources.

### 1.2.8 Water-Supply Source Vulnerability/Security

Following the events of September 11th, Congress passed the Bio-Terrorism Preparedness and Response Act. Drinking water utilities serving more than 3,300 people were required and have completed vulnerability preparedness assessments and response plans for their water, wastewater, and stormwater facilities. The U.S. Environmental Protection Agency (EPA) funded the development of three voluntary guidance documents, which provide practical advice on improving security in new and existing facilities of all sizes. The documents include:

*Interim Voluntary Security Guidance for Water Utilities* www.awwa.org

*Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities* www.wef.org

*Interim Voluntary Guidelines for Designing an Online Contaminant Monitoring System* www.asce.org

### 1.2.9 Supply Source Protection

According to the 1996 Safe Drinking Water Act Amendments, the Texas Commission on Environmental Quality (TCEQ) is required to assess every public drinking water source for susceptibility to certain chemical constituents. The Source Water Protection Program is a voluntary program designed to help public water systems identify and implement measures that will protect their sources of water from potential contamination. Assessment reports are provided to the public water systems and are often used to implement local source water protection projects. Table 1-2 lists Plateau Region public water systems currently involved in the TCEQ's Source Water Protection Program. A list of participants State-wide can be accessed at the following link: https://www.tceq.texas.gov/drinkingwater/SWAP/participants.html.

**Table 1-2. Plateau Region Source Water Protection Participants**

| PWS Name | County | Report Date |
|---|---|---|
| Bandera County FWSD 1 | Bandera | 7/1/1997 |
| City of Bandera | Bandera | 7/1/1997 |
| Medina Children's Home | Bandera | 7/1/1999 |
| Flying L Ranch PUD | Bandera | 7/1/1999 |
| Bandera River Ranch 1 | Bandera | 7/31/2000 |
| TPWD Lost Maples SNA | Bandera | 7/1/1999 |
| Bandina Christian Youth Camp | Bandera | 7/1/1999 |
| Camp Sionito Business | Bandera | 7/1/1999 |
| Bandera ISD Bandera High School | Bandera | 7/1/1999 |
| Mayan Dude Ranch | Bandera | 7/1/1999 |
| Dixie Dude Ranch | Bandera | 7/1/1999 |
| Blue Medina Water | Bandera | 1/31/2001 |
| Lake Medina Shores | Bandera | 6/30/2005 |
| Bandera Homestead Condominiums | Bandera | 7/31/1999 |
| MHC Medina Lake Campgrounds | Bandera | 5/30/2000 |
| Bandera ISD Alkek Elementary | Bandera | 7/1/1999 |
| Pipe Creek Junction Café | Bandera | 7/1/1999 |
| Lakewood Water | Bandera | 7/31/1999 |
| Elmwood Estates | Bandera | 7/31/1999 |
| Twin Elm Guest Ranch and RV Park | Bandera | 7/1/1999 |
| Bandina | Bandera | 7/1/1999 |
| Hill Country Mobile Home Park | Bandera | 7/1/1999 |
| Oak Country Property Owners Assn | Bandera | 7/1/1999 |
| Mansfield Park | Bandera | 7/1/1999 |
| Comanche Cliffs | Bandera | 7/31/1999 |
| Pomarosa RV Park | Bandera | 7/1/1999 |
| Scenic Valley Mobile Home Park | Kerr | 1/31/2001 |
| Cedar Springs MHP | Kerr | 5/31/2000 |
| Verde Park Estates Wiedenfeld Water Work | Kerr | 7/31/2000 |
| Westcreek Estates Water System | Kerr | 9/1/2002 |
| Hills & Dales Wiedenfeld Water Work | Kerr | 5/31/2000 |
| Verde Hills WSC | Kerr | 7/31/1999 |
| Oak Forest South Water Supply | Kerr | 5/31/2000 |
| Nickerson Farm Water System | Kerr | 5/31/2000 |
| Four Seasons | Kerr | 5/31/2000 |
| Sleepy Hollow | Kerr | 5/31/2000 |
| Pecan Valley | Kerr | 7/31/2000 |
| Forest Oaks Mobile Home Park | Kerr | 5/31/2000 |
| Center Point North Water System | Kerr | 5/31/2000 |
| Four Seasons | Kerr | 5/31/2000 |
| Horseshoe Oaks Subdivision Water System | Kerr | 5/31/2000 |
| Northwest Hills Subdivision | Kerr | 7/31/1999 |

**Table 1-2. (Continued) Plateau Region Source Water Protection Participants**

| PWS Name | County | Report Date |
|---|---|---|
| Bear Paw Water System | Kerr | 7/31/1999 |
| Southern Hills Wiedenfeld Water Works | Kerr | 5/31/2000 |
| Cardinal Acres | Kerr | 7/31/1999 |
| Kamira Water System | Kerr | 5/31/2000 |
| Real Oaks Subdivision | Kerr | 7/31/2000 |
| Cherry Ridge Water | Kerr | 5/31/2000 |
| Silver Hills Park | Kerr | 1/31/2001 |
| Saddlewood Subdivision | Kerr | 5/31/2000 |
| Twin Forks Estates WSC | Real | 11/30/1994 |
| Twin Forks Estates WSC | Real | 8/31/2010 |
| Del Rio Utilities Commission | Val Verde | 12/31/1986 |

# 1.3 REGIONAL WATER DEMAND

## 1.3.1 Major Demand Categories

Total estimated year-2020 water consumptive use in the Plateau Region is 39,802 acre-feet. The largest category of demand is municipal and county other (25,567 acre-feet), followed by irrigation (10,929 acre-feet), livestock (2,926 acre-feet), mining (355 acre-feet), and manufacturing (25 acre-feet). Municipal, county-other and irrigation combined represent 92 percent of all water use in the Region (Figure 1-9). Current and projected water demand for all water-use types are discussed in detail in Chapter 2.

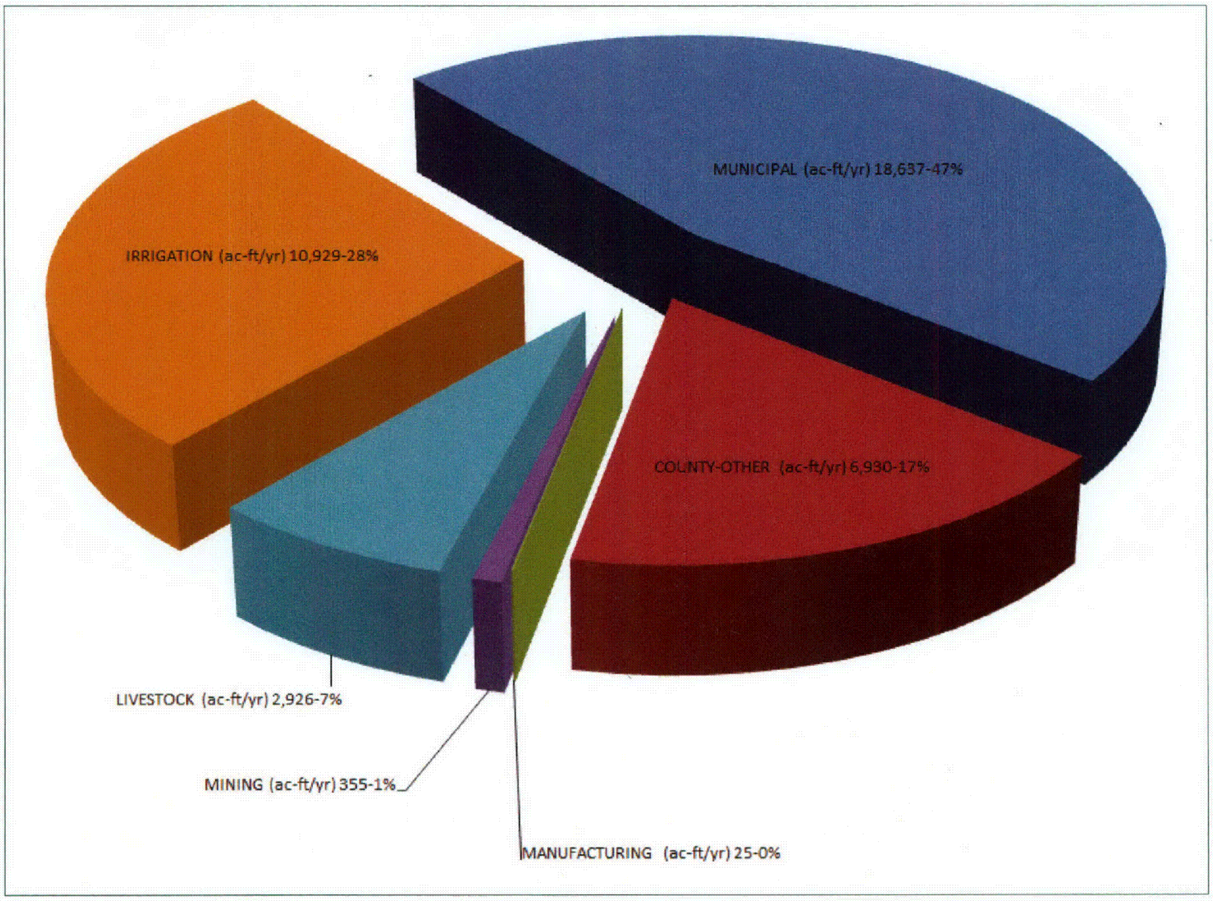


**Figure 1-9. Year 2020 Projected Water Demand by Water-Use Category**

### 1.3.2 Municipal

Municipal demand consists of both residential and commercial water uses. Commercial water consumption includes business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial uses are categorized together because they are similar types of uses, i.e.: they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering.

The largest center of municipal demand is the City of Del Rio in Val Verde County, where 10,645 acre-feet of water was estimated to be used in 2020 to supply the residents and businesses within the City. Fifty-three percent of regional municipal water is used in Val Verde County, and 28 percent is used in Kerr County.

### 1.3.3 Wholesale Water Provider

The City of Del Rio is the only entity in the Plateau Region that is designated as a wholesale water provider. In addition to its own use, the city provides water to Laughlin Air Force Base and subdivisions outside of the City. The city also provides water and wastewater services to two colonias, Cienegas Terrace and Val Verde Park Estates. Total year-2020 wholesale water use projected for the City of Del Rio is 12,129 acre-feet.

### 1.3.4 Agriculture and Ranching

Agriculture and ranching water demand consists of all water used by the agricultural industry to support the cultivation of crops and the watering of livestock and wildlife. Where groundwater is the source of irrigation water, the TWDB defines irrigation use as "on farm demand." Where surface water is the source of irrigation water, the TWDB defines irrigation use as both "on farm" demand and "diversion loss." Surface water is typically conveyed by an open canal system, which exposes the water supply to possible loss from seepage, breaks, evaporation, and uptake by riparian vegetation. In the year 2020, irrigation represents the second greatest water use in the Region (10,929 acre-feet) with Kinney County accounting for 62 percent. Livestock use in the Region amounted to 2,926 acre-feet.

### 1.3.5 Manufacturing and Mining

Manufacturing (and industrial) demand consists of all water used in the production of goods for domestic and foreign markets. Some processes require direct consumption of water as part of the manufacturing process. Others require very little water consumption, but may require large volumes of water for cooling or cleaning purposes. In some manner or another, water is passed through the manufacturing facility and used either as a component of the product or as a transporter of waste heat and materials. Within the Plateau Region, manufacturing is only accounted for in Kerr County.

Mining demand consists of all water used in the production and processing of nonfuel (e.g., sulfur, clay, gypsum, lime, salt, stone and aggregate) and fuel (e.g., oil, gas, and coal) natural resources by the mining industry. In all instances, water is required in the mining of minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation. This also includes the production of crude petroleum and natural gas. Water used in the mining industry in the Plateau Region is principally reported in Edwards, Kerr, and Val Verde Counties.

### 1.3.6 Environmental and Recreational Water Needs

Environmental and recreational water use in the Plateau Region is recognized as being an important consideration as it relates to the natural community in which the residents of this Region share and appreciate. In addition, for rural counties, tourism activities based on natural resources offer perhaps the best hope for modest economic growth to areas that have seen a long decline in traditional economic activities such as agriculture.

A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future water needs (Chapter 5) includes a distinct consideration of the impact that each implemented strategy might have on the environment.

Recreation activities involving human interaction with the outdoor environment are often directly dependent on water resources. It is recognized that the maintenance of the regional environmental community's water supply needs serves to enhance the lives of citizens of the Plateau Region as well as the tens of thousands of annual visitors to this Region. Environmental and recreational water needs are further discussed throughout the *Plan* and especially in Chapters 2, 3, and 8.

# 1.4 WATER SUPPLY SOURCES

Water supply sources in the Plateau Region include groundwater primarily from six aquifers and surface water from five river basins. Reuse of existing supplies is also considered a water supply source. A more detailed description of these sources and estimates of their supply availability are provided in Chapter 3.

## 1.4.1 Groundwater

Within the Plateau Region, the TWDB recognizes three major aquifers [the Trinity, the Edwards-Trinity (Plateau), and the Edwards (Balcones Fault Zone)]. For this *Plan,* the Austin Chalk Aquifer in Kinney County and the Frio and Nueces River Alluvium Aquifers in Real and Edwards Counties have also been identified as groundwater sources (Figure 1-10). Groundwater Conservation Districts in Bandera, Kerr, Kinney, Real and Edwards Counties provide for local management control of their groundwater resources.

### 1.4.1.1 Trinity Aquifer

The Trinity Aquifer occurs in its entirety in a band from the Red River in North Texas to the Hill Country of south-central Texas and provides water in all or parts of 55 counties. Trinity Group formations also occur as far west as the Panhandle and Trans-Pecos regions where they are included as part of the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) Aquifers. The Trinity Aquifer in south-centrals Texas has been further subdivided into:

- Upper Trinity Aquifer
  - Upper Glen Rose Limestone
- Middle Trinity Aquifer
  - Lower Glen Rose Limestone
  - Hensell Sand / Bexar Shale
  - Cow Creek Limestone
- Lower Trinity Aquifer
  - Sligo Limestone / Hosston Formation

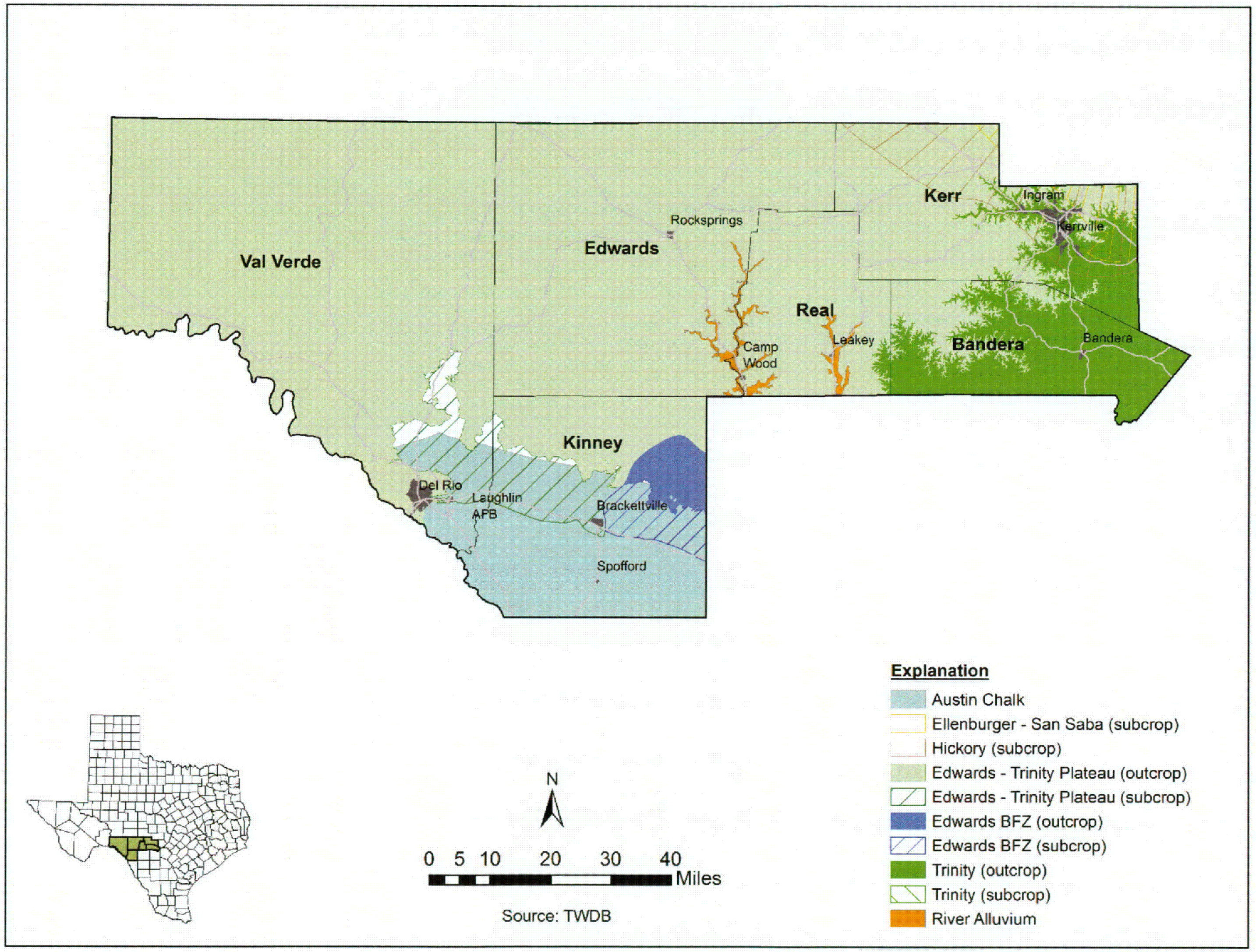


**Figure 1-10. Groundwater Sources**

#### 1.4.1.2 Edwards-Trinity (Plateau) Aquifer

Rock formations of the Edwards-Trinity (Plateau) Aquifer form the Edwards Plateau east of the Pecos River, and in its entirety provide water to all or parts of 38 counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of West Texas. The aquifer consists of saturated sediments of lower Cretaceous age Trinity Group formations and overlying limestones and dolomites of the Edwards Group. The Glen Rose limestone is the primary unit in the Trinity in the southern part of the Plateau. Springs issuing from the aquifer form the headwaters of several eastward and southerly flowing rivers. Some of the largest springs of the area are located in Val Verde and Kinney Counties, such as San Felipe Springs near Del Rio and Los Moras Springs in Brackettville.

#### 1.4.1.3 Edwards (BFZ) Aquifer

The Edwards (Balcones Fault Zone (BFZ)) Aquifer in its entirety covers approximately 4,350 $mi^2$ in parts of 11 counties. It forms a narrow belt extending from a groundwater divide in Kinney County through the San Antonio area northeastward to the Leon River in Bell County. Within the Plateau Region, water in the aquifer generally moves from the recharge zone toward natural spring discharge points such as Las Moras Springs near Brackettville or southeasterly underground toward San Antonio.

#### 1.4.1.4 Austin Chalk Aquifer

The Austin Chalk Aquifer occurs in the southern half of Kinney County and in the southernmost extent of Val Verde County. Most Austin Chalk wells discharge only enough water for domestic or livestock use; however, primarily in the area along Las Moras Creek, a few wells are large enough to support irrigation.

#### 1.4.1.5 Nueces River Alluvium Aquifer

The Nueces River Alluvium occurs along the boundary between Edwards and Real Counties. Extending over an area of approximately 24,450 acres, the alluvial aquifer contains approximately 3,574 acre-feet of annually available water. The Community of Barksdale, local subdivisions, and other rural domestic homes derive their water supply from this aquifer.

#### 1.4.1.6 Frio River Alluvium Aquifer

The Frio River Alluvium in central Real County extends over an area of approximately 9,530 acres and contains approximately 2,145 acre-feet of annually available water. Water supplies for the Community of Leakey, several subdivisions, and other rural domestic homes are derived from this small aquifer.

#### 1.4.1.7 Other Aquifers

Located along many of the streams and rivers throughout most of the Region are shallow alluvial floodplain deposits mostly composed of gravels and sands eroded from surrounding limestone hills. Wells completed in these deposits supply small to moderate quantities of water mostly for domestic and livestock purposes.

Also within the Region, the State has identified other minor aquifers only in Kerr County. These are the downdip extensions of the Ellenburger-San Saba and the Hickory. According to TWDB records none of their inventoried wells penetrate either aquifer. There is significant interest in Kerr County to explore the possibility of deriving new water supplies from the Ellenburger Aquifer.

### 1.4.2 Surface Water

The Plateau Region is unique within all planning regions in that it straddles five river basins rather than generally following a single river basin or a large part of a single river basin (Figure 1-11). From west to east, these basins include the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio. The headwaters of rivers that form the Nueces, Guadalupe, and San Antonio river basins originate within this Region; and the headwaters of the South Llano River, a major tributary to the Colorado River, also occur here.

#### 1.4.2.1 Rio Grande Basin

The Rio Grande, or Rio Bravo as it is known in Mexico, forms the border between the United States and Mexico. International treaties governing the ownership and distribution of water in the Rio Grande are discussed in Chapter 3. The 3.4 million acre-foot International Amistad Reservoir is located on the Rio Grande in Val Verde County. Within the Plateau Region, the Pecos and Devil's Rivers in Val Verde County are the primary tributaries to the Rio Grande. Numerous springs, including San Felipe, Goodenough, and Las Moras, issue from the Edwards Aquifer and flow into tributaries of the Rio Grande. The main stream of the Rio Grande does not provide water for municipal use in the Plateau Region and only provides limited amounts for irrigation use, primarily from a tributary, San Felipe Creek.

#### 1.4.2.2 Nueces River Basin

The main stem of the Nueces River forms a portion of the border between Edwards and Real Counties. Tributaries of the Nueces River located in the Plateau Region include the Sabinal River and Hondo Creek in Bandera County, the West Nueces River in Edwards and Kinney Counties, and the Frio, East Frio, Dry Frio Rivers in Real County, and other minor tributaries.

#### 1.4.2.3 Colorado River Basin

The City of Rocksprings in Edwards County straddles the drainage divide between the Nueces River Basin and the Colorado River Basin. The portion of Edwards County north of Rocksprings, small northern portions of Real County and the northwestern part of Kerr County drain to the Llano River watershed in the Colorado River Basin. The South Llano River, part of the headwaters of the Llano/Colorado, begins in Edwards County.

#### 1.4.2.4 Guadalupe River Basin

The majority of Kerr County lies in the Guadalupe River Basin. The Guadalupe is not only an important water supply source for Kerrville and other communities in Kerr County, but is also a major tourist attraction for the area. Although Kerrville and the Upper Guadalupe River Authority own water rights, much of the flow of the Guadalupe is permitted for downstream use.

#### 1.4.2.5 San Antonio River Basin

Most of Bandera County is split between the Nueces and San Antonio River Basins. The Medina River flows through Bandera County and drains to the San Antonio River. Medina Lake straddles the boundary between Bandera, Medina and Bexar Counties and serves as a major irrigation source for land downstream in Medina County. This reservoir has a conservation storage capacity of 254,823 acre-feet; however, as of spring 2015 the reservoir is only 3.5 percent full. The firm yield of Medina Lake and its associated Diversion Lake is zero. Bandera County has contracted for 5,000 acre-feet and Bexar

Metropolitan Water District has contracted for 6,000 acre-feet. The Bexar-Medina-Atascosa Counties Water Control and Improvement District #1 has a permit to sell 20,000 acre-feet of water diverted from Medina Lake.

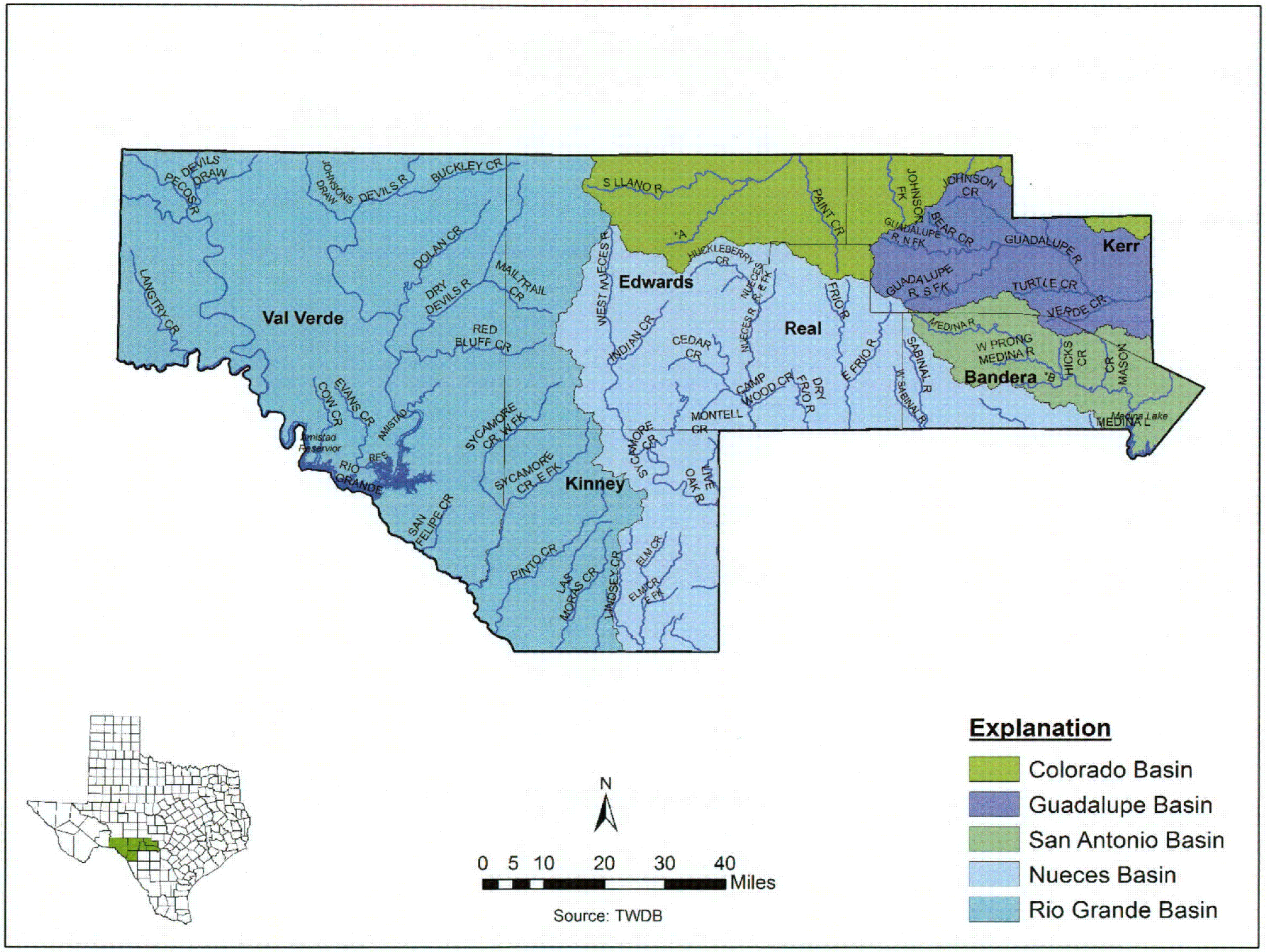


**Figure 1-11. Surface Water Sources**

### 1.4.3 Springs and Wildlife Habitat

Springs have played an important role in the development of the Plateau Region. They were important sources of water for Native American Indians, as indicated by the artifacts and petroglyphs found in the vicinity of many of the springs. These springs were also principal sources of water for early settlers and ranchers. Although springs are often recognized by a given name, in reality, most springs are complexes of numerous openings through which groundwater flows to the surface. Additional discussion pertaining to springs and their function in the relationship between groundwater and surface water is contained in Chapter 3.

The PWPG has identified three "Major Springs" that are important for their municipal water supply (Figure 1-12). The fourth largest spring in Texas, San Felipe Springs, discharges to San Felipe Creek east of Del Rio and provides municipal drinking water for Del Rio, as well as irrigation use downstream. Las Moras Springs in Kinney County is of historical significance for its importance as a supply source on early travel routes and military fortifications. Today, Las Moras Springs supports the Fort Clark community and is hydrologically associated with the same aquifer system that serves Fort Clark MUD and the City of Brackettville. The third major spring is Old Faithful in Real County, which is the drinking-water supply source for the City of Camp Wood. Although only three springs are identified as "Major Springs", the PWPG recognizes that all springs in the Region are important and are deserving of natural resource protection. The PWPG also recognizes the important ecological water supply function that all springs perform in the Region. Springs create and maintain base flow to rivers, contribute to the esthetic and recreational value of land, and are significant sources of water for wild game and aquatic species. Water issuing from springs forms wetlands that attract migratory birds and other fowl throughout the year. The wetlands host numerous terrestrial and aquatic species, some of which are listed as threatened or endangered.

Two supplemental study reports were prepared during the previous planning period for the PWPG that address springs (Table 1-1). The first report considers the location and geohydrology of springs in Kinney and Val Verde Counties, and the second report relates springflow in western Kerr County to base flow in the three branches of the upper Guadalupe River.

### 1.4.4 Reuse

Water recycling, or reuse, is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation or industrial processes. The Cities of Kerrville, Bandera and Camp Wood have active water reuse programs that are described in Chapter 3.

### 1.4.5 Water Quality Issues

Water quality is generally good throughout the Plateau Region; however, a few specific water quality issues should be mentioned. Increasing population impacts water quality in many ways, one of which is the increase in urban runoff that comes with the increase in impervious cover in populated areas. Impervious cover concentrates runoff into storm sewers and drains, which then discharges into streams, increasing the flow, which also increases the erosional power of the water. In addition, urbanization also causes increased pollutant loads, including sediment, oil/grease/toxic chemicals from motor vehicles, pesticides/herbicides/fertilizers from gardens and lawns, viruses/bacteria/ nutrients from human and animal wastes including septic systems, heavy metals from a variety of sources, and higher temperatures of the runoff.

Increasing population has also manifested itself in the fragmentation of larger properties. With the advent of fragmentation comes the proliferation of new wells being drilled to serve the individual properties. Each new well thus becomes another potential conduit for surface contamination to reach the underlying aquifer system.

From a regional perspective, groundwater quality is relatively good. However, the constituent of most concern is nitrate, which is found above the primary maximum contaminant level in a number of water-sample analyses from the Edwards (BFZ) Aquifer and the Austin Chalk Aquifer in Kinney County.

Historically, the primary contribution to poor groundwater quality occurs in wells that do not have adequately cemented casing. Improperly completed wells allow poorer quality water to migrate into zones containing good quality water. Poorer groundwater quality in the Region is generally from two different sources, evaporite beds in the Glen Rose formation and from surface contamination, both of which can be prevented by proper well construction. Also of concern are above normal levels of radioactivity that have been detected in sand sequences of the Glen Rose and Hensell formations in some areas.

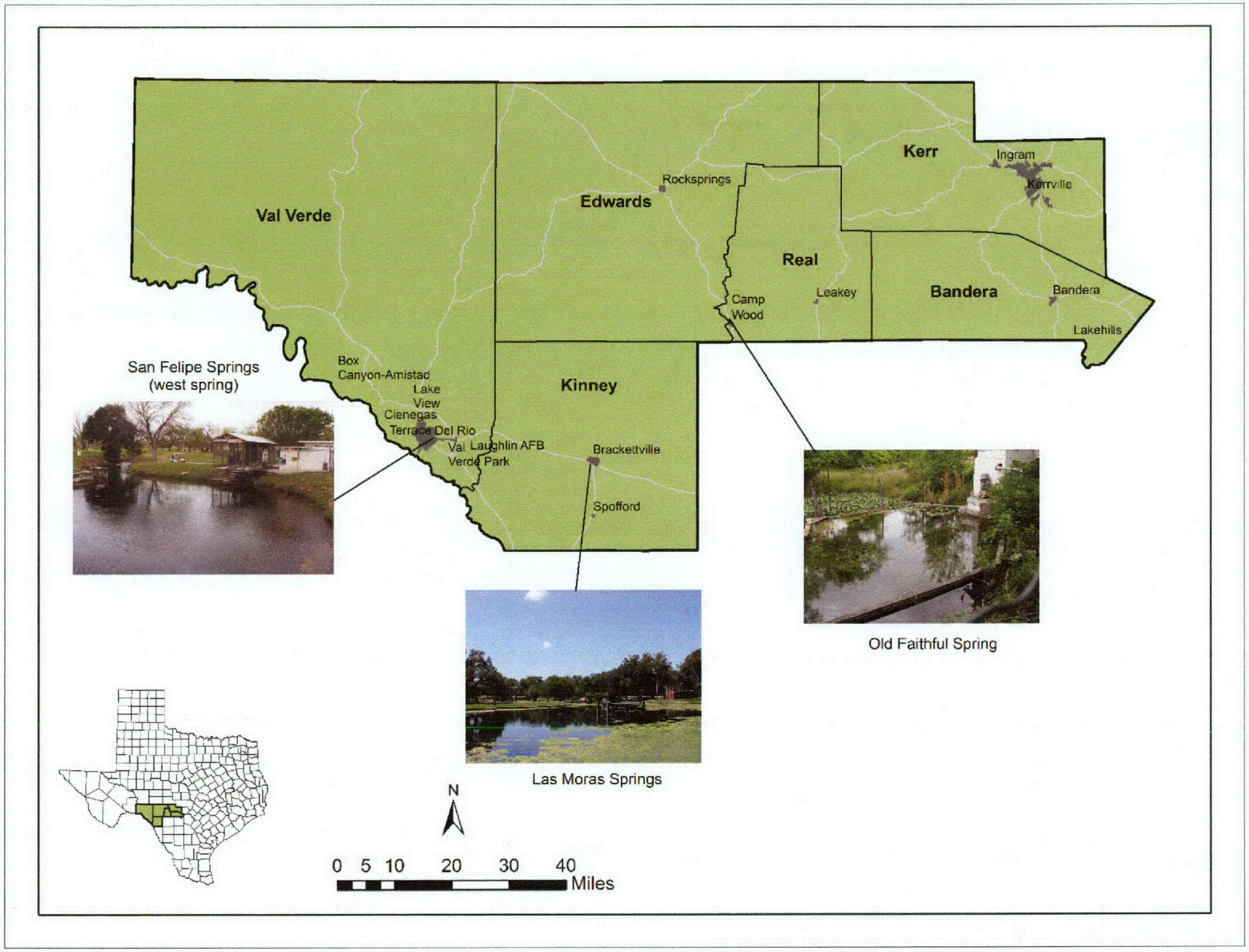


**Figure 1-12. Major Springs**

## 1.5 COLONIAS

Disadvantaged political subdivisions, often referred to as "colonias"' represent a special subset of municipal demand in the Region, and a challenge to water suppliers. Most colonias are subdivisions in unincorporated areas located along the United States/Mexico international border and typically consist of small land parcels sold to citizens of low-income. These subdivisions often lack basic services such as potable water, sewage disposal and treatment, paved roads, and proper drainage. Public health problems are often associated with these colonias.

The Economically Distressed Area Program (EDAP) was created by the Texas Legislature in 1989 and is administered by the TWDB. The intent of the program is to provide local governments with financial assistance for bringing water and wastewater services to disadvantaged political subdivisions, including cities, counties, water districts and non-profit water supply corporations. An economically distressed area is defined as one in which water supply or wastewater systems are not adequate to meet minimal state standards, financial resources are inadequate to provide services to meet those needs, and there was an established residential subdivision on or prior to June 1, 2005. Affected counties are counties adjacent to the Texas/Mexico border, or that have per capita income 25 percent below the state median and unemployment rates 25 percent above the state average for the most recent three consecutive years for which statistics are available. Additional information pertaining to eligibility and requirements for this program are available on the TWDB web site: http://www.twdb.texas.gov/financial/programs/EDAP/index.asp.

EDAP projects in the Plateau Region are located in Kerr, Kinney and Val Verde Counties. Data pertaining to all EDAP projects in the State can be accessed through the TWDB web site: http://www.twdb.texas.gov/publications/reports/edap_reports/doc/Status.pdf. The following construction and planning projects are listed as EDAP funded as of August 31, 2014:

- City of Spofford – Kinney County
    - Brackettville Transmission Line
    - Permanent water supply line from City of Brackettville.
    - EDAP Planning /PAD Funding, $13,000
    - EDAP Construction Funding, $404,079
    - Status – Construction completed 9/98
- Nueces River Authority – Real County
    - City of Leakey Wastewater System
    - Centralized wastewater system for first time service to City of Leakey and surrounding areas. A future second phase would expand the plant and provide collection for two subdivisions.
    - EDAP Planning /PAD Funding, $3,736,250
    - Other TWDB Funding, $9,961,460
    - Status - Active

- City of Del Rio – Val Verde County
    - Cienegas Terrace
    - Improved water service and first-time wastewater service.
    - EDAP Planning /PAD Funding, $23,606
    - EDAP Construction Funding, $3,508,710
    - Status – Construction completed 10/96
- City of Del Rio – Val Verde County
    - Val Verde Park Estates
    - Improved water service and first-time wastewater service.
    - EDAP Planning /PAD Funding, $36,000
    - EDAP Construction Funding, $12,010,573
    - Status – Construction completed 8/04
- Val Verde County
    - Water and Wastewater
    - Planning for water and wastewater for unincorporated areas.
    - EDAP Planning /PAD Funding, $283,284
    - Status – Facility plan completed
- Val Verde County
    - Lakeview Estates Water and Wastewater
    - Planning for water and wastewater for unincorporated areas.
    - EDAP Planning /PAD Funding, $460,000
    - Status – Planning completed 8/12
- Kerr County
    - Center Point Wastewater System
    - Wastewater collection system for first-time service.
    - EDAP Planning /PAD Funding, $242,500
    - Other TWDB Funding, $1,860,000

## 1.6 WATER LOSS AUDITS

In 2003, the 78th Texas Legislature, enacted House Bill 3338 to help conserve the State's water resources by reducing water loss occurring in the systems of drinking water utilities. This statute requires that retail public utilities providing water within Texas file a standardized water audit once every five years with the Texas Water Development Board (TWDB). In response to the mandates of House Bill 3338, TWDB developed a water audit methodology for utilities that measures efficiency, encourages water accountability, quantifies water losses, and standardizes water loss reporting across the State. This standardized approach to auditing water loss provides utilities with a reliable means to analyze their water loss performance. By reducing water loss, utilities can increase their efficiency, improve their financial status, minimize their need for additional water resources, and assist long-term water sustainability.

Any retail water supplier that has an active financial obligation with the TWDB is required to submit a water loss audit annually. Additionally, retail water suppliers with more than 3,300 connections are now required to submit an audit annually; all other retail public water suppliers are required to submit a water loss audit once every five years. The next scheduled audit for this requirement is for the year 2015 and will be due by May 1, 2016. The audits should help answer these questions:

- Where did we lose the water?
- How much water was lost?
- How much did the loss cost the utility?
- Why did we lose the water?

Utilizing a methodology derived from the American Water Works Association (AWWA) and the International Water Association (IWA), the TWDB has published a manual that outlines the process of completing a water loss audit: Water Loss Audit Manual for Texas Utilities – TWDB Report 367 (2008), which can be viewed at http://www.twdb.texas.gov/publications/brochures/conservation/doc/WaterLossManual_2008.pdf. Table 1-3 provides a listing of reported utility audits performed in the Plateau Region.

**Table 1-3. Plateau Region 2010 Public Water System Water Loss Report in Gallons**

| Public Water Supply Name | System Input Volume | Reported Breaks/Leaks | Unreported Loss | Total Real Loss | Cost Of Real Loss | Percent Total Loss |
|---|---|---|---|---|---|---|
| Amistad Village Water System | 0 | 0 | -4,608,360 | -4,608,360 | 0.00 | 0.00 |
| Bandera County FWSD 1 | 32,248,000 | 160,000 | 3,427,999 | 3,587,999 | 1,794.00 | 12.26 |
| Bandera River Ranch 1 | 18,246,316 | 1,547,000 | -198,589 | 1,348,411 | 9,034.35 | 12.20 |
| Bandina | 1,374,490 | 53,250 | 1,970 | 55,220 | 165.66 | 8.04 |
| Barksdale WSC | 5,768,842 | 34,300 | 315,151 | 349,451 | 0.00 | 26.64 |
| Bear Springs Trails Subdivision | 1,722,525 | 1 | -23,860 | -23,859 | -71.58 | 0.76 |
| Canyon Springs Water Works | 21,243,333 | 1,409,070 | -304,417 | 1,104,653 | 2,209.31 | 6.38 |
| Center Point Wiedenfeld Water Works | 3,424,200 | 4,500 | 579,587 | 584,087 | 2,569.98 | 17.31 |
| City of Kerrville | 1,406,185,567 | 1,283,000 | 230,695,626 | 231,978,626 | 280,694.14 | 20.68 |
| City of Kerrville Schreiner Park | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| City of Leakey | 68,274,490 | 1,318,200 | 1,112,352 | 2,430,552 | 1,701.39 | 4.60 |
| City of Rocksprings | 55,124,907 | 700,490 | 577,870 | 1,278,360 | 2,096.51 | 4.49 |
| Del Rio Utilities Commission | 3,055,963,303 | 17,218,237 | 180,759,796 | 197,978,033 | 494,945.08 | 19.53 |
| Devils Shores WSC | 4,728,586 | 1 | 59,436 | 59,437 | 178.31 | 1.51 |
| Flying L Ranch PUD | 21,378,000 | 978,512 | 494,128 | 1,472,640 | 1,178.11 | 7.14 |
| Fort Clark Springs MUD | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| Heritage Park Water System | 1,680,300 | 0 | 63,556 | 63,556 | 279.64 | 4.03 |
| Hills & Dales Wiedenfeld Water Work | 5,759,900 | 209,000 | 1,170,306 | 1,379,306 | 6,068.94 | 24.20 |
| Mary Mead Water System | 10,350,808 | 694,766 | -148,244 | 546,522 | 546.52 | 6.46 |
| Medina WSC | 15,858,600 | 2,820 | 2,617,901 | 2,620,721 | 7,259.40 | 16.78 |
| Oak Ridge Estates Water System | 2,716,200 | 3,500 | -238,318 | -234,818 | -1,033.20 | 0.00 |
| Oakmont Saddle Mountain Water System | 5,498,557 | 25,000 | 116,793 | 141,793 | 42.54 | 4.75 |
| Real WSC | 12,745,918 | 10,000 | 2,829,603 | 2,839,603 | 851.88 | 26.14 |
| Rustic Hills Water | 2,731,053 | 181,615 | -31,407 | 150,208 | 150.21 | 10.40 |
| Shalako Water Supply | 4,121,616 | 273,386 | -59,063 | 214,323 | 278.62 | 6.38 |
| Southern Hills Wiedenfeld Water Works | 16,411,200 | 38,000 | 1,091,452 | 1,129,452 | 4,969.59 | 7.13 |
| Split Rock Water System | 3,574,737 | 1,000 | -476,178 | -475,178 | -2,185.82 | 3.75 |
| The Falls WSC | 6,157,143 | 167,000 | -43,857 | 123,143 | 0.00 | 2.00 |
| Three Rivers RV Park | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| Twin Forks Estates WSC | 6,085,863 | 1 | 59,917 | 59,918 | 119.84 | 3.18 |
| Val Verde County WCID Comstock | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| Verde Park Estates Wiedenfeld Water Work | 3,877,300 | 4,500 | 1,025,891 | 1,030,391 | 4,533.72 | 26.82 |
| Village West Water System | 3,561,364 | 239,751 | -50,999 | 188,752 | 188.75 | 6.48 |
| Westwood Water System | 7,889,100 | 1,300 | 498,804 | 500,104 | 2,200.46 | 6.59 |
| Windwood Oaks Water System | 1,429,400 | 0 | 12,059 | 12,059 | 53.06 | 1.09 |
| Woods WSC | 15,280,104 | 250,000 | -167,363 | 82,637 | 247.91 | 2.75 |

# 1.7 STATE AND FEDERAL AGENCIES

## 1.7.1 Texas Water Development Board (TWDB)

The TWDB (http://www.twdb.texas.gov) is the State agency charged with statewide water planning and administration of low-cost financial programs for the planning, design and construction of water supply, wastewater treatment, flood control and agricultural water conservation projects. The TWDB, especially the Water Resources Planning Division, is at the center of the legislatively mandated regional water planning effort. The agency has been given the responsibility of directing the process in order to ensure consistency and to guarantee that all regions of the state submit plans in a timely manner.

## 1.7.2 Texas Commission on Environmental Quality (TCEQ)

The TCEQ (http://www.tceq.texas.gov) strives to protect the State's natural resources, consistent with a policy of sustainable economic development. TCEQ's goal is clean air, clean water, and the safe management of waste, with an emphasis on pollution prevention. The TCEQ is the major State agency with regulatory authority over State waters in Texas and administers water rights of the Lower Rio Grande through the office of the Watermaster. The TCEQ is also responsible for ensuring that all public drinking water systems are in compliance with the strict requirements of the State of Texas. TCEQ is involved with the TWDB in developing a state consensus water plan. Prior to permit approval, TCEQ is required to determine if projects are consistent with regional water plans.

## 1.7.3 Texas Parks and Wildlife Department (TPWD)

The TPWD (http://www.tpwd.state.tx.us) provides outdoor recreational opportunities by managing and protecting wildlife and wildlife habitat and acquiring and managing parklands and historic areas. The agency currently has six internal divisions: Wildlife, Coastal Fisheries, Inland Fisheries, Law Enforcement, State Parks, Infrastructure. TPWD is involved with the TWDB in developing a state consensus water plan. Specifically, the agency looks to see that statewide environmental water needs are included. A TPWD staff person is a non-voting member of the Plateau Water Planning Group and provides essential environmental expertise to the planning process.

## 1.7.4 Texas Department of Agriculture (TDA)

The TDA (http://www.texasagriculture.gov/Home.aspx) was established by the Texas Legislature in 1907. The TDA has marketing and regulatory responsibilities and administers more than 50 separate laws. The current duties of the Department include: (1) promoting agricultural products locally, national, and internationally (2) assisting in the development of the agribusiness in Texas; (3) regulating the sale, use and disposal of pesticides and herbicides; (4) controlling destructive plant pests and diseases; and (5) ensuring the accuracy of all weighing or measuring devices used in commercial transactions. The Department also collects and reports statistics on all activities related to the agricultural industry in Texas. A TDA staff person is a non-voting member of the Plateau Water Planning Group and provides essential agricultural expertise to the planning process.

### 1.7.5 Texas State Soil and Water Conservation Board (TSSWCB)

The TSSWCB (http:/www.tsswcb.texas.gov/) is charged with the overall responsibility for administering and coordinating the state's soil and water conservation program with the State's soil and water conservation districts. The agency is responsible for planning, implementing, and managing programs and practices for abating agricultural and sivicultural nonpoint source pollution. Currently, the agricultural/sivicultural nonpoint source management program includes: problem assessment, management program development and implementation, monitoring, education, and coordination.

### 1.7.6 South Texas Watermaster Program

The South Texas Watermaster Program is responsible for an area that encompasses 50 counties in south central Texas and manages water rights based on "run of the river rights". Individuals and groups are informed as needed concerning water rights and other matters related to availability of surface water. The water master program also updates and maintains water-right ownerships and assessments due to each water-right account.

### 1.7.7 International Boundary and Water Commission (IBWC) and Comisión Internacional de Límites y Aquas (CILA)

The IBWC (http:/ibwc.state.gov/) and CILA provide binational solutions to issues that arise during the application of United States - Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and flood control in the border region; the treaties are discussed in Chapter 3.

### 1.7.8 United States Geological Survey (USGS)

The USGS (http://www.usgs.gov/) serves the Nation by providing reliable scientific information to (1) describe and understand the Earth; (2) minimize loss of life and property from natural disasters; (3) manage water, biological, energy, and mineral resources; and (4) enhance and protect quality of life. The USGS's Water Resources Division has played a major role in the understanding of the groundwater resources of Texas. Scientists with the USGS have conducted regional studies of water availability and water quality. Many of these studies have been conducted in conjunction with the TWDB. These studies have provided much of the data for more recent investigations conducted by graduate students and faculty members of many Texas universities.

### 1.7.9 United States Environmental Protection Agency (EPA)

The mission of the EPA (http://www.epa.gov/) is to protect human health and the environment. Programs of the EPA are designed (1) to promote national efforts to reduce environmental risk, based on the best available scientific information; (2) ensure that federal laws protecting human health and the environment are enforced fairly and effectively; (3) guarantee that all parts of society have access to accurate information sufficient to manage human health and environmental risks; and (4) guarantee that environmental protection contributes to making communities and ecosystems diverse, sustainable, and economically productive.

### 1.7.10 United States Fish and Wildlife Department (USFWS)

The USFWS (http://www.fws.gov) enforces federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores vital wildlife habitat, protects and recovers endangered species, and helps other governments with conservation efforts. It also administers a federal aid program that distributes money for fish and wildlife restoration, hunter education, and related projects across the country. The USFWS has provided comments that are pertinent to wildlife water needs to draft planning documents.

### 1.7.11 Upper Guadalupe River Authority

The Upper Guadalupe River Authority (UGRA) (http://www.ugra.org) was created as a conservation and reclamation district by the Texas Legislature in 1939. UGRA is a highly respected steward in managing the watershed and water resources of the Upper Guadalupe River benefiting both people and the environment. The mission of the UGRA is to conserve and reclaim surface water through the preservation and distribution of the water resources for future growth in order to maintain and enhance the quality of life for all Kerr County citizens.

### 1.7.12 Nueces River Authority

The Nueces River Authority (NRA) (http://www.nueces-ra.org) was created in 1935 by special act of the 44th Texas Legislature. Under supervision of the Texas Commission on Environmental Quality, NRA has broad authority to preserve, protect, and develop surface water resources including flood control, irrigation, navigation, water supply, wastewater treatment, and water quality control. NRA may develop parks and recreational facilities, acquire and dispose of solid wastes, and issue bonds and receive grants and loans.

2

# CHAPTER 2
# POPULATION AND WATER DEMAND

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# 2 POPULATION AND WATER DEMAND

Planning for the wise use of the existing water resources in the Plateau Region requires a reasonable estimation of current and future water needs for all water-use categories. Regional population and water demand data was initially provided to the planning groups at the beginning of the planning period, which incorporated data from the State Data Center and the U.S. Census Bureau's 2010 census count. The Plateau Water Planning Group (PWPG) requested revisions to specific water demand categories for use in the *2016 Plateau Region Water Plan*, which were subsequently approved by the TWDB. Thus, the population and water demand projections shown in this chapter are derived from a combination of TWDB data and approved revisions.

The PWPG made available draft population and water demand summary tables to municipalities, water providers, county judges, and non-municipal water use representatives, and solicited all entities within the Region to submit desired changes to the projections. After thoughtful consideration, the PWPG chose not to modify the draft population estimates. However, the PWPG did voice reservations with the way that these population numbers are used to calculate county rural water demand projections as further expressed in Section 2.2.1 below. Requested revisions in draft water-demand projections fell into three categories, irrigation in Kinney County, mining in Edwards County, and livestock in all counties. All of the requested revisions were subsequently granted by the TWDB.

# 2.1 POPULATION

## 2.1.1 Population Projection Methodology

County population projections are based on Texas State Data Center / Office of the State Demographer county-level population projections. These projections are based on recent and projected demographic trends, including birth and survival rates and net migration rates of population groups defined by age, gender, and race/ethnicity. The projected county population is then allocated to cities with a 2010 population greater than 500. In some cases, the water user group (WUG) is a utility. In these cases, the population reported for the utility represents the population served by that utility. The rural "county-other" population is calculated as the difference between the total projected population of cities and major utilities, and the total projected county population. Population is thus projected from the 2010 base year by decade to the year 2070. A more detailed explanation of the TWDB population projection methodology is available at http://www.twdb.texas.gov/waterplanning/data/projections/index.asp.

The PWPG expresses concern that the population projections do not recognize the impact to the municipal and rural population and its related water demand that occurs as the result of seasonal vacationers, hunters, and absentee land-owner homes, especially in the rural counties. The PWPG recommends that for future regional water plans, that a region be allowed to adjust the total regional population rather than having to adjust individual county populations to achieve a non-changeable total population.

## 2.1.2 Year - 2020 and Projected Population

In the year 2010, the U.S. Census Bureau performed a census count, which provides the base year for future population projections. Although the PWPG accepts the 2010 census count, members again expressed concern that the census does not recognize the significant seasonal population increase that occurs as the Region draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting properties. Therefore, an emphasis is being made in this planning document, especially for the rural counties, to recognize a need for more water than is justified simply from the population-derived water demand quantities.

The approved projections may also underestimate population and subsequent water demand in Kerr County. The cohort-component model used to project population growth does not adequately account for expected business and market factors that can influence population growth. Several Kerr County organizations are actively pursuing market development and business growth in order to maintain a consistent double-digit growth rate not reflected in the long-term population forecast. Similar underestimations may also occur elsewhere in the Region.

Population projections by decade for communities, water utilities, and county rural areas in the Plateau Region are listed in Table 2-1. The projected year-2020 population for the entire Region is 141,476 of which 76 percent reside in Kerr and Val Verde Counties (Figure 2-1). Del Rio (including Laughlin AFB), with a year-2020 projected population of 39,839, is the largest community in the Region. The Regional population is projected to increase by 30 percent to 184,595 by the year 2070, which is an increase of 43,119 citizens (Figure 2-2). The water demand table (Table 2-2) depicts water demand for County-Other use as equally distributed throughout the rural portion of each county; whereas in reality, County-Other population and water demand are often concentrated in smaller areas of the county, such as unincorporated communities, subdivisions and mobile home parks.

Population estimates do not consider population density, which concentrates water demand and strains available local water supplies. Figure 2-3 shows the concentration of rural population in the eastern portions of both Kerr and Bandera Counties. The challenge of meeting the water needs for these concentrated rural areas is addressed in water management strategies provided in Chapter 5.

**Table 2-1. Plateau Region Population Projection**

| | Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Bandera County** | | | | | | | |
| County-Other | Guadalupe | 150 | 173 | 186 | 190 | 194 | 196 |
| Total Population | | 150 | 173 | 186 | 190 | 194 | 196 |
| County-Other | Nueces | 1,373 | 1,581 | 1,696 | 1,744 | 1,772 | 1,787 |
| Total Population | | 1,373 | 1,581 | 1,696 | 1,744 | 1,772 | 1,787 |
| Bandera | San Antonio | 1,045 | 1,204 | 1,291 | 1,327 | 1,349 | 1,361 |
| County-Other | | 22,423 | 25,822 | 27,708 | 28,481 | 28,950 | 29,193 |
| Total Population | | 23,468 | 27,026 | 28,999 | 29,808 | 30,299 | 30,554 |
| **Bandera County Total Population** | | **24,991** | **28,780** | **30,881** | **31,742** | **32,265** | **32,537** |
| **Edwards County** | | | | | | | |
| Rocksprings | Colorado | 841 | 841 | 841 | 841 | 841 | 841 |
| County-Other | | 199 | 199 | 199 | 199 | 199 | 199 |
| Total Population | | 1,040 | 1,040 | 1,040 | 1,040 | 1,040 | 1,040 |
| Rocksprings | Nueces | 413 | 413 | 413 | 413 | 413 | 413 |
| County-Other | | 565 | 565 | 565 | 565 | 565 | 565 |
| Total Population | | 978 | 978 | 978 | 978 | 978 | 978 |
| County-Other | Rio Grande | 105 | 105 | 105 | 105 | 105 | 105 |
| Total Population | | 105 | 105 | 105 | 105 | 105 | 105 |
| **Edwards County Total Population** | | **2,123** | **2,123** | **2,123** | **2,123** | **2,123** | **2,123** |
| **Kerr County** | | | | | | | |
| County-Other | Colorado | 628 | 661 | 681 | 700 | 714 | 725 |
| Total Population | | 628 | 661 | 681 | 700 | 714 | 725 |
| Ingram | Guadalupe | 1,837 | 1,867 | 1,885 | 1,903 | 1,916 | 1,926 |
| Kerrville | | 23,319 | 24,209 | 24,736 | 25,258 | 25,633 | 25,922 |
| Loma Vista Water System | | 3,448 | 3,629 | 3,736 | 3,843 | 3,919 | 3,977 |
| County-Other | | 23,066 | 24,677 | 25,632 | 26,576 | 27,255 | 27,776 |
| Total Population | | 51,670 | 54,382 | 55,989 | 57,580 | 58,723 | 59,601 |
| County-Other | Nueces | 8 | 8 | 8 | 8 | 9 | 9 |
| Total Population | | 8 | 8 | 8 | 8 | 9 | 9 |
| County-Other | San Antonio | 338 | 356 | 366 | 377 | 384 | 390 |
| Total Population | | 338 | 356 | 366 | 377 | 384 | 390 |
| **Kerr County Total Population** | | **52,644** | **55,407** | **57,044** | **58,665** | **59,830** | **60,725** |
| **Kinney County** | | | | | | | |
| County-Other | Nueces | 81 | 81 | 81 | 81 | 81 | 81 |
| Total Population | | 81 | 81 | 81 | 81 | 81 | 81 |
| Brackettville | Rio Grande | 1,734 | 1,746 | 1,746 | 1,746 | 1,746 | 1,746 |
| Fort Clark Springs MUD | | 1,262 | 1,270 | 1,270 | 1,270 | 1,270 | 1,270 |
| County-Other | | 618 | 623 | 623 | 623 | 623 | 623 |
| Total Population | | 3,614 | 3,639 | 3,639 | 3,639 | 3,639 | 3,639 |
| **Kinney County Total Population** | | **3,695** | **3,720** | **3,720** | **3,720** | **3,720** | **3,720** |
| **Real County** | | | | | | | |
| County-Other | Colorado | 35 | 35 | 35 | 35 | 35 | 35 |
| Total Population | | 35 | 35 | 35 | 35 | 35 | 35 |
| Camp Wood | Nueces | 698 | 698 | 698 | 698 | 698 | 698 |
| County-Other | | 2,596 | 2,596 | 2,596 | 2,596 | 2,596 | 2,596 |
| Total Population | | 3,294 | 3,294 | 3,294 | 3,294 | 3,294 | 3,294 |
| **Real County Total Population** | | **3,329** | **3,329** | **3,329** | **3,329** | **3,329** | **3,329** |
| **Val Verde County** | | | | | | | |
| Del Rio | Rio Grande | 38,083 | 40,524 | 42,887 | 45,315 | 47,627 | 49,856 |
| Laughlin AFB | | 1,756 | 1,939 | 2,116 | 2,225 | 2,225 | 2,225 |
| County-Other | | 14,855 | 17,926 | 20,899 | 24,026 | 27,108 | 30,080 |
| Total Population | | 54,694 | 60,389 | 65,902 | 71,566 | 76,960 | 82,161 |
| **Val Verde County Total Population** | | **54,694** | **60,389** | **65,902** | **71,566** | **76,960** | **82,161** |
| **Region J Total Population** | | **141,476** | **153,748** | **162,999** | **171,145** | **178,227** | **184,595** |

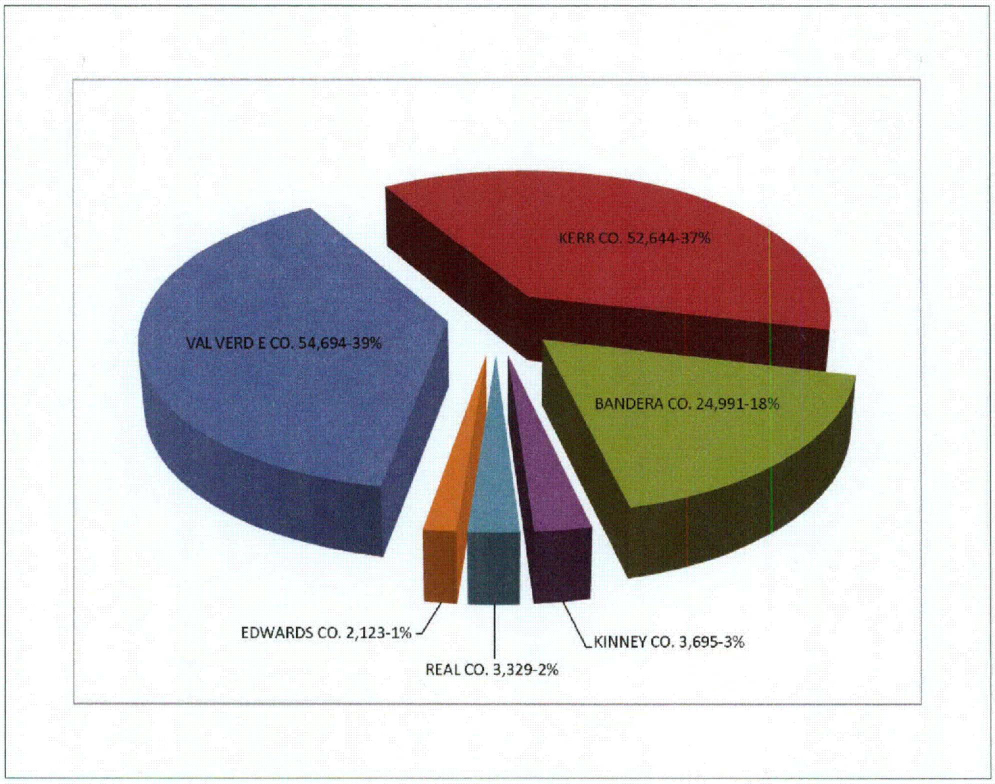


**Figure 2-1. Year 2020 Population Projection**

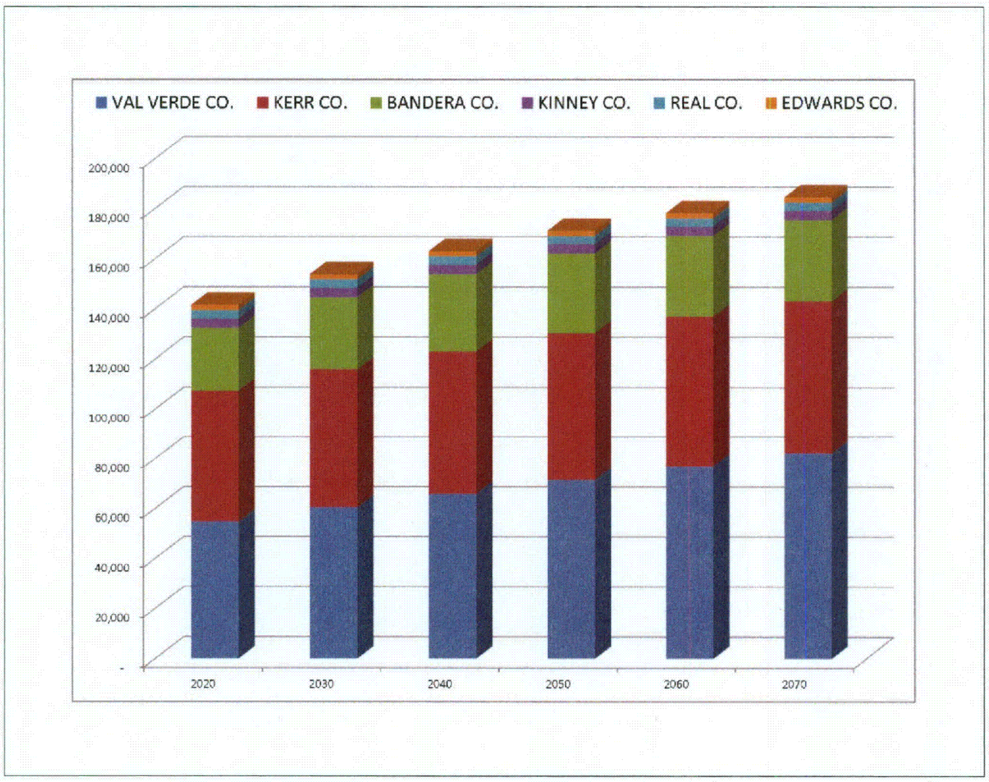


**Figure 2-2. Regional Population Projection**

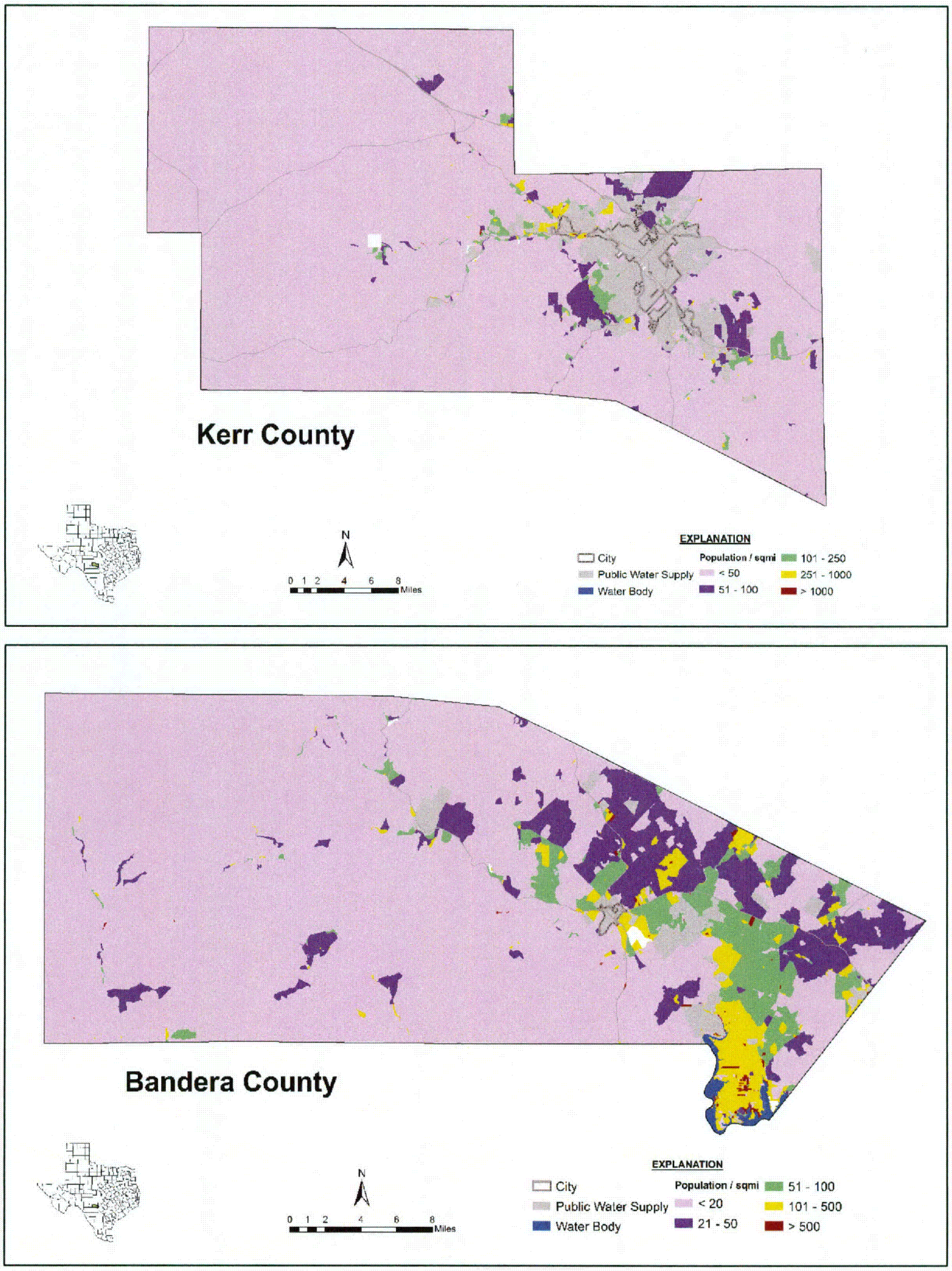


**Figure 2-3. Rural Population Concentration in Kerr and Bandera Counties**

# 2.2 WATER DEMAND

## 2.2.1 Water Demand Projections

A major component of water planning is the establishment of accurate water demand estimates for all water-use categories. Categories of water use include (1) municipal, (2) rural domestic (county-other), (3) manufacturing, (4) irrigation, (5) livestock, and (6) mining. There is no recognized water use in the Plateau Region for "steam-electric power generation". Table 2-2 lists the current and future projected Regional water demand by county and water-use category. The municipal category includes cities and retail public utilities. The percent distribution of water demand in the Region by the five water-use categories is shown in Figure 2-5. Water demand is reported in "acre-feet"; one acre-foot is equivalent to a quantity of water one foot deep occupying one acre, or 325, 851 gallons. Other water use categories that are not quantified in this *Plan* include environmental and recreational needs, and are addressed in Section 2.3.

Figure 2-4 and Figure 2-6 show projected water demand by county in acre-feet per year. From the year 2020 to 2070 the total water demand in the Region is projected to increase from 39,802 acre-feet to 44,937 acre-feet. Water demand methodologies and trends for each of the five water-use categories are provided in the following subsections.

The potential role of conservation is an important factor in projecting future water supply requirements. Water demands listed in this *Plan* included demand adjustments based on expected conservation practices. In this *Plan,* conservation is only included in the municipal projections as a measure of expected savings based on requirements of the State plumbing code. All other conservation practices are discussed in terms of water supply management strategies in Chapter 5 and as a component of drought management plans in Chapter 7.

As stated previously, the PWPG is concerned that the population and subsequent water demand projections throughout the Region may be understated due to the large number of temporary residents in the Region including hunters, tourists and absentee landowners. In addition to these factors, water demand may be understated in Kerr County (as well as elsewhere in the Region) because the cohort-component model does not reflect market and business factors that are expected to increase water demand in the county, especially in the municipal and manufacturing use category. Population estimates do not consider population density, which concentrates water demand and strains available local water supplies.

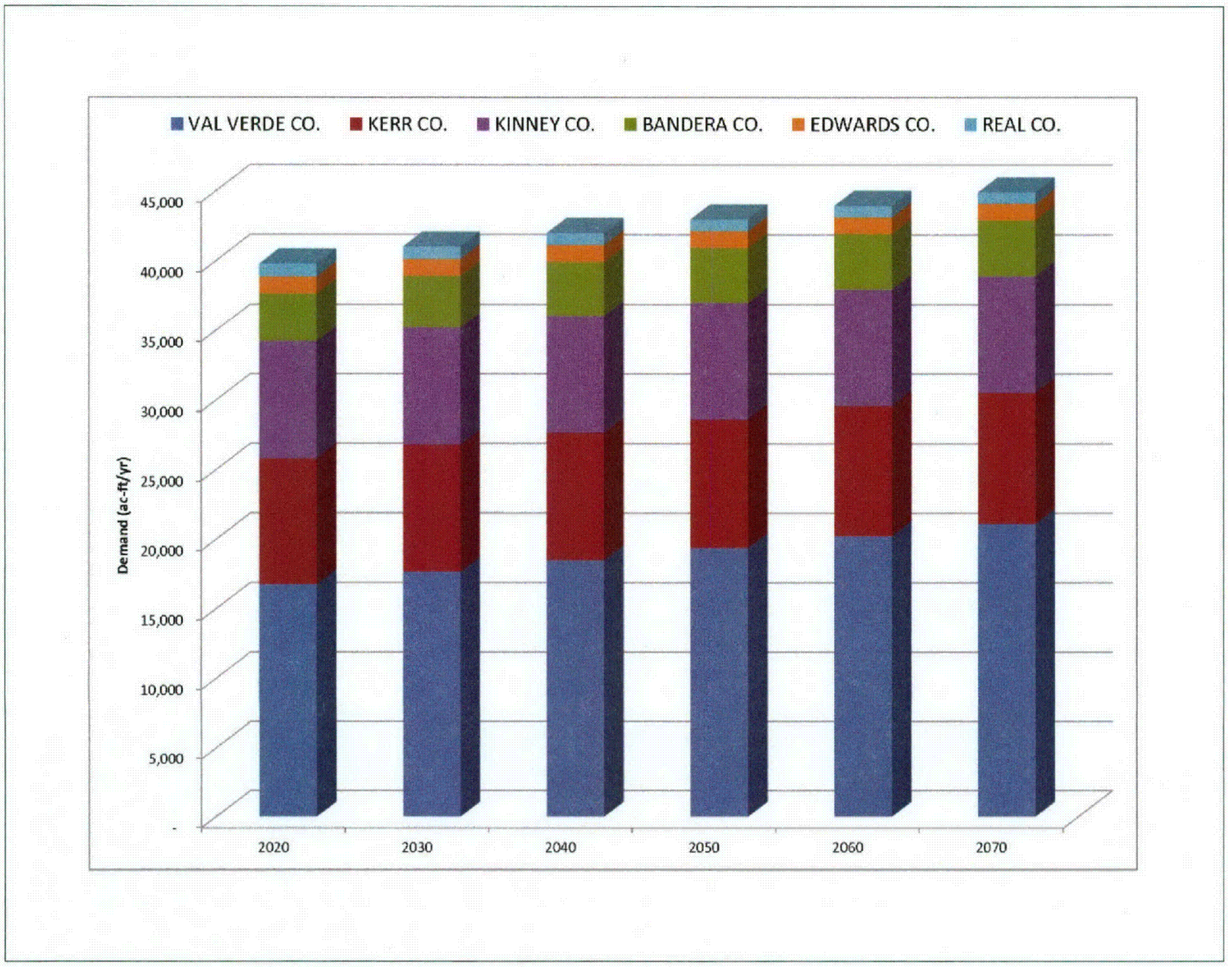


**Figure 2-4. Projected Water Demand by County**

**Table 2-2. Plateau Region Water Demand Projection**

| | Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Bandera County** | | | | | | | |
| County-Other | Guadalupe | 16 | 18 | 19 | 19 | 19 | 19 |
| Livestock | Guadalupe | 13 | 13 | 13 | 13 | 13 | 13 |
| Total Demand | Guadalupe | 29 | 31 | 32 | 32 | 32 | 32 |
| County-Other | Nueces | 143 | 159 | 168 | 171 | 173 | 174 |
| Livestock | Nueces | 58 | 58 | 58 | 58 | 58 | 58 |
| Irrigation | Nueces | 86 | 86 | 86 | 86 | 86 | 86 |
| Total Demand | Nueces | 287 | 303 | 312 | 315 | 317 | 318 |
| Bandera | San Antonio | 191 | 214 | 225 | 231 | 234 | 236 |
| County-Other | San Antonio | 2,334 | 2,597 | 2,731 | 2,778 | 2,817 | 2,840 |
| Livestock | San Antonio | 226 | 226 | 226 | 226 | 226 | 226 |
| Irrigation | San Antonio | 346 | 346 | 346 | 346 | 346 | 346 |
| Total Demand | San Antonio | 3,097 | 3,383 | 3,528 | 3,581 | 3,623 | 3,648 |
| **Bandera County Total Demand** | | **3,413** | **3,717** | **3,872** | **3,928** | **3,972** | **3,998** |
| **Edwards County** | | | | | | | |
| Rocksprings | Colorado | 197 | 193 | 190 | 190 | 189 | 189 |
| County-Other | Colorado | 22 | 20 | 20 | 20 | 19 | 19 |
| Mining | Colorado | 19 | 19 | 19 | 19 | 19 | 19 |
| Livestock | Colorado | 140 | 140 | 140 | 140 | 140 | 140 |
| Irrigation | Colorado | 76 | 73 | 70 | 67 | 64 | 62 |
| Total Demand | Colorado | 454 | 445 | 439 | 436 | 431 | 429 |
| Rocksprings | Nueces | 98 | 96 | 94 | 94 | 94 | 94 |
| County-Other | Nueces | 62 | 60 | 57 | 57 | 57 | 57 |
| Mining | Nueces | 25 | 25 | 25 | 25 | 25 | 25 |
| Livestock | Nueces | 252 | 252 | 252 | 252 | 252 | 252 |
| Irrigation | Nueces | 89 | 85 | 82 | 78 | 75 | 72 |
| Total Demand | Nueces | 526 | 518 | 510 | 506 | 503 | 500 |
| County-Other | Rio Grande | 12 | 12 | 11 | 11 | 11 | 11 |
| Mining | Rio Grande | 45 | 45 | 45 | 45 | 45 | 45 |
| Livestock | Rio Grande | 131 | 131 | 131 | 131 | 131 | 131 |
| Irrigation | Rio Grande | 62 | 60 | 57 | 55 | 52 | 50 |
| Total Demand | Rio Grande | 250 | 248 | 244 | 242 | 239 | 237 |
| **Edwards County Total Demand** | | **1,230** | **1,211** | **1,193** | **1,184** | **1,173** | **1,166** |
| **Kerr County** | | | | | | | |
| County-Other | Colorado | 53 | 53 | 53 | 53 | 54 | 55 |
| Mining | Colorado | 14 | 15 | 19 | 19 | 21 | 23 |
| Livestock | Colorado | 195 | 195 | 195 | 195 | 195 | 195 |
| Irrigation | Colorado | 23 | 22 | 21 | 21 | 20 | 19 |
| Total Demand | Colorado | 285 | 285 | 288 | 288 | 290 | 292 |
| Ingram | Guadalupe | 165 | 160 | 155 | 153 | 154 | 155 |
| Kerrville | Guadalupe | 4,619 | 4,688 | 4,706 | 4,759 | 4,821 | 4,875 |
| Loma Vista Water System | Guadalupe | 417 | 424 | 425 | 431 | 438 | 444 |
| County-Other | Guadalupe | 1,946 | 1,986 | 1,994 | 2,029 | 2,072 | 2,110 |
| Manufacturing | Guadalupe | 25 | 27 | 29 | 30 | 32 | 34 |
| Mining | Guadalupe | 62 | 65 | 81 | 83 | 90 | 97 |
| Livestock | Guadalupe | 642 | 642 | 642 | 642 | 642 | 642 |
| Irrigation | Guadalupe | 804 | 779 | 755 | 730 | 708 | 687 |
| Total Demand | Guadalupe | 8,680 | 8,771 | 8,787 | 8,857 | 8,957 | 9,044 |
| County-Other | Nueces | 1 | 1 | 1 | 1 | 1 | 1 |
| Livestock | Nueces | 11 | 11 | 11 | 11 | 11 | 11 |
| Total Demand | Nueces | 12 | 12 | 12 | 12 | 12 | 12 |

**Table 2-2. (Continued) Plateau Region Water Demand Projections**

| | Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Kerr County** | | | | | | | |
| County-Other | San Antonio | 29 | 29 | 28 | 29 | 29 | 30 |
| Livestock | | 42 | 42 | 42 | 42 | 42 | 42 |
| Irrigation | | 15 | 15 | 14 | 14 | 13 | 13 |
| Total Demand | | 86 | 86 | 84 | 85 | 84 | 85 |
| **Kerr County Total Demand** | | **9,063** | **9,154** | **9,171** | **9,242** | **9,343** | **9,433** |
| **Kinney County** | | | | | | | |
| County-Other | Nueces | 11 | 11 | 10 | 10 | 10 | 10 |
| Livestock | | 189 | 189 | 189 | 189 | 189 | 189 |
| Irrigation | | 2,356 | 2,356 | 2,356 | 2,356 | 2,356 | 2,356 |
| Total Demand | | 2,556 | 2,556 | 2,555 | 2,555 | 2,555 | 2,555 |
| Brackettville | Rio Grande | 539 | 534 | 527 | 526 | 525 | 525 |
| Fort Clark Springs MUD | | 620 | 618 | 614 | 612 | 611 | 611 |
| County-Other | | 84 | 82 | 81 | 80 | 80 | 80 |
| Livestock | | 233 | 233 | 233 | 233 | 233 | 233 |
| Irrigation | | 4,374 | 4,374 | 4,374 | 4,374 | 4,374 | 4,374 |
| Total Demand | | 5,850 | 5,841 | 5,829 | 5,825 | 5,823 | 5,823 |
| **Kinney County Total Demand** | | **8,406** | **8,397** | **8,384** | **8,380** | **8,378** | **8,378** |
| **Real County** | | | | | | | |
| County-Other | Colorado | 4 | 4 | 4 | 4 | 4 | 4 |
| Livestock | | 22 | 22 | 22 | 22 | 22 | 22 |
| Irrigation | | 13 | 12 | 12 | 11 | 11 | 10 |
| Total Demand | | 39 | 38 | 38 | 37 | 37 | 36 |
| Camp Wood | Nueces | 134 | 131 | 128 | 127 | 126 | 126 |
| County-Other | | 276 | 266 | 258 | 254 | 253 | 253 |
| Livestock | | 239 | 239 | 239 | 239 | 239 | 239 |
| Irrigation | | 225 | 216 | 207 | 198 | 188 | 181 |
| Total Demand | | 874 | 852 | 832 | 818 | 806 | 799 |
| **Real County Total Demand** | | **913** | **890** | **870** | **855** | **843** | **835** |
| **Val Verde County** | | | | | | | |
| Del Rio | Rio Grande | 10,645 | 11,144 | 11,649 | 12,229 | 12,837 | 13,435 |
| Laughlin AFB | | 1,012 | 1,107 | 1,208 | 1,269 | 1,268 | 1,268 |
| County-Other | | 1,937 | 2,267 | 2,596 | 2,959 | 3,331 | 3,694 |
| Mining | | 190 | 249 | 259 | 223 | 192 | 171 |
| Livestock | | 533 | 533 | 533 | 533 | 533 | 533 |
| Irrigation | | 2,460 | 2,364 | 2,274 | 2,185 | 2,101 | 2,026 |
| Total Demand | | 16,777 | 17,664 | 18,519 | 19,398 | 20,262 | 21,127 |
| **Val Verde County Total Demand** | | **16,777** | **17,664** | **18,519** | **19,398** | **20,262** | **21,127** |
| **Region J Total Demand** | | **39,802** | **41,033** | **42,009** | **42,987** | **43,971** | **44,937** |

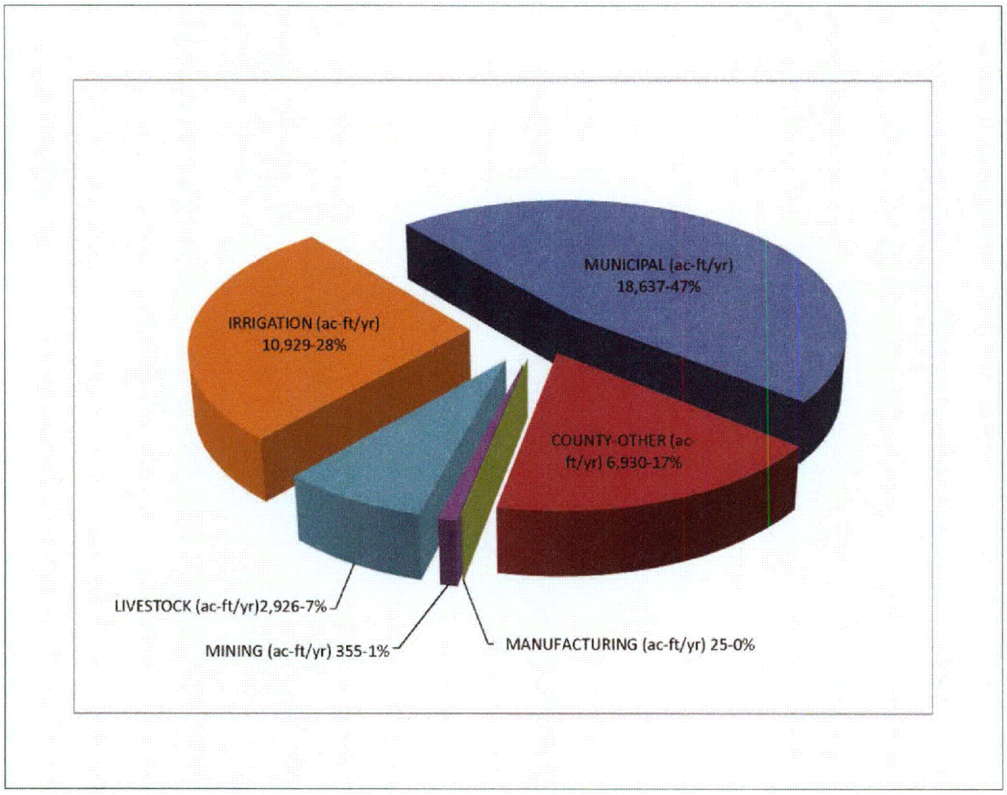


**Figure 2-5. Year 2020 Projected Water Demand by Water-Use Category**

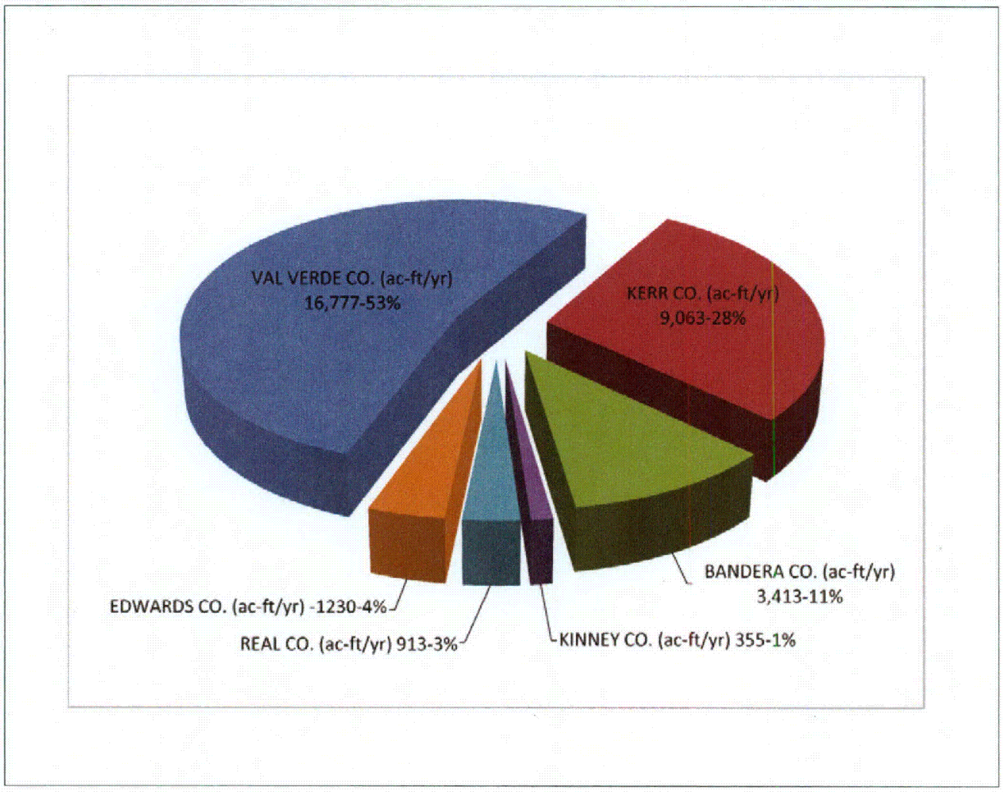


**Figure 2-6. Year 2020 Projected Water Demand by County**

### 2.2.2 Municipal and County-Other

The quantity of water used for municipal and rural domestic (County-Other) purposes is heavily dependent on population growth, climatic conditions, and water-conservation measures. For planning purposes, municipal water use comprises both residential and commercial. Commercial water use includes business establishments, public offices, and institutions. Residential and commercial uses are categorized together because they are similar types of uses: i.e., they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering. Also included in this category is water supplied to golf courses from municipal supply sources. Water use within a city that is not included in the quantification of municipal demand is that used in manufacturing and industrial processes.

Projected municipal water demand is based on the year-2010 per-capita water use, which is calculated with year-2010 population counts divided into reported water use for the same year. Per-capita water use in communities with significant non-residential water demands, such as commercial customers will appear abnormally high. The year-2010 per-capita water use is reduced slightly over time to simulate expected conservation savings due to State-mandated plumbing code implementation. The conservation adjusted per-capita water use is then applied to each of the decade population estimates to produce the projected water demand for each entity.

Municipal (and County-Other) water demand in the Plateau Region is projected to increase from a year-2020 level of 25,567 acre-feet to 31,315 acre-feet by the year 2070 (Table 2-3). Because municipal water demand is directly related to population, Val Verde County has the highest demand in the Region. Bandera County, with the greatest projected percentage population increase, will likewise see the greatest percentage municipal water demand increase over the 50-year period, 122 percent.

**Table 2-3. Municipal and County-Other Water Demand Projection (Acre-Feet per Year)**

| County | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 2,684 | 2,988 | 3,143 | 3,199 | 3,243 | 3,269 |
| Edwards | 391 | 381 | 372 | 372 | 370 | 370 |
| Kerr | 7,230 | 7,341 | 7,362 | 7,455 | 7,569 | 7,670 |
| Kinney | 1,254 | 1,245 | 1,232 | 1,228 | 1,226 | 1,226 |
| Real | 414 | 401 | 390 | 385 | 383 | 383 |
| Val Verde | 13,594 | 14,518 | 15,453 | 16,457 | 17,436 | 18,397 |
| **County Total Demand** | **25,567** | **26,874** | **27,952** | **29,096** | **30,227** | **31,315** |

**Wholesale Water Provider** – A wholesale water provider is any person or entity that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last *Regional Water Plan*. The City of Del Rio is the only entity in the Plateau Region to meet this criterion. In addition to its own use, the city provides water to Laughlin Air Force Base and subdivisions outside of the city. Del Rio also provides water and wastewater services to two colonias, Cienegas Terrace and Val Verde Park Estates. Table 2-4 shows the distribution of water demand supplied by the City of Del Rio in the Rio Grande River Basin.

**Table 2-4. Del Rio Wholesale Water Provider Water Demand (Acre-Feet per Year)**

| County | Basin | Water User Group | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Val Verde | Rio Grande | City of Del Rio | 10,645 | 11,144 | 11,649 | 12,229 | 12,837 | 13,435 |
| | | Laughlin AFB | 961 | 1,052 | 1,148 | 1,206 | 1,205 | 1,205 |
| | | County Other | 523 | 612 | 700 | 800 | 900 | 997 |
| **Total Wholesale Water Demand** | | | **12,129** | **12,808** | **13,497** | **14,235** | **14,942** | **15,637** |

Municipal water demands incorporate anticipated future water savings due to the natural instillation of plumbing fixtures and appliances to more water-efficient fixtures and appliances (Table 2-5).

**Table 2-5. Municipal Savings Due to Plumbing Fixture Requirements (Acre-Feet per Year)**

| County | Entity Name | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Bandera | Bandera | 13 | 21 | 27 | 28 | 29 | 30 |
| Bandera | County-Other, Bandera | 243 | 377 | 464 | 508 | 524 | 529 |
| Edwards | County-Other, Edwards | 10 | 14 | 18 | 18 | 18 | 18 |
| Edwards | Rocksprings | 14 | 20 | 25 | 26 | 26 | 26 |
| Kerr | County-Other, Kerr | 233 | 349 | 435 | 491 | 513 | 523 |
| Kerr | Ingram | 18 | 26 | 33 | 37 | 38 | 38 |
| Kerr | Kerrville | 240 | 356 | 448 | 503 | 519 | 526 |
| Kerr | Loma Vista Water System | 35 | 52 | 65 | 73 | 76 | 77 |
| Kinney | Brackettville | 19 | 28 | 35 | 36 | 37 | 37 |
| Kinney | County-Other, Kinney | 5 | 8 | 9 | 10 | 10 | 10 |
| Kinney | Fort Clark Springs MUD | 13 | 18 | 22 | 25 | 25 | 25 |
| Real | Camp Wood | 7 | 11 | 14 | 15 | 15 | 15 |
| Real | County-Other, Real | 24 | 34 | 42 | 46 | 47 | 47 |
| Val Verde | County-Other, Val Verde | 160 | 263 | 354 | 432 | 495 | 552 |
| Val Verde | Del Rio | 404 | 614 | 794 | 918 | 981 | 1,030 |
| Val Verde | Laughlin AFB | 23 | 35 | 39 | 42 | 43 | 43 |
| **Total** | | **1,461** | **2,226** | **2,823** | **3,208** | **3,396** | **3,526** |

### 2.2.3 Manufacturing

Manufacturing and industrial water use is quantified separately from municipal use even though the demand centers may be located within a city limits. Draft manufacturing water demand projections utilized 2004-2008 data from TWDB's Water Use Survey (WUS). In counties where reported employment from the companies returning surveys was low compared to manufacturing employment data reported by the Bureau of Economic Analysis (BEA), surveyed water use was adjusted to account for non-responses. The rate of change for projections from the *2011 Regional Water Plan* was then applied to the new base year estimate. In the Plateau Region, the use of water for manufacturing purposes is only recognized in Kerr County (Table 2-6).

**Table 2-6. Manufacturing Water Demand Projection (Acre-Feet per Year)**

| County | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 0 | 0 | 0 | 0 | 0 | 0 |
| Edwards | 0 | 0 | 0 | 0 | 0 | 0 |
| Kerr | 25 | 27 | 29 | 30 | 32 | 34 |
| Kinney | 0 | 0 | 0 | 0 | 0 | 0 |
| Real | 0 | 0 | 0 | 0 | 0 | 0 |
| Val Verde | 0 | 0 | 0 | 0 | 0 | 0 |
| **County Total Demand** | **25** | **27** | **29** | **30** | **32** | **34** |

### 2.2.4 Irrigation

Draft irrigation water demand projections utilized an average of TWDB's 2005-2009 irrigation water use estimates as a base. Annual water use estimates are developed at the county level by applying a calculated evapotranspiration-based "crop water need" estimate to reported irrigated acreage from Farm Service Agency (FSA). These estimates are then adjusted based on surface water release data from TCEQ and Texas Water Masters and comments from Groundwater Conservation Districts. The rate of change for projections from the *2011 Regional Water Plan* was then applied to the new base.

Statewide, irrigation water demands are expected to decline over time. More efficient canal delivery systems have improved water-use efficiencies of surface water irrigation. More efficient on-farm irrigation systems have also improved the efficiency of groundwater irrigation. Other factors that have contributed to decreased irrigation demands are declining groundwater supplies and the voluntary transfer of water rights historically used for irrigation to municipal uses.

In lieu of the above process, irrigation demand in Kinney County is more accurately based on actual measured diversions or pumping withdrawals as monitored by the Kinney County Groundwater Conservation District. Future irrigation use is then projected from this 2010 base year at a rate established for the same county irrigation projection in the previous *Regional Water Plan*. Although Table 2-7 shows a level Kinney County irrigation demand in future decades, local sources suggest that there is a recent surge in agricultural interest that may significantly increase future irrigation activity in the county. Water supply availability Table 3-1 in Chapter 3 illustrates that there is sufficient unused groundwater in both the Edwards-Trinity (Plateau) Aquifer and the Edwards (BFZ) Aquifer to accommodate additional irrigation demands.

Kinney County has the highest irrigation water use in the Region (62 percent) and is the only county in which irrigation use is greater than municipal use. Elsewhere in the Region, most irrigation that occurs is for the watering of pastures and hay fields. Because of the typically rocky and uneven terrain throughout much of the Region, irrigation of commercial row crops is minimal. On a regional basis, water used for irrigation is projected to decline slightly over the 50-year planning horizon, from the year-2020 level of 10,929 acre-feet to 10,282 acre-feet by 2070. However, as any irrigator can attest, climate, water availability, and the market play key roles in how much water is actually applied on a year- by-year basis.

The PWPG is concerned about the accuracy of the irrigation surveys and believes that there is significantly more irrigation water use than is documented. For example, numerous small irrigated exotic and wildlife feed plots are likely not identified. Also, groundwater used to irrigate golf courses, if not provided by municipalities, may not be accounted for in the irrigation survey estimates. These withdrawals may have a significant impact on local supplies.

**Table 2-7. Irrigation Water Demand Projection (Acre-Feet per Year)**

| County | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 432 | 432 | 432 | 432 | 432 | 432 |
| Edwards | 227 | 218 | 209 | 200 | 191 | 184 |
| Kerr | 842 | 816 | 790 | 765 | 741 | 719 |
| Kinney | 6,730 | 6,730 | 6,730 | 6,730 | 6,730 | 6,730 |
| Real | 238 | 228 | 219 | 209 | 199 | 191 |
| Val Verde | 2,460 | 2,364 | 2,274 | 2,185 | 2,101 | 2,026 |
| **County Total Demand** | **10,929** | **10,788** | **10,654** | **10,521** | **10,394** | **10,282** |

### 2.2.5 Livestock

Texas is the nation's leading livestock producer, accounting for approximately 11 percent of the total United States production. Although livestock production is an important component of the Texas economy, the industry consumes a relatively small amount of water.

Draft livestock water demand projections utilized an average of TWDB's 2005-2009 livestock water use estimates as the base. Water use estimates are calculated by applying a water use coefficient for each livestock category to county level inventory estimates from Texas Agricultural Statistics Service. The rate of change for projections from the *2011 Regional Water Plan* was then applied to the new base. Many counties chose to hold the base constant throughout the planning horizon.

For water-supply planning purposes, livestock water use is held constant throughout the 50-year planning period. However, reality dictates that during prolonged drought periods, when poor range conditions exist and/or during unfriendly market conditions, livestock herds are generally reduced thus resulting in significantly less water demand. Kerr County has the greatest livestock water use in the region (Table 2-8).

In recent years, an expanding use of groundwater in the Region has been to fill and maintain artificial lakes that primarily are intended to add aesthetic value to the property. Although not quantified, the amount of water pumped from local aquifers for this purpose is likely significant and is not reflected in the water demand estimates provided in this chapter. To manage the volume of groundwater used for this purpose, the Headwaters Groundwater Conservation District in Kerr County permits a maximum production of one acre-foot (325,851 gallons) per year.

Exotic game ranching has become commonplace throughout the state, and is quite evident in the Plateau Region counties. Bandera and Kerr Counties have the largest population of exotic game in the State (Texas A&M Exotics on the Range). The total numbers of exotic game likely may equal or even exceed domestic livestock. Yet the livestock water demand projections reported in this *Plan* may not fully reflect this water use.

High game fences that come with the exotic game industry often block the ability of both native and exotic game to access surface water, thus requiring more wells and groundwater use. Groundwater is also often used to irrigate small acreage feed plots for these animals. Future water plans will need to attempt to quantity this specific use and include it in the overall total projected water needs in the State.

In an analysis report prepared for the PWPG during the previous planning period, Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area, the amount of water used by various exotic game species is estimated. However, the report states that there is insufficient data on the number of animals in the Region to make an estimate of total use. Estimates made by the Real-Edwards Conservation and Reclamation District find that approximately 602 and 233 acre-feet per year in Edwards and Real Counties is consumed by exotic game animals.

**Table 2-8. Livestock Water Demand Projection (Acre-Feet per Year)**

| County | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 297 | 297 | 297 | 297 | 297 | 297 |
| Edwards | 523 | 523 | 523 | 523 | 523 | 523 |
| Kerr | 890 | 890 | 890 | 890 | 890 | 890 |
| Kinney | 422 | 422 | 422 | 422 | 422 | 422 |
| Real | 261 | 261 | 261 | 261 | 261 | 261 |
| Val Verde | 533 | 533 | 533 | 533 | 533 | 533 |
| **County Total Demand** | **2,926** | **2,926** | **2,926** | **2,926** | **2,926** | **2,926** |

### 2.2.6 Mining

Although the Texas mineral industry is foremost in the production of crude petroleum and natural gas in the United States, it also produces a wide variety of important nonfuel minerals. In all instances, water is required in the mining of these minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation.

Draft mining water demand projections were developed through a TWDB-contracted study with the Bureau of Economic Geology (BEG). The BEG study estimated current mining water use and projected that use across the planning horizon using data collected from trade, organizations, government agencies, and other industry representatives. County-level projections are compiled as the sum of individual projections for four sub-sector mining categories: oil and gas, aggregates, coal and lignite, and other.

Although the oil and gas industry is relatively minor compared to other parts of the state, in recent years increased oil and gas exploration activity has occurred in the Plateau Region. Railroad Commission of

Texas files list 263 wells drilled in Edwards County from 1999 through 2008. As a result, increased water demand is projected for the mining category in Edwards County (Table 2-9).

**Table 2-9. Mining Water Demand Projection (Acre Feet per Year)**

| County | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 0 | 24 | 24 | 24 | 24 | 24 |
| Edwards | 89 | 89 | 89 | 89 | 89 | 89 |
| Kerr | 76 | 80 | 100 | 102 | 111 | 120 |
| Kinney | 0 | 0 | 0 | 0 | 0 | 0 |
| Real | 0 | 0 | 0 | 0 | 0 | 0 |
| Val Verde | 190 | 249 | 259 | 223 | 192 | 171 |
| **County Total Demand** | **355** | **418** | **448** | **414** | **392** | **380** |

## 2.3 ENVIRONMENTAL AND RECREATIONAL WATER NEEDS

Environmental and recreational water use in the Plateau Region is not quantified but is recognized as being an important consideration as it relates to the natural community in which the residents of this region share and appreciate. In Chapter 1, environmental and recreational resources are identified and described. In this section, the water resources needed to maintain these functions are discussed. Water-supply sources that serve environmental needs are characterized in Chapter 3 and potential water-supply strategy consequences on the environment are analyzed in Chapter 5.

All living organisms require water. The amount and quality of water required to maintain a viable population, whether it is plant or animal, is highly variable. While some individuals are capable of migrating long distances in search of water (birds, larger mammals, etc.), others are stationary (plants, fishes, etc.) and must rely on existing supplies.

Natural and environmental resources are often overlooked when considering the consequences of prolonged drought conditions. As water supplies diminish during drought periods, the balance between both human and environmental water requirements becomes increasingly competitive. A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future water needs includes a distinct consideration of the impact that each implemented strategy might have on the environment.

As discussed in Section 2.2.5 (Livestock), an expanding use of groundwater in the Region has been to fill and maintain artificial lakes. Although this use may exert stress on the local aquifer system, the resulting impoundments do provide aesthetic value to the property and a water source for wildlife.

Recreational activities that involve human interaction with the outdoors environment are often directly dependent on water resources such as fishing, swimming and boating; while a healthy environment enhances many others, such as hunting, hiking, and bird watching. Thus, it is recognized that the maintenance of the regional environmental community's water-supply needs serves to enhance the lives of citizens of the Plateau Region as well as the multitude of annual visitors to this Region.

In Chapter 5, each water management strategy contains an environmental impact assessment. A review of these strategies reveals that while some strategies may contain variable levels of negative impact, other strategies may likely have a positive effect. Negative environmental impacts are generally associated with the lowering of aquifer water levels due to increased groundwater withdrawals and its potential to cause a reduction or cessation of spring flow. Also of concern is that lowered water levels could deplete supplies in shallow livestock wells, which are often the only available source of water for some wildlife. The positive environmental aspect of the strategies is that during severe drought conditions when normal wildlife water supplies may naturally diminish, new supply sources might be developed such that wildlife could benefit.

3

# CHAPTER 3

# REGIONAL WATER SUPPLY SOURCES

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# 3 REGIONAL WATER SUPPLY SOURCES

From the semi-arid Hill Country to the arid Rio Grande Basin, both groundwater and surface water are critical resources for the livelihood of the citizens of the Plateau Region and the environment in which they reside. Chapter 3 explores the current and future availability of all water supply resources in the Region including surface water, groundwater, reuse, and local supply. The water demand and supply availability analysis developed in Chapters 2 and 3, respectively, form the basis for identifying in Chapter 4 the areas within the Plateau Region that potentially could experience supply shortages in future years.

The City of Kerrville currently uses surface water from the Guadalupe River in conjunction with their groundwater supply. Kerrville also injects excess treated surface water into the Trinity Aquifer through an aquifer storage and recovery (ASR) system. The City of Del Rio obtains their water from San Felipe Springs, which issues from the Edwards limestone. The spring water is treated to drinking water standards in a new microfiltration plant prior to distribution. For planning purposes, San Felipe Springs is recognized as a surface water source that falls within the Rio Grande Run-of-River. Camp Wood in Real County is supplied from Old Faithful Springs on a tributary of the Nueces River. All other communities in the Region are totally dependent on groundwater sources for their supplies.

Water supplies available to meet the demands reported in Chapter 2 are shown in Table 3-1 and Table 3-2. Table 3-1 lists groundwater and surface water availability by county and river basin. Water source availability analyses, including water-quality concerns, are discussed in more detail in Section 3.2 (groundwater) and Section 3.3 (surface water). Table 3-2 lists water supplies available to cities and general water use categories based on the current infrastructure ability of each to obtain water supplies. These abilities primarily include existing infrastructure, water-rights limitations, and Groundwater Conservation District permit limitations. Table 3-3 lists water supplies available to Del Rio wholesale water provider. All water supplies based upon contracts are assumed to be renewed.

**Table 3-1. Water Source Availability (Acre Feet per Year)**

| Groundwater | County | Basin | Salinity | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|---|
| Austin Chalk | Kinney | Rio Grande | Brackish | 4,928 | 4,928 | 4,928 | 4,928 | 4,928 | 4,928 |
| Edwards-BFZ Aquifer | Kinney | Nueces | Fresh | 6,319 | 6,319 | 6,319 | 6,319 | 6,319 | 6,319 |
| Edwards-BFZ Aquifer | Kinney | Rio Grande | Fresh | 2 | 2 | 2 | 2 | 2 | 2 |
| Edwards-Trinity (Plateau) Aquifer | Kerr | Colorado | Fresh | 245 | 245 | 245 | 245 | 245 | 245 |
| Edwards-Trinity (Plateau) Aquifer | Kerr | Guadalupe | Fresh | 1,015 | 1,015 | 1,015 | 1,015 | 1,015 | 1,015 |
| Edwards-Trinity (Plateau) Aquifer | Kerr | Nueces | Fresh | 5 | 5 | 5 | 5 | 5 | 5 |
| Edwards-Trinity (Plateau) Aquifer | Kerr | San Antonio | Fresh | 3 | 3 | 3 | 3 | 3 | 3 |
| Edwards-Trinity (Plateau) Aquifer | Bandera | Guadalupe | Fresh | 21 | 21 | 21 | 21 | 21 | 21 |
| Edwards-Trinity (Plateau) Aquifer | Bandera | Nueces | Fresh | 101 | 101 | 101 | 101 | 101 | 101 |
| Edwards-Trinity (Plateau) Aquifer | Bandera | San Antonio | Fresh | 561 | 561 | 561 | 561 | 561 | 561 |
| Edwards-Trinity (Plateau) Aquifer | Edwards | Colorado | Fresh | 2,306 | 2,306 | 2,306 | 2,306 | 2,306 | 2,306 |
| Edwards-Trinity (Plateau) Aquifer | Edwards | Nueces | Fresh | 1,632 | 1,632 | 1,632 | 1,632 | 1,632 | 1,632 |
| Edwards-Trinity (Plateau) Aquifer | Edwards | Rio Grande | Fresh | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 |
| Edwards-Trinity (Plateau) Aquifer | Kinney | Nueces | Fresh | 12 | 12 | 12 | 12 | 12 | 12 |
| Edwards-Trinity (Plateau) Aquifer | Kinney | Rio Grande | Fresh | 70,326 | 70,326 | 70,326 | 70,326 | 70,326 | 70,326 |
| Edwards-Trinity (Plateau) Aquifer | Real | Colorado | Fresh | 278 | 278 | 278 | 278 | 278 | 278 |
| Edwards-Trinity (Plateau) Aquifer | Real | Guadalupe | Fresh | 3 | 3 | 3 | 3 | 3 | 3 |
| Edwards-Trinity (Plateau) Aquifer | Real | Nueces | Fresh | 7,196 | 7,196 | 7,196 | 7,196 | 7,196 | 7,196 |
| Edwards-Trinity (Plateau) Aquifer | Val Verde | Rio Grande | Fresh | 24,988 | 24,988 | 24,988 | 24,988 | 24,988 | 24,988 |
| Nueces River Alluvium Aquifer | Edwards | Nueces | Fresh | 1,787 | 1,787 | 1,787 | 1,787 | 1,787 | 1,787 |
| Nueces River Alluvium Aquifer | Real | Nueces | Fresh | 1,787 | 1,787 | 1,787 | 1,787 | 1,787 | 1,787 |
| Nueces River Alluvium Aquifer \| Frio River | Real | Nueces | Fresh | 2,145 | 2,145 | 2,145 | 2,145 | 2,145 | 2,145 |
| Trinity Aquifer | Bandera | Guadalupe | Fresh | 76 | 76 | 76 | 76 | 76 | 76 |
| Trinity Aquifer | Bandera | Nueces | Fresh/Brackish | 903 | 903 | 903 | 903 | 903 | 903 |
| Trinity Aquifer | Bandera | San Antonio | Fresh/Brackish | 6,305 | 6,305 | 6,305 | 6,305 | 6,305 | 6,305 |
| Trinity Aquifer | Kerr | Colorado | Fresh | 318 | 318 | 318 | 318 | 318 | 318 |
| Trinity Aquifer | Kerr | Guadalupe | Fresh/Brackish | 14,129 | 14,056 | 13,767 | 13,450 | 13,434 | 13,434 |
| Trinity Aquifer | Kerr | Nueces | Fresh | 0 | 0 | 0 | 0 | 0 | 0 |
| Trinity Aquifer | Kerr | San Antonio | Fresh | 471 | 471 | 471 | 471 | 471 | 471 |
| Trinity Aquifer | Real | Nueces | Fresh | 52 | 52 | 52 | 52 | 52 | 52 |
| **Groundwater Total Source Availability** | | | | **149,614** | **149,541** | **149,252** | **148,935** | **148,919** | **148,919** |

## Table 3-1 (Continued). Water Source Availability (Acre Feet per Year)

| Surface Water | County | Basin | Salinity | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|---|
| Colorado Other Local Supply | Edwards | Colorado | Fresh | 13 | 13 | 13 | 13 | 13 | 13 |
| Colorado Other Local Supply | Kerr | Colorado | Fresh | 46 | 46 | 46 | 46 | 46 | 46 |
| Colorado Other Local Supply | Real | Colorado | Fresh | 3 | 3 | 3 | 3 | 3 | 3 |
| Colorado Run-Of-River | Edwards | Colorado | Fresh | 43 | 43 | 43 | 43 | 43 | 43 |
| Guadalupe Other Local Supply | Kerr | Guadalupe | Fresh | 393 | 393 | 393 | 393 | 393 | 393 |
| Guadalupe Run-Of-River | Bandera | Guadalupe | Fresh | 3 | 3 | 3 | 3 | 3 | 3 |
| Guadalupe Run-Of-River | Kerr | Guadalupe | Fresh | 1,221 | 1,221 | 1,221 | 1,221 | 1,221 | 1,221 |
| Medina Lake/Reservoir | Bandera | San Antonio | Fresh | 0 | 0 | 0 | 0 | 0 | 0 |
| Nueces Livestock Local Supply | Edwards | Nueces | Fresh | 47 | 47 | 47 | 47 | 47 | 47 |
| Nueces Livestock Local Supply | Real | Nueces | Fresh | 50 | 50 | 50 | 50 | 50 | 50 |
| Nueces Other Local Supply | Edwards | Nueces | Fresh | 11 | 11 | 11 | 11 | 11 | 11 |
| Nueces Other Local Supply | Kinney | Nueces | Fresh | 42 | 42 | 42 | 42 | 42 | 42 |
| Nueces Other Local Supply \| Old Faithful Springs | Real | Nueces | Fresh | 0 | 0 | 0 | 0 | 0 | 0 |
| Nueces Run-Of-River | Bandera | Nueces | Fresh | 27 | 27 | 27 | 27 | 27 | 27 |
| Nueces Run-Of-River | Edwards | Nueces | Fresh | 143 | 143 | 143 | 143 | 143 | 143 |
| Nueces Run-Of-River | Real | Nueces | Fresh | 2,162 | 2,162 | 2,162 | 2,162 | 2,162 | 2,162 |
| Rio Grande Livestock Local Supply | Edwards | Rio Grande | Fresh | 47 | 47 | 47 | 47 | 47 | 47 |
| Rio Grande Livestock Local Supply | Val Verde | Rio Grande | Fresh | 27 | 27 | 27 | 27 | 27 | 27 |
| Rio Grande Other Local Supply | Kinney | Rio Grande | Fresh | 42 | 42 | 42 | 42 | 42 | 42 |
| Rio Grande Other Local Supply | Val Verde | Rio Grande | Fresh | 149 | 149 | 149 | 149 | 149 | 149 |
| Rio Grande Run-Of-River | Kinney | Rio Grande | Fresh | 1,103 | 1,103 | 1,103 | 1,103 | 1,103 | 1,103 |
| *Rio Grande Run-Of-River | Val Verde | Rio Grande | Fresh | 13,935 | 13,935 | 13,935 | 13,935 | 13,935 | 13,935 |
| San Antonio Other Local Supply | Bandera | San Antonio | Fresh | 74 | 74 | 74 | 74 | 74 | 74 |
| San Antonio Other Local Supply | Kerr | San Antonio | Fresh | 23 | 23 | 23 | 23 | 23 | 23 |
| San Antonio Run-Of-River \| Medina River Combined | Bandera | San Antonio | Fresh | 0 | 0 | 0 | 0 | 0 | 0 |
| Trinity ASR | Kerr | Guadalupe | Fresh | 390 | 390 | 390 | 390 | 390 | 390 |
| **Surface Water Total Source Availability** | | | | **19,994** | **19,994** | **19,994** | **19,994** | **19,994** | **19,994** |
| **Region J Total Source Availability** | | | | **169,608** | **169,535** | **169,246** | **168,929** | **168,913** | **168,913** |

* San Felipe Springs falls within the Rio Grande Run-of-River

**Table 3-2. Existing Supply (Acre-Feet per Year)**

| | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Bandera County** | | | | | | | |
| **Guadalupe Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 20 | 20 | 20 | 20 | 20 | 20 |
| Livestock | Edwards-Trinity Plateau Aquifer | 1 | 1 | 1 | 1 | 1 | 1 |
| **Guadalupe Basin Total Existing Supply** | | **21** | **21** | **21** | **21** | **21** | **21** |
| **Nueces Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 39 | 39 | 39 | 39 | 39 | 39 |
| County-Other | Nueces Run-of-River | 2 | 2 | 2 | 2 | 2 | 2 |
| County-Other | Trinity Aquifer Fresh/Brackish | 109 | 109 | 109 | 109 | 109 | 109 |
| Livestock | Edwards-Trinity Plateau Aquifer | 24 | 24 | 24 | 24 | 24 | 24 |
| Livestock | Trinity Aquifer Fresh/Brackish | 48 | 48 | 48 | 48 | 48 | 48 |
| Irrigation | Nueces Run-of-River | 25 | 25 | 25 | 25 | 25 | 25 |
| Irrigation | Trinity Aquifer Fresh/Brackish | 461 | 461 | 461 | 461 | 461 | 461 |
| **Nueces Basic Total Existing Supply** | | **708** | **708** | **708** | **708** | **708** | **708** |
| **San Antonio Basin** | | | | | | | |
| Bandera | Trinity Aquifer Fresh/Brackish | 660 | 660 | 660 | 660 | 660 | 660 |
| County-Other | Edwards-Trinity Plateau Aquifer | 411 | 411 | 411 | 411 | 411 | 411 |
| County-Other | San Antonio Run-Of-River | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | Trinity Aquifer Fresh/Brackish | 1,960 | 1,960 | 1,960 | 1,960 | 1,960 | 1,960 |
| Livestock | Edwards-Trinity Plateau Aquifer | 52 | 52 | 52 | 52 | 52 | 52 |
| Livestock | San Antonio Other Local Supply | 74 | 74 | 74 | 74 | 74 | 74 |
| Livestock | Trinity Aquifer Fresh/Brackish | 99 | 99 | 99 | 99 | 99 | 99 |
| Irrigation | San Antonio Run-Of-River | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | Trinity Aquifer Fresh/Brackish | 217 | 217 | 217 | 217 | 217 | 217 |
| **San Antonio Basin Total Existing Supply** | | **3,473** | **3,473** | **3,473** | **3,473** | **3,473** | **3,473** |
| **Bandera County Total Existing Supply** | | **4,202** | **4,202** | **4,202** | **4,202** | **4,202** | **4,202** |
| **Edwards County** | | | | | | | |
| **Colorado Basin** | | | | | | | |
| Rocksprings | Edwards-Trinity Plateau Aquifer | 919 | 919 | 919 | 919 | 919 | 919 |
| County-Other | Edwards-Trinity Plateau Aquifer | 83 | 83 | 83 | 83 | 83 | 83 |
| Mining | Edwards-Trinity Plateau Aquifer | 23 | 23 | 23 | 23 | 23 | 23 |
| Livestock | Colorado Other Local Supply | 5 | 5 | 5 | 5 | 5 | 5 |
| Livestock | Edwards-Trinity Plateau Aquifer | 141 | 141 | 141 | 141 | 141 | 141 |
| Irrigation | Colorado Run-Of-River | 43 | 43 | 43 | 43 | 43 | 43 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 77 | 77 | 77 | 77 | 77 | 77 |
| **Colorado Basin Total Existing Supply** | | **1,291** | **1,291** | **1,291** | **1,291** | **1,291** | **1,291** |
| **Nueces Basin** | | | | | | | |
| Rocksprings | | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | Edwards-Trinity Plateau Aquifer | 223 | 223 | 223 | 223 | 223 | 223 |
| County-Other | Nueces River Alluvium Aquifer | 12 | 12 | 12 | 12 | 12 | 12 |
| Mining | Edwards-Trinity Plateau Aquifer | 32 | 32 | 32 | 32 | 32 | 32 |
| Mining | Nueces Other Local Supply | 11 | 11 | 11 | 11 | 11 | 11 |
| Livestock | Edwards-Trinity Plateau Aquifer | 189 | 189 | 189 | 189 | 189 | 189 |
| Livestock | Nueces Livestock Local Supply | 47 | 47 | 47 | 47 | 47 | 47 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 103 | 103 | 103 | 103 | 103 | 103 |
| Irrigation | Nueces Run-of-River | 143 | 143 | 143 | 143 | 143 | 143 |
| **Nueces Basin Total Existing Supply** | | **760** | **760** | **760** | **760** | **760** | **760** |
| **Rio Grande Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 44 | 44 | 44 | 44 | 44 | 44 |
| Mining | Edwards-Trinity Plateau Aquifer | 23 | 23 | 23 | 23 | 23 | 23 |
| Livestock | Edwards-Trinity Plateau Aquifer | 141 | 141 | 141 | 141 | 141 | 141 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 77 | 77 | 77 | 77 | 77 | 77 |
| **Rio Grande Basin Total Existing Supply** | | **285** | **285** | **285** | **285** | **285** | **285** |
| **Edwards County Total Existing Supply** | | **2,336** | **2,336** | **2,336** | **2,336** | **2,336** | **2,336** |

**Table 3-2 (Continued). Existing Supply (Acre-Feet per Year)**

| | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Kerr County** | | | | | | | |
| **Colorado Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 48 | 48 | 48 | 48 | 48 | 48 |
| Mining | Edwards-Trinity Plateau Aquifer | 2 | 2 | 2 | 2 | 2 | 2 |
| Livestock | Colorado Other Local Supply | 46 | 46 | 46 | 46 | 46 | 46 |
| Livestock | Edwards-Trinity Plateau Aquifer | 43 | 43 | 43 | 43 | 43 | 43 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 44 | 44 | 44 | 44 | 44 | 44 |
| **Colorado Basin Total Existing Supply** | | **183** | **183** | **183** | **183** | **183** | **183** |
| **Guadalupe Basin** | | | | | | | |
| Ingram | Trinity Aquifer Fresh/Brackish | 552 | 552 | 552 | 552 | 552 | 552 |
| Kerrville | Guadalupe Run-Of-River | 150 | 150 | 150 | 150 | 150 | 150 |
| Kerrville | Trinity Aquifer Fresh/Brackish | 885 | 885 | 885 | 885 | 885 | 885 |
| Kerrville | Trinity ASR | 390 | 390 | 390 | 390 | 390 | 390 |
| Loma Vista Water System | Trinity Aquifer Fresh/Brackish | 387 | 387 | 387 | 387 | 387 | 387 |
| County-Other | Edwards-Trinity Plateau Aquifer | 457 | 457 | 457 | 457 | 457 | 457 |
| County-Other | Guadalupe Run-Of-River | 15 | 15 | 15 | 15 | 15 | 15 |
| County-Other | Trinity Aquifer Fresh/Brackish | 4,716 | 4,716 | 4,716 | 4,716 | 4,716 | 4,716 |
| Manufacturing | Guadalupe Run-Of-River | 9 | 9 | 9 | 9 | 9 | 9 |
| Manufacturing | Trinity Aquifer Fresh/Brackish | 25 | 25 | 25 | 25 | 25 | 25 |
| Mining | Edwards-Trinity Plateau Aquifer | 10 | 10 | 10 | 10 | 10 | 10 |
| Mining | Guadalupe Run-Of-River | 89 | 89 | 89 | 89 | 89 | 89 |
| Mining | Trinity Aquifer Fresh/Brackish | 5 | 5 | 5 | 5 | 5 | 5 |
| Livestock | Edwards-Trinity Plateau Aquifer | 133 | 133 | 133 | 133 | 133 | 133 |
| Livestock | Guadalupe Other Local Supply | 393 | 393 | 393 | 393 | 393 | 393 |
| Livestock | Trinity Aquifer Fresh/Brackish | 247 | 247 | 247 | 247 | 247 | 247 |
| Irrigation | Guadalupe Run-Of-River | 958 | 958 | 958 | 958 | 958 | 958 |
| Irrigation | Trinity Aquifer Fresh/Brackish | 402 | 402 | 402 | 402 | 402 | 402 |
| **Guadalupe Basin Total Existing Supply** | | **9,823** | **9,823** | **9,823** | **9,823** | **9,823** | **9,823** |
| **Nueces Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | Edwards-Trinity Plateau Aquifer | 5 | 5 | 5 | 5 | 5 | 5 |
| **Nueces Basin Total Existing Supply** | | **5** | **5** | **5** | **5** | **5** | **5** |
| **San Antonio Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 1 | 1 | 1 | 1 | 1 | 1 |
| County-Other | Trinity Aquifer | 112 | 112 | 112 | 112 | 112 | 112 |
| Livestock | Edwards-Trinity Plateau Aquifer | 1 | 1 | 1 | 1 | 1 | 1 |
| Livestock | San Antonio Other Local Supply | 23 | 23 | 23 | 23 | 23 | 23 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 1 | 1 | 1 | 1 | 1 | 1 |
| **San Antonio Basin Total Existing Supply** | | **138** | **138** | **138** | **138** | **138** | **138** |
| **Kerr County Total Existing Supply** | | **10,149** | **10,149** | **10,149** | **10,149** | **10,149** | **10,149** |
| **Kinney County** | | | | | | | |
| **Nueces Basin** | | | | | | | |
| County-Other | Edwards-BFZ Aquifer | 29 | 29 | 29 | 29 | 29 | 29 |
| County-Other | Edwards-Trinity Plateau Aquifer | 5 | 5 | 5 | 5 | 5 | 5 |
| Livestock | Edwards-BFZ Aquifer | 162 | 162 | 162 | 162 | 162 | 162 |
| Livestock | Edwards-Trinity Plateau Aquifer | 7 | 7 | 7 | 7 | 7 | 7 |
| Livestock | Nueces Other Local Supply | 42 | 42 | 42 | 42 | 42 | 42 |
| Irrigation | Edwards-BFZ Aquifer | 2,694 | 2,694 | 2,694 | 2,694 | 2,694 | 2,694 |
| **Nueces Basin Total Existing Supply** | | **2,939** | **2,939** | **2,939** | **2,939** | **2,939** | **2,939** |
| **Rio Grande Basin** | | | | | | | |
| Brackettville | Edwards-Trinity Plateau Aquifer | 645 | 645 | 645 | 645 | 645 | 645 |
| Brackettville | Rio Grande Run-Of-River | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 3-2 (Continued). Existing Supply**

| | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Rio Grande Basin (Continued)** | | | | | | | |
| Fort Clark Springs MUD | Edwards-Trinity Plateau Aquifer | 1,371 | 1,371 | 1,371 | 1,371 | 1,371 | 1,371 |
| County-Other | Austin Chalk Aquifer Brackish | 125 | 125 | 125 | 125 | 125 | 125 |
| County-Other | Edwards-Trinity Plateau Aquifer | 132 | 132 | 132 | 132 | 132 | 132 |
| Livestock | Austin Chalk Aquifer Brackish | 85 | 85 | 85 | 85 | 85 | 85 |
| Livestock | Edwards-Trinity Plateau Aquifer | 84 | 84 | 84 | 84 | 84 | 84 |
| Livestock | Rio Grande Other Local Supply | 42 | 42 | 42 | 42 | 42 | 42 |
| Irrigation | Austin Chalk Aquifer Brackish | 673 | 673 | 673 | 673 | 673 | 673 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 3,367 | 3,367 | 3,367 | 3,367 | 3,367 | 3,367 |
| Irrigation | Rio Grande Run-Of-River | 1,099 | 1,099 | 1,099 | 1,099 | 1,099 | 1,099 |
| **Rio Grande Basin Total Existing Supply** | | **7,623** | **7,623** | **7,623** | **7,623** | **7,623** | **7,623** |
| **Kinney County Total Existing Supply** | | **10,562** | **10,562** | **10,562** | **10,562** | **10,562** | **10,562** |
| **Real County** | | | | | | | |
| **Colorado Basin** | | | | | | | |
| County-Other | Edwards-Trinity Plateau Aquifer | 15 | 15 | 15 | 15 | 15 | 15 |
| Livestock | Colorado Other Local Supply | 3 | 3 | 3 | 3 | 3 | 3 |
| Livestock | Edwards-Trinity Plateau Aquifer | 52 | 52 | 52 | 52 | 52 | 52 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 50 | 50 | 50 | 50 | 50 | 50 |
| **Colorado Basin Total Existing Supply** | | **120** | **120** | **120** | **120** | **120** | **120** |
| **Nueces Basin** | | | | | | | |
| Camp Wood | Nueces Other Local Supply | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | Edwards-Trinity Plateau Aquifer | 357 | 357 | 357 | 357 | 357 | 357 |
| County-Other | Nueces River Alluvium Aquifer | 736 | 736 | 736 | 736 | 736 | 736 |
| County-Other | Nueces Run-of-River | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | Edwards-Trinity Plateau Aquifer | 156 | 156 | 156 | 156 | 156 | 156 |
| Livestock | Nueces Livestock Local Supply | 50 | 50 | 50 | 50 | 50 | 50 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 153 | 153 | 153 | 153 | 153 | 153 |
| Irrigation | Nueces Run-of-River | 2,162 | 2,162 | 2,162 | 2,162 | 2,162 | 2,162 |
| **Nueces Basin Total Existing Supply** | | **3,614** | **3,614** | **3,614** | **3,614** | **3,614** | **3,614** |
| **Real County Total Existing Supply** | | **3,734** | **3,734** | **3,734** | **3,734** | **3,734** | **3,734** |
| **Val Verde County** | | | | | | | |
| **Rio Grande Basin** | | | | | | | |
| Del Rio | Edwards-Trinity Plateau Aquifer | 15,484 | 15,484 | 15,484 | 15,484 | 15,484 | 15,484 |
| Del Rio | Rio Grande Run-Of-River | 11,416 | 11,416 | 11,416 | 11,416 | 11,416 | 11,416 |
| Laughlin AFB | Edwards-Trinity Plateau Aquifer | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 |
| County-Other | Edwards-Trinity Plateau Aquifer | 4,513 | 4,513 | 4,513 | 4,513 | 4,513 | 4,513 |
| Mining | Edwards-Trinity Plateau Aquifer | 37 | 37 | 37 | 37 | 37 | 37 |
| Mining | Rio Grande Other Local Supply | 149 | 149 | 149 | 149 | 149 | 149 |
| Livestock | Edwards-Trinity Plateau Aquifer | 506 | 506 | 506 | 506 | 506 | 506 |
| Livestock | Rio Grande Livestock Local Supply | 27 | 27 | 27 | 27 | 27 | 27 |
| Irrigation | Edwards-Trinity Plateau Aquifer | 276 | 276 | 276 | 276 | 276 | 276 |
| Irrigation | Rio Grande Run-Of-River | 2,519 | 2,519 | 2,519 | 2,519 | 2,519 | 2,519 |
| **Rio Grande Basin Total Existing Supply** | | **37,226** | **37,226** | **37,226** | **37,226** | **37,226** | **37,226** |
| **Val Verde County Total Existing Supply** | | **37,226** | **37,226** | **37,226** | **37,226** | **37,226** | **37,226** |
| **Region J Total Existing Supply** | | **68,209** | **68,209** | **68,209** | **68,209** | **68,209** | **68,209** |

**Table 3-3. Del Rio Wholesale Water Provider Supply**

| County | Basin | Water User Group | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Val Verde | Rio Grande | City of Del Rio | 26,900 | 26,900 | 26,900 | 26,900 | 26,900 | 26,900 |
| | | Laughlin AFB | 961 | 1,052 | 1,148 | 1,206 | 1,205 | 1,205 |
| | | County Other | 523 | 612 | 700 | 800 | 900 | 997 |
| **Total Wholesale Supply** | | | **28,384** | **28,564** | **28,748** | **28,906** | **29,005** | **29,102** |

# 3.1 GROUNDWATER RESOURCES

The principal aquifers in the Plateau Region are the Trinity, Edwards-Trinity (Plateau), Edwards (Balcones Fault Zone), Austin Chalk, and the Frio and Nueces River Alluviums (Figure 3-1). Aquifer descriptions provided in this chapter are relatively limited; more detailed hydrogeological characterization of the aquifers may be obtained from reports published by the TWDB, USGS, UTBEG, and other agencies and universities. The water quality of aquifers is relatively good and a detailed discussion on water-quality characteristics and issues is provided in Chapter 1, Section 1.4.5.

Two water-source characterization studies were conducted during the previous planning period. The first study (Occurrence of Significant River Alluvium Aquifers in the Plateau Region) identifies and quantifies viable groundwater sources in shallow alluvial aquifers that parallel many of the major streams in the Region. As a result of the study, substantial volumes were estimated for the Frio and Nueces River Alluvium Aquifers in Real and Edwards Counties. These new sources are identified as "other-aquifer" sources in this *Plan.*

The second study (Groundwater Data Acquisition in Edwards, Kinney and Val Verde Counties, Texas) was performed to assist in the further characterization of the Edwards and associated aquifers in the western part of the Plateau Region. The project included four general tasks: (1) review of existing aquifer evaluations, field studies and new well data; (2) performance of dye tracer tests to analyze groundwater flow direction and speed; (3) measurement of water levels in wells during two seasonal periods; and (4) review of recent water quality sampling projects. These two reports can be viewed at (www.ugra.org/waterdevelopment.html).

Over much of the Region, water levels generally fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions. Discharge from the aquifers occurs naturally through springs and artificially by pumping from wells. Some discharge also occurs through leakage from one water-bearing unit to another and through natural down-gradient flow out of the Region.

## 3.1.1 Groundwater Availability

Base flow to the many rivers and streams that flow through the Plateau Region is principally generated from the numerous springs that issue from rock formations that form the major aquifers in the Region. The Plateau Region contains the headwaters of the Guadalupe, San Antonio, Medina, Sabinal, Frio, Nueces, and West Nueces Rivers; and tributaries to the Colorado River and Rio Grande such as the Pecos, Devils, and South Llano Rivers. Flow in these rivers and streams is critical to the Plateau Region in that it provides municipal drinking water, supplies irrigation and livestock needs, maintains environmental habitat, and supports a thriving ecological and recreational tourist economy. Water users downstream of the Plateau Region (Regions K, L, and M) likewise have a stake in maintaining and protecting river flows that originate in the Plateau Region.

It is thus recognized that sustaining flow in these important rivers and streams is highly dependent on maintaining an appropriate water level in the aquifer systems that feed the supporting springs. With the sustainability of local water supplies and the economic welfare of the Region in mind, the PWPG in the previous *2011 Plan* defined groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions.

In so defining groundwater availability, the planning group established a policy decision to protect the long-term water supply and related economic needs of the Plateau Region. The PWPG acknowledges that Groundwater Conservation Districts have regulatory authority over permitted withdrawals from aquifers within their respective boundaries.

Groundwater availability as listed in Table 3-1in this *2016 Plateau Region Water Plan* is based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs) (per Texas Water Code §36.001). The GMA process is explained in more detail in Chapter 1, Section 1.1.5.

Aquifers recognized in this *Plan* that are not included in the GMA-MAG process are termed "non-relevant" and "other aquifer". Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods, which include the following:

- Non-relevant

  Edwards-Trinity (Plateau) Aquifer (Kerr County) – Availability is produced by the TWDB Edwards-Trinity (Plateau) Aquifer Groundwater Availability Model (GAM).

- Other Aquifer

  Nueces and Frio River Alluvium Aquifers (Edwards and Real Counties) and Austin Chalk Aquifer (Kinney County) – Availability estimates are based on drought level recharge over the areal extent of the portion of the aquifer with sufficient saturated thickness to sustain well pumping. The Plateau Region report *Occurrence of Significant River Alluvium Aquifers in the Plateau Region* (see Chapter 1, Section 1.1.1) provides a description of the analyses.

### 3.1.2 Trinity Aquifer

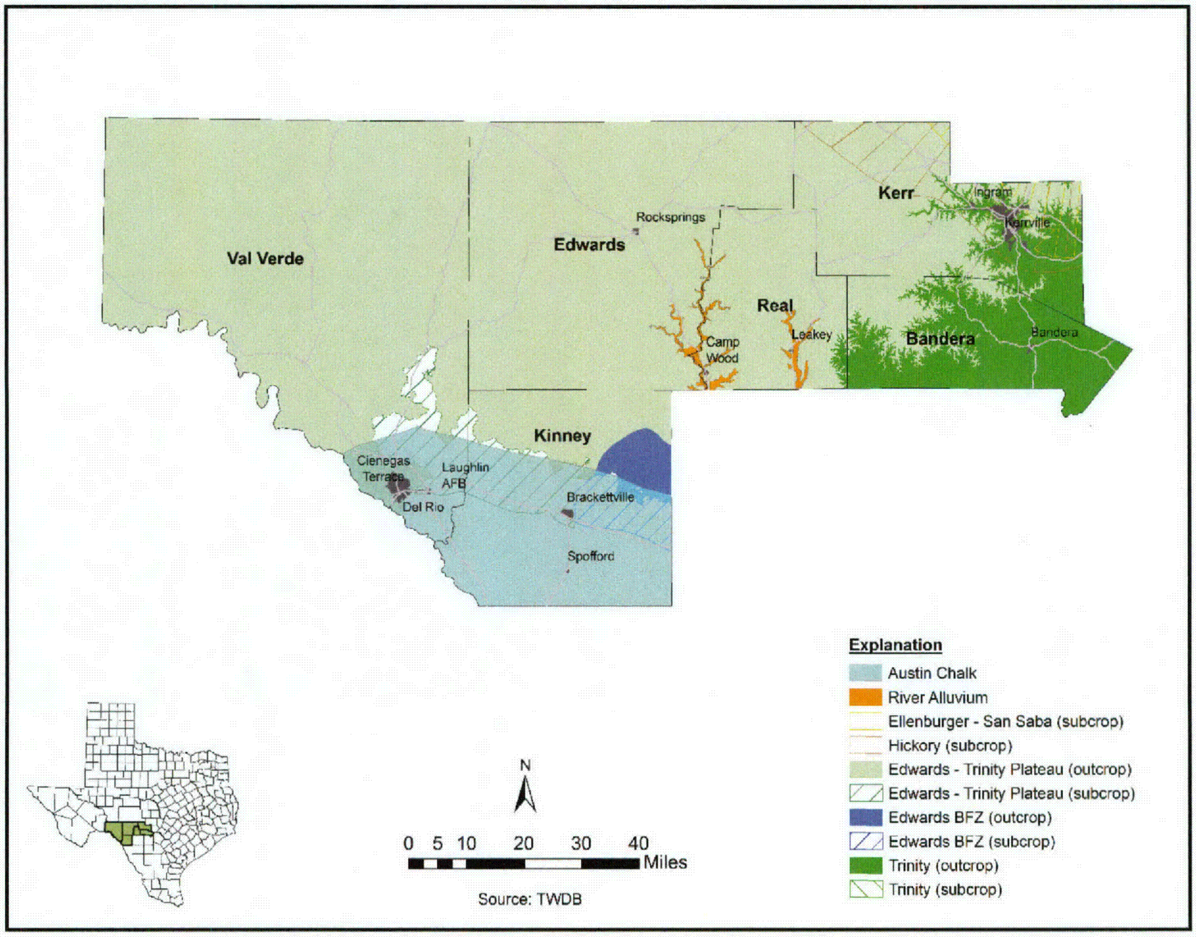
Located mostly in the Hill Country counties of Bandera and Kerr, the Trinity Aquifer system is composed of deposits of sand, clay and limestone of the Glen Rose and Travis Peak formations of the Lower Cretaceous Trinity Group. The water-bearing units include, in descending order, the Glen Rose Limestone, Hensell Sand, Cow Creek Limestone, Sligo Limestone and Hosston Sand (Table 3-4). The Glen Rose formation is divided informally into upper and lower members. Based on their hydrologic relationships, the water-bearing rocks of the Trinity Group, collectively referred to as the Trinity Aquifer system, are organized into the following aquifer units.

**Table 3-4. Water-Bearing Rocks of the Trinity Group**

| Aquifer | Formations |
|---|---|
| Upper Trinity | Upper Glen Rose Limestone |
| Middle Trinity | Lower Member of the Glen Rose Limestone, Hensell Sand and Cow Creek Limestone |
| | Pine Island/Hammet Shale (confining bed) |
| Lower Trinity | Sligo Limestone and Hosston Sand |

Because of fractures, faults and other hydrogeological factors, the Upper, Middle and Lower Trinity Aquifer units often are in hydraulic communication with one another and collectively should be considered a leaky-aquifer system.

**Figure 3-1. Groundwater Sources**



#### 3.1.2.1 Upper and Middle Trinity Aquifer

The upper member of the Glen Rose, when weathered on the land surface, creates the distinctive "stair-step" topography found throughout the hilly train of the Hill Country. The upper Glen Rose, which forms the Upper Trinity Aquifer, often contains water with relatively high concentrations of sulfate. Total dissolved solids (TDS) often exceed 1,000 milligrams per liter (mg/l), especially in wells that penetrate "gyp" (evaporite) beds. Water in evaporite beds has a tendency to be high in sulfate and generally should be sealed off in a well. Radium has been detected in some Trinity wells in Kerr County. Upper Trinity wells are generally shallow and are mostly used for domestic and livestock purposes.

The Middle Trinity aquifer, consisting of lower Glen Rose, Hensell, and Cow Creek formations, generally contains TDS of less than 1,000 mg/l. In the Hill Country region, the primary contribution to poor water-quality occurs in wells that do not adequately case off water from evaporite beds in the upper part of the Glen Rose (Upper Trinity Aquifer). Water levels in Upper and Middle Trinity wells fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions.

#### 3.1.2.2 Lower Trinity Aquifer in Bandera and Kerr Counties

Separating the Middle and Lower Trinity is the Hammett Shale (sometimes referred to as the Pine Island Shale). The approximately 60-foot thick formation acts as a confining bed, or barrier to cross-formational flow in most areas, and thus divides the producing sections of the Middle and Lower Trinity Aquifer units.

The Lower Trinity Aquifer is composed of sandy limestone, sand, clay and shale of the Sligo and Hosston. The Lower Trinity thins toward the northeast and is completely missing or coalesces with upper Trinity units near the Llano Uplift. The Lower Trinity is principally used to provide water supplies for the Cities of Bandera and Kerrville and for a few private water-supply companies and resorts.

Yields from wells completed into the Lower Trinity are generally unpredictable and vary greatly. The greater depth and difficulty of sealing off the Hammett Shale make completing wells into the Lower Trinity more difficult and more expensive. However, in some areas, the Lower Trinity has higher yields and better water quality than shallower aquifers. Recharge to the Lower Trinity in Bandera and Kerr Counties likely occurs primarily by lateral underflow from the north and west. The overlying Hammett Shale mostly prevents vertical movement of water downward except possibly in highly fractured or faulted areas.

### 3.1.3 Edwards-Trinity (Plateau) Aquifer

The Edwards-Trinity (Plateau) Aquifer consists of lower Cretaceous age saturated limestone and dolomite of the Edwards Group and underlying sediments of the Trinity Group where they occur underlying the Edwards Plateau. The upper Edwards portion of the aquifer system is generally more porous and permeable than the underlying Trinity, and where exposed at the land surface, the Edwards-Trinity (Glen Rose) interface gives rise to numerous springs that form the headwaters of several eastward and southerly flowing rivers.

In Kinney and Val Verde Counties, the Edwards aquifer consists of the Devils River Limestone or the Salmon Peak, McKnight and West Nueces Limestone. Aquifer thickness is as much as 1,000 feet. All known water wells produce water from the Salmon Peak and McKnight formations. San Felipe Springs in Val Verde County issues from the Edwards and is the primary municipal supply source for Del Rio.

Recharge to the aquifer occurs primarily by the downward percolation of surface water from streams draining off the Edwards Plateau to the north and west and by direct infiltration of precipitation on the outcrop. Some water enters the Region in the aquifer as underflow from counties up gradient (generally north).

The Glen Rose Limestone is the primary unit in the Trinity in the southern part of the Plateau. The aquifer generally exists under water-table conditions; however, where the Glen Rose is fully saturated and a zone of low permeability occurs near the base of the overlying Edwards, artesian conditions exist.

Reported well yields commonly range from less than 50 gallons per minute (gpm) where saturated thickness is thin to more than 1,000 gpm where large-capacity wells are completed in jointed and cavernous limestone. There are little pumping withdrawals from the aquifer over most of its extent, and water levels have generally fluctuated only with seasonal precipitation. In some instances, water levels have declined as a result of increased pumping. Del Rio, Brackettville, Fort Clark, and Rocksprings have municipal wells that produce from this aquifer.

### 3.1.4 Edwards (BFZ) Aquifer

In the Plateau Region, the Edwards-Balcones Fault Zone (BFZ) Aquifer is designated only in eastern Kinney County at its westernmost extent. The Edwards portion of the Edwards-Trinity (Plateau) Aquifer and the Edwards of the Edwards (BFZ) Aquifer are the same geologic formation and their boundary is arbitrarily established by the TWDB. There is no significant hydrologic boundary between the outcrops of these two aquifer systems, thus groundwater in the Edwards-Trinity freely moves down gradient into the Edwards (BFZ).

The Edwards (BFZ) Aquifer exists under water-table conditions in the outcrop and under artesian conditions where it is confined below the overlying Del Rio Clay in its downdip extent. Water in the aquifer generally moves from the recharge zone toward natural discharge points such as Las Moras Springs at Brackettville. Additional water is lost from the Kinney County area as underflow that leaves the County to the east into Uvalde County (Region L). Very little pumping has occurred from this aquifer in Kinney County, and therefore water levels have remained relatively constant with only minor changes over time.

### 3.1.5 Austin Chalk Aquifer

The Austin Chalk is located in the southern half of Kinney County and the southernmost part of Val Verde County. Many wells located south of Highway 90 obtain part or all of their water from the Austin Chalk. A veneer of gravel deposits covers much of the southwest portion of Kinney County; some wells penetrate both these gravels and the underlying Austin Chalk. Source of water in the Austin Chalk is from precipitation recharge and stream loss over the outcrop areas and probably from Edwards Aquifer underflow through faults located up-gradient.

A wide range of production rates exists for wells completed in the Austin Chalk. The best production from the aquifer occurs in areas that have been fractured or contain a number of solution openings. Most wells only discharge enough water for domestic or livestock use, but a few wells are large enough for irrigation purposes. The largest reported yield for an Austin Chalk well in Kinney County is 2,000 gpm (Bennett and Sayre, 1962). Most of the more productive wells completed in the Austin Chalk are located along Las Moras Creek. Much less production is apparent in the Nueces River Basin in the eastern part of the county.

### 3.1.6 Frio River Alluvium Aquifer

The Frio River Alluvium in central Real County extends over an area of approximately 9,530 acres. Recharge to the aquifer is from stream loss and direct infiltration of precipitation. Water supplies for the City of Leakey and other rural domestic homes are derived from this small aquifer. Because of the limited extent of this aquifer and its shallow water table, the aquifer system is readily susceptible to diminished supplies during drought conditions and potentially from over pumping. Also due to its shallow nature, the aquifer is susceptible to contamination from surface sources.

### 3.1.7 Nueces River Alluvium Aquifer

The Nueces River Alluvium between Edwards and Real Counties extends over an area of approximately 24,450 acres. Recharge to the aquifer is from stream loss and direct infiltration of precipitation. Water supplies for the Community of Barksdale and rural domestic homes are derived from this small aquifer. As with the Frio Alluvium, the Nueces River Alluvium Aquifer is readily susceptible to diminished supplies during drought conditions and potentially from over pumping, and to contamination from surface sources.

### 3.1.8 Other Aquifers

Located along many of the streams and rivers are shallow alluvial floodplains composed of sediments ranging from clay and silt to sand, gravel, cobbles and boulders. Wells completed in these deposits supply small to moderate quantities of water mostly for domestic and livestock purposes. However, because these wells are relatively shallow, many are prone to going dry during drought conditions. The alluvium is often in direct hydraulic connection with the rivers and streams that meander through them.

In addition, the TWDB has identified the downdip extents of the Ellenburger-San Saba and the Hickory Aquifers in northeast Kerr County. Because no known wells have penetrated these aquifers in Kerr County, very little is known about their water-bearing characteristics. These aquifers are mentioned as possible resources but are not currently included in the supply analysis for this *Plan.* There is strong interest in Kerr County to explore the potential for developing a new water supply from the Ellenburger.

### 3.1.9 Public Supply Use of Groundwater

All communities in the Plateau Region rely partially or completely on groundwater supply sources. Even the spring sources used by Del Rio and Camp Wood originate from aquifers. The higher concentration of wells in Kerr and Bandera Counties related to population growth may present water supply availability problems in the future. Public supply wells serving communities in Edwards, Kinney, Real and Val Verde Counties are not anticipated to have long-term declines due to the relatively smaller quantities of water that are needed to serve these communities. Also, no long-term water-quality deterioration has been detected in groundwater supplies for these communities. Long-term viability of the aquifers serving these other communities appears to be acceptable. However, new wells should be located outside the local areas of pumping influence of the existing wells. Although no evidence of contamination from surface sources have been detected in public-supply groundwater sources in the Plateau Region, a wellhead protection program should be considered by all communities.

#### 3.1.9.1 City of Bandera

The City of Bandera is dependent on wells completed into the Lower Trinity Aquifer and must compete for this water with numerous private wells in the county. Long-term viability of the Trinity Aquifer as a supply source for Bandera and outlying areas will require implementation of management policies aimed at establishing withdrawals based on the sustainable yield of the aquifer.

City of Bandera Well No. 69-24-202 shows a consistent decline from the 1950s through the 1990s, with a total of approximately 400 feet of water level decline. Most of the water withdrawn by Bandera public supply wells is produced from the Lower Trinity (Hosston) which receives very little vertical recharge and an undetermined amount of lateral underflow from the north and west of the well fields. Because of the continuous water-level decline in these well fields, the City should monitor levels to anticipate production reductions.

#### 3.1.9.2 City of Kerrville

The City of Kerrville is dependent on conjunctive use of surface water from the Guadalupe River and groundwater from Lower Trinity Aquifer wells. Kerrville Wells No. 4 and No. 11 experienced declines of as much as 200 feet through the early to mid-1980s. Between the early to mid-1980s and the early 1990s, water levels in these two wells increased by as much as 200 feet in response to the decreased pumpage by the City when surface water sources were brought on-line. Since 1998, water levels have remained relatively constant.

The only long-term water-quality degradation trend observed in Kerrville public-supply wells is noted in the increase in sodium, chloride and total dissolved solids in the City's Travis Well No. 14 during the late 1960s to mid-1970s. The well showed steady increases in sodium (18 to 72 mg/l), chloride (55 to 200 mg/l), and total dissolved solids (417 to 624 mg/l) between 1968 and 1976. This corresponded with the time period that large drawdowns in water levels were occurring in the Kerrville area. Today, the City mixes water from Well No. 14 with water from all other sources to maintain acceptable overall quality.

The City of Kerrville operates an aquifer storage and recovery (ASR) operation where treated surface water is injected into the Lower Trinity Aquifer to maintain aquifer pressure and provide a source for peak demand periods.

Specific strategies to meet Kerrville's future water needs are addressed in Chapter 5. If additional wells are needed for increasing supply needs, the City should consider locating new wells outside the local area of pumping influence. The City should also cooperate with efforts of the local Groundwater Conservation Districts to establish aquifer management policies.

#### 3.1.9.3 City of Ingram

Ingram Water Supply Inc. provides water to the City of Ingram from wells completed in the Middle and Lower Trinity Aquifers. The supply source appears to be sufficient to meet future needs. However, these wells are completed in the same aquifer as many other wells in the area and thus may be somewhat impacted in the future.

### 3.1.9.4 City of Rocksprings

The City of Rocksprings obtains its water supply from wells completed in the Edwards Limestone of the Edwards-Trinity (Plateau) Aquifer. This rural community has little competition for groundwater and, thus, its supply is considered dependable. A new well has been drilled and is currently being connected to the City distribution system.

### 3.1.9.5 City of Brackettville and Fort Clark Springs MUD

Water wells completed in the Edwards portion of the Edwards-Trinity (Plateau) Aquifer produce water used for municipal supply in these two adjacent communities. Las Moras Springs, an identified major spring, also exists at the same location of the Fort Clark Springs wells. Under existing conditions, there appears to be sufficient supply to meet futures needs. The Kinney County Groundwater Conservation District is currently evaluating potential impacts that might result from increased future pumping within the District.

### 3.1.9.6 City of Camp Wood

Camp Wood located in southwestern Real County derives its water supply from Old Faithful Springs. The spring has reportedly always flowed. However, with increasing population and the drilling of additional wells in the area, the spring may experience decreasing flow during drought periods in the future.

### 3.1.9.7 City of Leakey

The City of Leakey obtains its water supply from four shallow wells ranging in depth from 34 to 42 feet in the Frio River Alluvium Aquifer. An additional well has recently been constructed and an application for an operation permit is being filed with the Real-Edwards Conservation and Reclamation District. The City must compete for groundwater from this small aquifer with numerous private domestic wells. Trinity Aquifer wells in the local area have proven to be unreliable and often contain poor-quality groundwater.

### 3.1.9.8 City of Del Rio

The City of Del Rio is supplied with water from San Felipe Springs, which issue from the Edwards portion of the Edwards-Trinity (Plateau) Aquifer. The water is collected through pumps set in the springs, treated with microfiltration and chlorine and then distributed to the City, Laughlin Air Force Base, and outlying neighborhoods.

The average discharge of San Felipe Springs since Lake Amistad was filled is about 110 cubic feet per second or about 80,000 acre-feet/yr. During recent droughts, the spring discharge has fallen below 50 cfs or, extrapolated over one year, about 36,000 acre-feet. Recent droughts as compared to the 1950s drought would be appropriate to use as a drought-condition gage because the filling of Amistad Lake has generally increased the springflow after the late 1960s. A minimum flow has not been determined for the threatened species living downstream of the springs and a study is needed to determine the actual amount that would have to be subtracted from the total spring flow to meet these environmental needs.

## 3.1.10 Agricultural Use of Groundwater

Because of the arid conditions and lack of well-developed soils over much of the Region, irrigated agricultural activities are generally limited in most of the counties. Low well yields common throughout much of the Region also limit the development of large-scale irrigation. Water quality, however, is not generally a limiting factor for irrigation in the Region. Kinney County has the greatest amount of agricultural use of water. The acreage of land irrigated by groundwater in the year 2000 in each county as reported in TWDB Report 347 is, from most to least, Kinney, 4,865 acres; Bandera, 173 acres; Val Verde, 145 acres; Kerr, 57 acres; Edwards, 40 acres; and Real, 15 acres. The PWPG is concerned about the accuracy of the irrigation surveys and believes that there is significantly more irrigation water use than is documented. For example, the Headwaters Groundwater Conservation District in Kerr County documents approximately 700 acres being irrigated just with groundwater.

A review of historical and current data suggests that there has been no long-term change in regional water levels or water quality as a result of agricultural pumping. Local water-level declines occur during the irrigation season but generally recover during the off- season. Although irrigation conservation efficiencies could be improved, currently used equipment and practices are not resulting in depletion of the aquifers. At the current rate of agricultural use, groundwater of sufficient quantity in the Edwards-Trinity (Plateau), Edwards (BFZ), and Austin Chalk Aquifers should remain available for future agricultural use. However, the competition for Trinity Aquifer water between municipal and agricultural needs in Bandera and Kerr Counties is increasing. The Bandera County River Authority and Groundwater District and the Headwaters Groundwater Conservation District are both actively involved in managing the use of groundwater in these counties.

### 3.1.11 Brackish Groundwater Desalination Sources

As expressed in Chapter 1, Section 1.4.5, most groundwater in the Plateau Region contains total dissolved-solids (TDS) concentrations of less than 1,000 mg/l and thus meets drinking water standards. Groundwater of slightly poorer quality (1,000 to 3,000 mg/l) occurs in the Trinity Aquifer in some areas. Elevated levels of calcium-sulfate resulting from the dissolution of evaporate beds in the upper Glen Rose is the primary source of higher TDS groundwater. Productivity from this aquifer source makes desalination a marginal option at this time.

## 3.2 SURFACE WATER SUPPLIES

The Plateau Region is unique within all planning regions in that it straddles several different river basins rather than generally following a single river basin or a large part of a single river basin (Figure 3-2). From west to east, these basins include the Rio Grande, Nueces, Colorado, San Antonio, and Guadalupe. The headwaters of three of these river basins (Nueces, San Antonio, and Guadalupe), as well as major tributaries of the Rio Grande and Colorado River, originate in this Region.

Available surface water supplies under drought-of-record conditions depend on two components: water that is physically present (usually substantially reduced during a drought-of-record since by definition it is the most severe) and the authorized amount per existing water right adjudications. The Texas Commission on Environmental Quality (TCEQ) Water Availability Models (WAMs) perform a simulation of availability and diversion for all water rights in a river basin based on naturalized flows over a specified hydrologic period. These models generally follow an appropriation of water in priority date order, but appropriation order from upstream to downstream may be simulated. The TCEQ WAMs of the five river basins were used to determine surface water availability during a drought-of-record. The simulations used to determine water availability assume that all water rights in each basin are allowed to divert the full authorized amount when water is available, following appropriation in priority date order. They also assume that no return flows are present. Municipal run-of-river calculations use the unmodified TCEQ WAM Run 3 to insure that all monthly demands are fully met. Area-capacity of major reservoirs was adjusted to reflect sedimentation conditions for 2000 and 2060. Drought-of-record supply source amounts by county and river basin are provided in Table 3-1. Water Source Availability (Acre Feet per Year). A list of all authorized surface water rights in the Region is available in Appendix 3A.

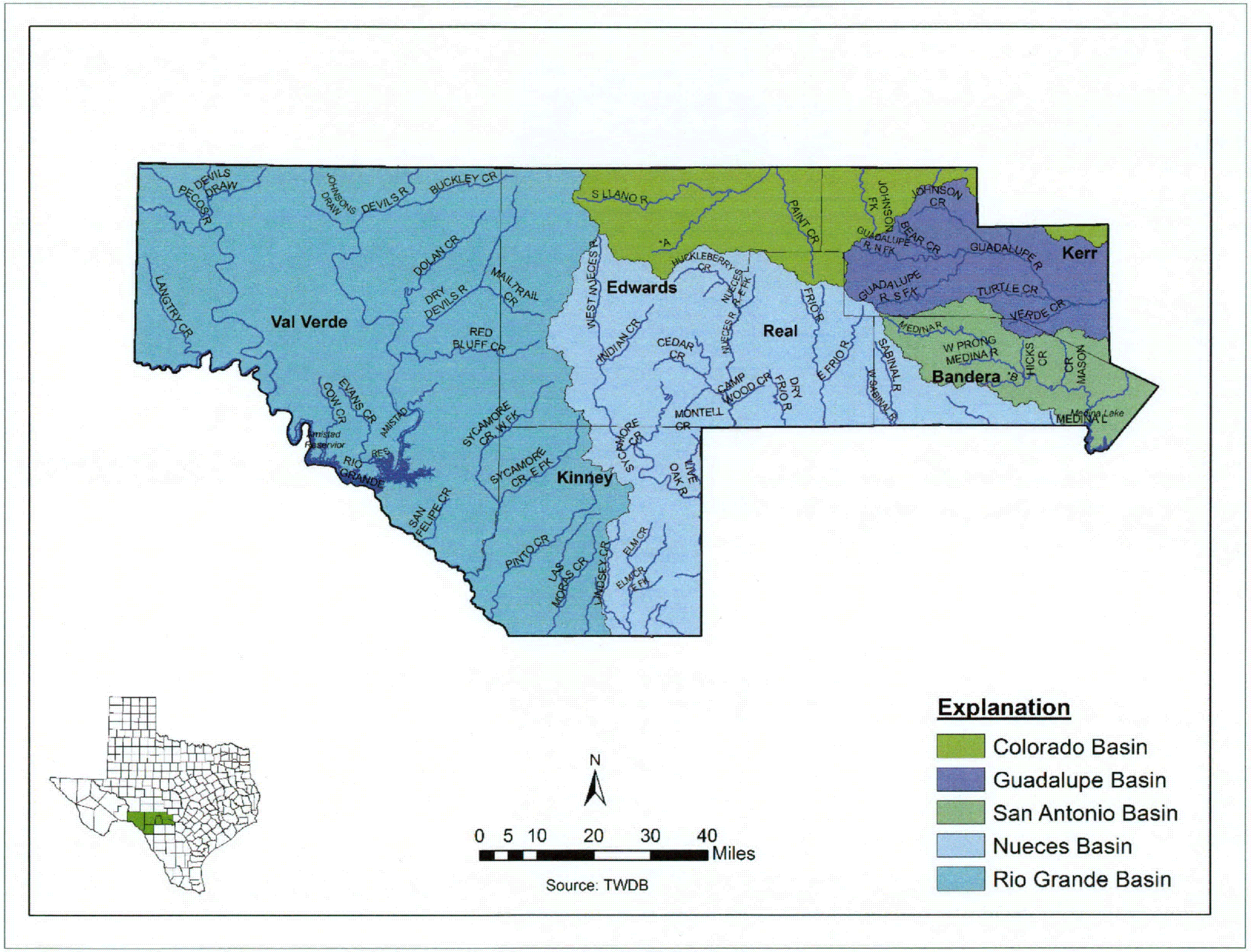



**Figure 3-2. Surface Water Sources**

The term "run-of-the-river" is used to distinguish water rights with diversion points directly on a watercourse from water rights with diversion points on a reservoir. Generally, run-of-the-river water rights, also referred to as "direct diversions", are less dependable than water rights on reservoirs because of the lack of storage. However, run-of-the-river diversions are often very convenient, especially for irrigators and small entities, because a diversion point on a watercourse can be located extremely close to the location where the water will actually be consumed, thereby negating the need to pipe the water over long distances.

Diversions under a drought-of-record are extracted from results of a WAM simulation for each basin. For purposes of this *Plan*, a drought-of-record supply for run-of-the-river diversions is categorized by use (municipal, irrigation, industrial and other) and by county. Supply amounts on river segments have always been difficult to assess due to the lack of storage to catch excess flows. In this *Plan*, the reliable supply for run-of-the-river diversions is expressed as the minimum annual diversion for each category during the hydrologic period considered in the water availability models.

Drought-of-record supply amounts for reservoirs are on a firm-yield basis. To understand firm yield, one must understand the concept of "mass balance" - the simple but true principle of physics that mass can neither be created nor be destroyed (i.e., what goes in has to come out). In practical terms as applied to a reservoir, the water going in (inflows from drainage areas of tributaries feeding the reservoir site) equals the water going out (evaporation off the lake surface plus water spilled over the dam plus any water allowed to pass through the dam to satisfy senior water rights downstream plus the demand placed on the reservoir plus other factors which may exist). Engineers and hydrologists simulate the operation of a reservoir under various demands placed on the reservoir, iterating the simulation to find a demand that the reservoir can supply consistently throughout a repeat of the historical hydrologic regime. Demand is termed the "firm yield" of the reservoir if for every year of the historical hydrologic regime (even during a drought-of-record) the reservoir can supply the demand placed on it.

Canyon Reservoir and the Medina/Diversion system are potential water supply reservoirs for the Plateau Region's future water needs. Although neither reservoir currently serves a water need within the Region, both reservoirs could likely do so in the future. Although recreational use of streams and lakes serves an important function in the Plateau Region, its use has no impact on reservoir yields, as these uses are non-consumptive.

### 3.2.1 Rio Grande Basin (Including the Pecos and Devils River)

The Rio Grande, or Rio Bravo as it is known in Mexico, forms the border between the United States and Mexico. International treaties govern the ownership and distribution of the water in this river. Under The 1906 Treaty, the United States is obligated to deliver 60,000 acre-feet annually from the Rio Grande to Mexico, except in the cases of severe drought or serious accident to the irrigation system in the United States. The 1944 Treaty addresses the waters in the international segment of the Rio Grande from Fort Quitman, Texas to the Gulf of Mexico. The United States receives 1/3 of the flow from six tributaries (Rio Conchos, San Diego, San Rodrigo, Escondido, Salado Rivers, and Las Vacas Arroyo), provided that the running average over a five-year period cannot be less than 350,000 acre-feet/yr.

While the International Boundary and Water Commission is responsible for implementing the allocation of water on the U.S. side, the Watermaster office of TCEQ administers the allocation of Texas' share of the international waters. The two reservoirs located in the middle of the lower Rio Grande, the Amistad and Falcon, store the water regulated by the Watermaster. The Watermaster oversees Texas' share of water in the Rio Grande and its Texas tributaries from Fort Quitman to Amistad Dam, excluding drainage basins of the Pecos River and Devils River.

The Pecos River forms a portion of the boundary between Terrell County in the Far West Texas Region and Crockett County in Region F before reaching Langtry in Val Verde County in the Plateau Region. The Devils River originates in Sutton County and proceeds generally southward through Val Verde County before reaching Amistad International Reservoir. There are no surface-water rights on the Pecos and Devils Rivers within the Plateau Region.

Flow of the Pecos River within the Plateau Region is inconsistent, with livestock and wildlife watering apparently being the only use made of whatever water that may remain in the River. Independence Creek, a large spring-fed creek in northern Terrell County west of Val Verde County, is the most important of the few remaining freshwater tributaries to the lower Pecos River. Independence Creek's contribution increases the Pecos River water volume by 42 percent at the confluence and reduces the total suspended solids by 50 percent, thus improving both water quantity and quality (Nature Conservancy of Texas descriptive flier).

Flows of the Devils River are gaged at the Pafford Crossing near Comstock in Val Verde County. This gage (USGS 08449400) began recording in 1978 and was discontinued in 1985. Therefore, it does not record flows for the 1950s. However, from 1978 through 1985 the flows are consistently between approximately 100 and 300 cfs, with rare spikes ranging from 4,000 cfs up to 50,000 cfs. These spikes result from unusually intense but short rainfall events. In absence of data for the 1950s drought period, and considering the generally low and undependable flows within the Devils River, a realistic estimate of the drought-of-record amount of supply from the Devils River within the Plateau Region is zero.

### 3.2.2 Amistad International Reservoir on the Rio Grande

The Amistad International Reservoir is located on the border between the United States and Mexico near the City of Del Rio, and was constructed jointly by the two nations. It was completed in 1968 with a maximum capacity of 5,250,000 acre-feet, 3,505,000 acre-feet of which are used for water conservation. The water is distributed among downstream users of Mexico and the United States. Amistad is not a source of supply for the Plateau Region, as the City of Del Rio and downstream irrigators in Val Verde County obtain their supply primarily from San Felipe Springs and Creek. Thus the constraints on Amistad Reservoir as a source of water supply for the Plateau Region are the existing water rights held by water rights holders and enforced by the Rio Grande Watermaster.

Goodenough Spring is inundated by Lake Amistad and was at one time considered the third largest spring in Texas. The spring, which discharges from the Edwards-Trinity (Plateau) Aquifer, still provides a significant flow contribution to the Rio Grande.

### 3.2.3 The Nueces River Basin

The upper Nueces River Basin lies in Edwards, Real, Bandera, and Kinney Counties, with the main stem Nueces forming a portion of the border between Real County and Edwards County. Headwater tributaries of the Nueces River located in the Plateau Region include the Sabinal River and Hondo Creek in Bandera County, the West Nueces River in Edwards and Kinney Counties, and the Frio, East Frio, and Dry Frio

Rivers in Real County. Although undocumented, there appears to be a significant amount of underflow occurring through gravel beds that line long stretches of the river bottom.

Total authorized diversions by water rights on the Nueces River within the Plateau Region are 11,419 acre-feet/year. Most of this amount (10,116 acre-feet/year or 88 percent) is for irrigation use. Diversions for municipal use total 1,259 acre-feet/year. The City of Camp Wood holds the largest municipal right for 1,000 acre-feet/year. Small water rights for other uses have a total authorized diversion of 44 acre-feet/year.

The drought-of-record for the Nueces River Basin appears to have occurred not in the 1950s, but in 1996. USGS gages on the Sabinal River, Hondo Creek and West Nueces River seem to substantiate this assertion; flows at these gages during 1996 were significantly reduced from expected historical flows. The locations of gages USGS 08198500 (Sabinal River at Sabinal in eastern Uvalde County) and USGS 08200700 (Hondo Creek at King Waterhole near Hondo in central Medina County) are outside the Plateau Region, but the gages themselves measure flows from drainage areas lying within counties of the Plateau Region. The location of USGS gage 08190500 on the West Nueces River is near Brackettville in Kinney County.

An internal TWDB memorandum dated May 26, 1998 cites the Sabinal and Hondo gages as having experienced streamflows in calendar years 1994 through 1996 significantly reduced from expected historical flows, and cites the West Nueces gage as having experienced streamflow in calendar years 1994 and 1995 significantly reduced from expected historical flows. The memorandum defines "significantly reduced" as showing a 40 percent or more difference between the historical and the recent year non-exceedance probabilities. (It should be noted that for all three of these gages, 1997 flows were higher than the 1994 through 1996 flows.)

Flows for the main stem Nueces River are gaged at USGS 08192000 near Uvalde in Uvalde County. These gaged flows for a period of record of 1939 through 1997 indicate a low annual flow of 3.63 cfs (approximately 2,650 acre-feet/year), occurring in 1956. Flows for the Frio River are gaged at USGS 08195000 at Concan in Uvalde County. These gaged flows for a period of record of 1930 through 1997 indicate a low annual flow of 8.8 cfs (approximately 6,424 acre-feet/year), occurring in 1956. For these areas, the 1950s drought was evidently the drought-of-record.

The TCEQ Water Availability Model for the Nueces River Basin was used to evaluate surface water supplies. The model includes data through the year 1996, and therefore addresses the drought-of-record occurring in 1996 for the localized areas on the Sabinal River and Hondo Creek.

### 3.2.4 Colorado River Basin

The headwaters of the South Llano River, a tributary of the Colorado River, lie in Edwards County. There are three water rights on the South Llano River and Paint Creek within the Plateau Region for irrigation use. The combined authorized amount of these rights is 180 acre-feet/year.

The TCEQ Colorado River Basin WAM was used to evaluate the supply for these rights. This model covers the period 1940-1998. Hydrologic data for these streams suggest that the drought-of-record occurred during the 1950s. The minimum annual diversion for the three rights is 43 acre-ft/yr.

### 3.2.5 San Antonio River Basin

Headwaters of the San Antonio River lie in Bandera County. Most water right authorizations from the San Antonio Basin are run-of-the-river diversions for irrigation use. Run-of-the-river diversions exclude authorizations on Medina Lake. Eight authorized water rights on the Medina River main stem total 236 acre-feet/year. Of these eight water right holders on the River, six use the water for irrigation. The sum of these six irrigation rights totals 227 acre-feet/year. Of the remaining two water right holders, one is for 9 acre-feet of water per year used by an individual for municipal purposes, and the other is for a non-consumptive recreation reservoir owned by the City of Bandera. This recreation-only reservoir is for non-consumptive use only.

Since the Guadalupe-San Antonio WAM covers the period 1934-1989, it is appropriate to consider if the drought of 1996 exceeded the severity of the drought of the mid-1950s. USGS gage 08178880 on the Medina River at Bandera just downstream of State Highway 173 gives a lowest annual streamflow amount at 33.7 cubic feet per second (cfs) (approximately 24,600 acre-feet/year) in 1996. However, this gage did not begin recording until 1982, and therefore records from the 1950s drought are missing and cannot be compared directly to the low flows of 1996. Data for the 1950s at the Bandera gage as extracted from the Guadalupe-San Antonio River Basin WAM gives an annual naturalized flow of 10,500 acre-feet in 1956. Regulated flows would be even lower once upstream diversions and impoundments are accounted for. Therefore, based on estimates of the Guadalupe-San Antonio Basins WAM, the drought of the 1950s represents the drought-of-record conditions for the San Antonio Basin in the Plateau Region.

### 3.2.6 Medina Lake on the Medina River

Medina Lake was constructed in 1911 to provide irrigation water for farmers to the southwest of San Antonio. Although commonly referred to as Medina Lake, the lake is actually a system consisting of Medina Lake and Diversion Lake. Impounded in 1913,

Diversion Lake is approximately 4 miles downstream of Medina Lake.

Diversions from the dual-lake system are authorized only from Diversion Lake, as per the water right held by Bexar-Medina-Atascosa Water Control and Improvement District #1 (BMAWCID#1). BMAWCID#1's Adjudication Certificate No. 19-2130C authorizes the District to divert up to 65,830 acre-feet/year of water for irrigation, municipal and industrial use, up to 750 acre-feet/year specifically for domestic and livestock purposes, and up to 170 acre-feet/year specifically for municipal use.

BMAWCID#1 has signed contracts to supply several irrigators and a development corporation with water. In January 2000, BMAWCID#1 signed a contract with Bexar Metropolitan Water Authority indicating that BMAWCID#1 will sell 20,000 acre-feet/year to the Authority for municipal use.

Bandera County currently has a Water Supply Agreement with BMAWCID#1 for purchase of up to 5,000 acre-feet/year; however, this agreement is not currently associated with the infrastructure necessary to carry out the purchase and subsequent distribution of the water. Alternate Strategy J-3 discussed in Chapter 5 describes the potential use of this source.

Loss of impounded water from Medina Lake to the Trinity Aquifer and Diversion Lake to the Edwards Aquifer reduces the firm yield of the system. This loss has long been known to be substantial. Quantification of water recharging the aquifers has been elusive, as different estimates of recharge have resulted in different firm-yield estimates for the system. In 1957, a Bureau of Reclamation study estimated the firm annual yield of the Medina Lake/Diversion Lake system to be 27,500 acre-feet/year if the lake system were operated under an agricultural (irrigation) demand only scenario, but it estimated 29,700 acre-feet/year as the firm yield for municipal and industrial demand. Due to effects of seepage around the dam and of recharge to the underlying aquifers, Espey Huston estimated a firm yield of zero for Medina Lake in 1994, based on the relationship they found between the Lake stage and recharge. HDR Engineering modified the Espey Huston stage-recharge curves for its Trans-Texas report and cited 8,770 acre-feet/year as the firm yield. According to personal communication, HDR assumed diversions would be from Medina Lake rather than from Diversion Lake and that all irrigation use would be curtailed. This assumption does not comply with existing conditions as regards to water right authorizations.

The latest USGS report, "Assessment of Hydrogeology, Hydrologic Budget, and Water Chemistry of the Medina Lake Area, Medina and Bandera Counties, Texas," maintains that earlier methods of estimating recharge (Lowry, Espey Huston curves as modified by HDR for the Trans-Texas report) overestimate recharge. Overestimation of recharge would result in an underestimation of firm yield; however, the USGS report did not include a firm-yield estimate for the reservoir system.

The TCEQ Guadalupe-San Antonio River Basins WAM incorporates the HDR Trans-Texas method of estimating recharge and probably provides the best overall data (water rights, inflows determined by water rights) available at this time. The model was used to determine a firm yield of the Medina/Diversion system of zero acre-feet/year.

### 3.2.7 Guadalupe River Basin

Within the Plateau Region, the Guadalupe River Basin occurs almost exclusively within Kerr County. The Basin drains approximately 510 square miles at Kerrville, and approximately 839 square miles at Comfort near the eastern county line. The River originates almost entirely within western Kerr County as three branches (Johnson Creek, North Fork, and South Fork) merge west of Kerrville to form the main river course. A study report titled Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County (2005) was prepared for the PWPG (www.ugra.org/waterdevelopment.html).

The total amount of authorized water rights for the Guadalupe River within the Plateau Region is 21,020 acre-feet/year. Municipal use accounts for the highest authorization at 8,076 acre-feet/year. Holders of these water rights include the City of Kerrville, the Upper Guadalupe River Authority (UGRA), and independent persons.

The City of Kerrville and the UGRA own the largest municipal water rights. Certificate of Adjudication 1996 and Permit 3505 are held solely by Kerrville. UGRA and Kerrville hold Permit 5394 jointly. Authorized diversions from the Guadalupe River associated with these water rights are taken from an 840-acre on-channel reservoir located in the City of Kerrville and are pumped from the reservoir to Kerrville's water treatment plant. A summary of the pertinent information for their water rights is shown in Table 3-5.

Texas Parks and Wildlife Department owns a continuous flow-through water right for 5,780 acre-feet/year used for the Heart of the Hills Fisheries Science Center, consumptive use is approximately 400 acre-feet/year. Industrial use permits are authorized for 17 acre-feet/year and irrigation rights for 6,904 acre-feet/year. The remaining water-rights holders use their water for mining, hydroelectric power, and recreation. One individual holds a water right (35,125 acre-feet/year) for hydroelectric use; however, this right has not been exercised. Kerr County holds the rights for three non-consumptive recreation-use reservoirs in and near Kerrville.

**Table 3-5. Municipal Water Rights for Kerrville and UGRA**

| Water Rights Permit | Authorized Diversion (acre-ft/yr) | Permit Holder | Priority Data | Storage (ac-ft) | Restrictions |
|---|---|---|---|---|---|
| 1996 (amended 4/10/98) | 150 (mun) 75 (irr) | Kerrville | 4/4/1914 | | |
| 3505 | 3,603 | Kerrville | 5/23/1977 | 840 | Max diversion rate = 9.7 cfs Divert only when reservoir is above 1,608 ft msl |
| 5394 (amended 4/10/98) | 2,169 | Kerrville (Kerrville Municipal use) | 1/6/1992 | Utilizes the storage authorized for Permit 3505 | Max combined diversion rate for water rights #3505 and #5394 = 15.5 cfs. Minimum instream flow requirements vary from 30 to 50 cfs during year. |
| | 2,000 | UGRA (County Municipal use) | | | |

Note: Permit 1996 authorizes a total diversion of 225 acre-feet/year, of which 150 acre-feet/year is designated for municipal use and 75 acre-feet/year for irrigation purposes.

During winter months when there is surplus surface water supply, a portion of the treated water is injected into the Lower Trinity Aquifer for subsequent use during the typically dry summer months. This aquifer storage and recovery (ASR) program has been in full operation since 1998.

Both the City of Kerrville and the UGRA have within their authorizations (Permits Nos. 5394B and 5394A respectively) a Special Condition addressing the seasonal distribution of allowed diversions. The Special Condition stipulates that during the months of October through May, the permittees may divert only when the flow of the Guadalupe River exceeds 40 cfs, and during the months of June through September, the permittees are authorized to divert only when the flow of the Guadalupe River exceeds 30 cfs. Another Special Condition common to both permittees is that, when inflows to Canyon Reservoir are less than 50 cfs, each permittee is to restrict diversions to allow a flow of at least 50 cfs to pass through. Yet another Special Condition imposed on both permittees is that diversions may be made only when the level of UGRA Lake is above 1,608 feet above mean sea level.

Pursuant to a Memorandum of Understanding (MOU) between the Guadalupe-Blanco River Authority (GBRA) and the Commissioner's Court of Kerr County, the South Central Texas Water Planning Group (Region L) recognizes a potential commitment of approximately 2,000 acre-feet/year from the firm yield of Canyon Reservoir for the calendar years 2021 through 2050. GBRA's hydrology studies indicate that a commitment of about 2,000 acre-feet/year would be necessary to allow permits for 6,000 acre-feet/year to be issued by TCEQ for diversions in Kerr County.

Data from the Corps of Engineers show a computed inflow into Lake Canyon of 132,900 acre-feet/year in 1996. The Guadalupe-San Antonio WAM estimates naturalized flows to be 27,800 acre-feet in 1956. The USGS gage 08167000 on the Guadalupe River at Comfort gives a lowest annual streamflow amount of 14.5 cfs (approximately 10,585 acre-feet/year) occurring in 1956. This gage has been recording since 1939. Interestingly, statistics for the gage include the fact that, for water years 1939 through 1997, the mean annual runoff was 157,800 acre-feet or approximately 216 cfs, and that 90 percent of these flows exceeded 25 cfs. This puts the 1956 occurrence of 14.5 cfs within the 0 to 10 percent non-exceedance category. In calendar year 1996, the annual mean was 151 cfs and the median was 85 cfs. The mean and median for 1997 exceeded the 1996 values. These facts seem to substantiate that the drought-of-record for Kerr County occurred in 1956, not in 1996, as consistent with most other areas of the State.

### 3.2.8 San Felipe Springs

The City of Del Rio has a water right authorizing it to divert 11,416 acre-feet/year from San Felipe Springs for municipal use. San Felipe Manufacturing and Irrigation Company has a water right authorizing it to divert 4,962 acre-feet/year for irrigation use and 50 acre-feet/year for industrial use. No data exists for flows during the drought of the 1950s. The only available records are from USGS gage 08452800 maintained by the IBWC at San Felipe Springs that covers the period of February 1961 to present. The minimum annual amount during this time period was 36,580 acre-feet/year (occurring in 1963).

### 3.2.9 Old Faithful Springs

Issuing from the upper Glen Rose Limestone portion of the Edwards-Trinity (Plateau) Aquifer and shallow creek alluvium, Old Faithful Springs is the sole-source water supply for the City of Camp Wood. The Spring has been a dependable source and was reported to have continuously flowed during the 1950s drought. There is current concern that the increase in the number of wells being drilled in the area may lower the local water table and thus negatively impact spring flow. The Spring is privately owned and may not be available for City use after the current contract expires.

### 3.2.10 Surface Water Rights

The right to use water from streams and lakes is permitted through the State of Texas. A list of all authorized surface water rights in the Region is available in Appendix 3A.

Major downstream water rights include those in Region L supplied by the Guadalupe-Blanco River Authority out of Canyon Lake and by the Bexar-Medina-Atascosa WCID#1 out of the Medina/Diversion system. The firm yields of Canyon and Medina limit the amount of water available for appropriation in both the Plateau Region and Region L. Major downstream water rights in Region M (i.e., cities and irrigators on the Rio Grande downstream from Amistad Reservoir) do not limit the amount of water available for appropriation in the Plateau Region because currently the Plateau Region does not depend on the Falcon-Amistad system. TCEQ's Lower Rio Grande Watermaster allocates water rights on the Rio Grande according to the supply in the Amistad Reservoir and in accordance with the 1944 International Treaty with Mexico.

## 3.3 GROUNDWATER/SURFACE WATER RELATIONSHIP

In the natural environment, water is constantly in transition between the land surface and underground aquifers. Under certain conditions, stream losses percolate downward to underlying aquifers as recharge; while in other cases, aquifers give up water to the land surface in the form of springs and seeps.

Most of the Plateau Region occurs at higher elevations that constitute the headwaters of the numerous streams and tributaries that frequent this Region. At these elevations, significant quantities of water exit the aquifer systems through springs and form the base flow of the surface streams. Downstream, only a portion of that water may renter the underground system. For this reason, these streams are generally gaining throughout much of their extent within the Plateau Region. Spring flows are also environmentally important in that they are the primary source of water for wildlife in the area. These discharges from springs are thus the primary source of continuous flow to the rivers downstream and, therefore, their protection is warranted.

Some of the largest springs in the Region, such as San Felipe Springs (Val Verde County) and Las Moras Springs (Kinney County), issue from the Edwards limestone. However, numerous other springs issue from either the Edwards or Glen Rose Limestones. Many of the springs, such as Fessenden Spring (Kerr County), issue near the contact between the Edwards and the upper Glen Rose Limestones. Smaller springs are more prevalent where they issue from the Glen Rose, particularly in Bandera and Kerr Counties.

Most springs located in the headwaters of rivers that traverse the eastern part of the Region issue from the contact between the Edwards limestone and underlying upper Glen Rose limestone. Most well production in this area is from deeper aquifers and, therefore, little impact to spring flow from the pumping is anticipated. However, as new development expands to the west, care should be given to potential water level declines that could diminish spring flow and base flow to the rivers.

Springs located in the western part of the Region issue primarily from the Edwards Limestone. Because of limited pumping of groundwater from wells in the Del Rio area, San Felipe Springs has not had to compete for source water. A significant increase in groundwater pumpage immediate updip and to the east of the springs may lower the water table sufficiently to affect flow from the springs. Because much of the recharge areas for the contributing zones of these western springs occur in remote areas, very little information is available concerning the relationship between the springs and the underlying aquifers.

Gain/loss studies are needed to identify stream segments that are critical to aquifer recharge and spring discharge. The studies can be used to identify where recharge structures would be most efficient and where most river base-flow gain occurs. Specific candidate areas occur over the plateau area that is underlain by Edwards Limestone, especially in the upper tributaries of all the rivers. Gain/loss studies of tributaries in the vicinity of Del Rio would be beneficial in understanding the recharge areas that contribute to San Felipe Springs.

Two supplemental study reports were prepared for the *Plateau Region Water Plan* that address springs. The first report (Springs of Kinney and Val Verde Counties, 2005) considers the location and geohydrology of springs in Kinney and Val Verde Counties, and the second report (Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County, Texas, 2005) relates springflow in western Kerr County to base flow in the three branches of the upper Guadalupe River.

## 3.4 WATER REUSE

While recycling is a term generally applied to aluminum cans, glass bottles, and newspapers, water can be recycled as well. Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a groundwater aquifer (referred to as groundwater recharge or ASR for aquifer storage and recovery). Water is sometimes recycled and reused onsite; for example, when an industrial facility recycles water used for cooling processes. A common type of recycled water is water that has been reclaimed from municipal wastewater, or sewage. The term "water recycling" is generally used synonymously with water reclamation and water reuse.

Kerrville treats its wastewater to the strictest set of standards in the State of Texas, which nearly meets drinking water standards. The treated wastewater is pumped through a dedicated pipeline for reuse as irrigation water for the Scott Schreiner Municipal Golf Course, the Hill Country Youth Soccer Fields, and the golf course at Comanche Trace Ranch & Golf Club. Additional treated water is sold by the truckload for construction projects. The remaining wastewater is released into Third Creek, which flows into Flatrock Lake on the Guadalupe River. That water is then available for use downstream of Kerrville. Future expansion of Kerrville's reuse project (see Strategy J-22 in Chapter 5) is anticipated to yield approximately 1 million gallons per day. The Cities of Bandera and Camp Wood also provide treated wastewater for non-potable uses.

## 3.5 LOCAL SUPPLY

"Local Supplies" are limited, unnamed individual surface water supplies that, separately, are available only to particular non-municipal WUGs. These supplies are generally contained within "stock tanks" that catch precipitation runoff and are used primarily for livestock watering, but at times may be available for other local needs such as mining. For planning purposes, the volume of runoff water in these catchment basins is considered to be significantly reduced during drought-of-record conditions and does not include any groundwater that might be pumped into them. Table 3-6 provides a listing of local supply volumes by County, River Basin, and Use that appear in the Region-wide listing of available supply sources (Tables 3-1 and 3-2). Supply volumes are based on a very subjective estimate of the number of stock tanks (each averaging approximately 5 acre-feet in volume) in existence as estimated from the total demand for livestock in each county-river basin area.

**Table 3-6. Local Supply**

| Source | Primary Use | Number of Tanks | County | Basin | Supply Volume in Acre-Feet / Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Local Supply | Livestock | 3 | Edwards | Colorado | 13 | 13 | 13 | 13 | 13 | 13 |
| | Livestock | 9 | Kerr | Colorado | 46 | 46 | 46 | 46 | 46 | 46 |
| | Livestock | 1 | Real | Colorado | 3 | 3 | 3 | 3 | 3 | 3 |
| | Livestock | 79 | Kerr | Guadalupe | 393 | 393 | 393 | 393 | 393 | 393 |
| | Livestock | 10 | Edwards | Nueces | 47 | 47 | 47 | 47 | 47 | 47 |
| | Livestock | 10 | Real | Nueces | 50 | 50 | 50 | 50 | 50 | 50 |
| | Mining | 10 | Edwards | Nueces | 11 | 11 | 11 | 11 | 11 | 11 |
| | Livestock | 8 | Kinney | Nueces | 42 | 42 | 42 | 42 | 42 | 42 |
| | Livestock | 9 | Edwards | Rio Grande | 47 | 47 | 47 | 47 | 47 | 47 |
| | Livestock | 5 | Val Verde | Rio Grande | 27 | 27 | 27 | 27 | 27 | 27 |
| | Livestock | 8 | Kinney | Rio Grande | 42 | 42 | 42 | 42 | 42 | 42 |
| | Mining | 30 | Val Verde | Rio Grande | 149 | 149 | 149 | 149 | 149 | 149 |
| | Livestock | 15 | Bandera | San Antonio | 74 | 74 | 74 | 74 | 74 | 74 |
| | Livestock | 5 | Kerr | San Antonio | 23 | 23 | 23 | 23 | 23 | 23 |

# APPENDIX 3A
# AUTHORIZED SURFACE WATER RIGHTS

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## APPENDIX 3A. AUTHORIZED SURFACE WATER RIGHTS AS EXTRACTED FROM TCEQ'S ACTIVE WATER RIGHTS MASTER FILE

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2027-000 | 6 | Bandera | 7720000000 | ROBERT L PARKER SR ET AL | VERDE CRK | IRRG | 8 | 3 | | |
| 2028-000 | 6 | Bandera | 7750000000 | HOWARD E BUTT | PALMER CRK | OTHER | | | 30 | |
| 2103-000 | 6 | Bandera | 5903000000 | O S PETTY | HONEY CRK | IRRG | 96 | 38 | | |
| 2104-000 | 6 | Bandera | 5902000000 | CLARENCE E LAUTZENHEISER | N PRONG MEDINA RIVER | IRRG | 20.24 | 23.85 | | AMEND 9/29/88, 8/22/89 |
| 2105-000 | 6 | Bandera | 5901500000 | STEVEN L PRICHARD TRUSTEE | MICKLE | IRRG | 5.44 | 8.16 | 5 | |
| 2105-000 | 6 | Bandera | 5901500000 | NEAL INCORPORATED | MICKLE | IRRG | 7.32 | 10.99 | 5 | |
| 2106-000 | 6 | Bandera | 5901450000 | BREWINGTON LAKE RANCH ASSN | BREWINGTON CRK | REC | 190 | | 190 | |
| 2107-000 | 6 | Bandera | 5901100000 | JOEL HELD, TRUSTEE/JJJ RANCH | N PRONG MEDINA RIVER | IRRG | 19 | 25 | | OUT OF A 1666.5 ACRE TRACT |
| 2108-000 | 6 | Bandera | 5900100000 | BEN & KAY MAYBERRY FAM PART | ROCKY CRK | IRRG | 19.82 | 14.41 | | ALSO KERR CO |
| 2108-000 | 6 | Bandera | 5900100000 | WALTER A WILLOUGHBY | ROCKY CRK | IRRG | 24.18 | 17.59 | | ALSO KERR CO |
| 2109-000 | 6 | Bandera | 5897200000 | NEVIN MARR | N PRONG MEDINA RIVER | IRRG | 2 | 10 | | AMEND 1-21-83 INCREASE ACRES |
| 2110-000 | 6 | Bandera | 5897000000 | DONALD F & MARTHA M MEAD | N PRONG MEDINA RIVER | IRRG | 21 | 12 | | |
| 2111-000 | 6 | Bandera | 5896000000 | TEXAS PETROLEUM CO. TR EST | COLLINS CRK | IRRG | 4 | 2 | 16 | |
| 2112-000 | 6 | Bandera | 5894500000 | MRS MARY WINKENHOWER | ELAM CRK | IRRG | 27 | 27 | | JOINTLY OWNS 27 AF TO IRR 27 ACRES |
| 2113-000 | 6 | Bandera | 5894000000 | SUSAN CRAWFORD TRACY | W PRONG MEDINA RIVER | IRRG | 35 | 45 | | OUT OF A 156 ACRE TRACT |
| 2114-000 | 6 | Bandera | 5892000000 | PHIL A GROTHUES ET UX | UNNAMED TRIB | IRRG | 5.705 | 20.715 | | |
| 2114-000 | 6 | Bandera | 5892000000 | INMANN T DABNEY JR ET UX | UNNAMED TRIB | IRRG | 6.542 | 23.756 | | |
| 2114-000 | 6 | Bandera | 5892000000 | RICHARD E WILSON | UNNAMED TRIB | IRRG | 3.753 | 13.629 | | |
| 2115-000 | 6 | Bandera | 5891500000 | DAVID R SCHMIDT MD ET AL | BAUERLEIN CRK | IRRG | 15 | 16 | | |
| 2116-000 | 6 | Bandera | 5891000000 | PAUL LAVON GARRISON | W PRONG MEDINA RIVER | IRRG | 36 | 36 | | |
| 2116-000 | 6 | Bandera | 5891000000 | GEORGE C. YAX | W PRONG MEDINA RIVER | IRRG | 15 | 15 | 162 | |
| 2117-000 | 6 | Bandera | 5889000000 | G. MILTON JOHNSON, ET UX | MEDINA RIVER | IRRG | 7 | 7 | | OUT OF A 175.5 ACRE TRACT |
| 2118-000 | 6 | Bandera | 5888870000 | DAVID J BRASK | UNNAMED TRIB | IRRG | 16 | 16 | | |
| 2119-000 | 6 | Bandera | 5888090000 | RAYMOND HICKS | MEDINA RIVER | IRRG | 3 | 8 | | |
| 2120-000 | 6 | Bandera | 5888051000 | BANDERA ELECTRIC COOP INC | MEDINA RIVER | IRRG | 2 | 4 | | 7/8/82 ADD DIV PT |
| 2121-000 | 6 | Bandera | 5888087000 | ANN DARTHULA MAULDIN | INDIAN CRK | IRRG | 31.03 | 8.27 | | |
| 2121-000 | 6 | Bandera | 5888087000 | TOLBERT S WILKINSON ET UX | INDIAN CRK | IRRG | 69.47 | 18.53 | | AMEND 7/30/90 |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2121-000 | 6 | Bandera | 5888087000 | JOHN W DINSE ET UX | INDIAN CRK | IRRG | 49.5 | 13.2 | | |
| 2122-000 | 6 | Bandera | 5887330000 | DON HICKS | MEDINA RIVER | MUNI | 9 | | | |
| 2123-000 | 6 | Bandera | 5887150000 | DON F TOBIN | MEDINA RIVER | IRRG | 152 | 61 | | OUT OF A 452 ACRE TRACT |
| 2124-000 | 6 | Bandera | 5887130000 | EVANGELINE RATCLIFFE WILSON | SAN JULIAN CRK | IRRG | 3 | 5 | | |
| 2125-000 | 6 | Bandera | 5887129000 | PETER K SHAVER ET UX | SAN JULIAN CRK | IRRG | 18 | 30 | | |
| 2126-000 | 6 | Bandera | 5887105000 | STANLEY D ROSENBERG ET UX | MEDINA RIVER | IRRG | 47 | 36 | | |
| 2127-000 | 6 | Bandera | 5887100000 | JERRY B PARKER ET AL | MEDINA RIVER | IRRG | 16 | 8 | | |
| 2128-000 | 6 | Bandera | 5887050000 | JOE H BERRY | SADDLE CRK | IRRG | 14 | 12 | 3 | |
| 2129-000 | 6 | Bandera | 5887000000 | JOE H BERRY | PRIVILEGE CRK | IRRG | 40 | 33 | 110 | |
| 2135-000 | 6 | Bandera | 5660000000 | KITTIE NELSON FERGUSON | SAN GERONIMO CRK | IRRG | 5 | 5 | 28 | |
| 3176-000 | 6 | Bandera | 2851020000 | TEXAS PARKS & WILDLIFE DEPT | CAN CRK | MUNI | 7 | | | |
| 3176-000 | 6 | Bandera | 2851020000 | TEXAS PARKS & WILDLIFE DEPT | CAN CRK | IRRG | | 3 | | |
| 3177-000 | 6 | Bandera | 2850500000 | BETTY F LEIGHTON | SABINAL RIVER | MUNI | 4 | | | |
| 3178-000 | 6 | Bandera | 2850000000 | KING & JEWEL FISHER | SABINAL RIVER | IRRG | 40 | 56 | 2 | AMENDED 6/21/96 |
| 3179-000 | 6 | Bandera | 2825000000 | JOHN K HARRELL | SABINAL RIVER | IRRG | 28.196 | 95.257 | | |
| 3179-000 | 6 | Bandera | 2825000000 | BARBARA JEAN GROTH ET VIR | SABINAL RIVER | IRRG | 8.804 | 29.743 | | |
| 3184-000 | 6 | Bandera | 2675000000 | ENRIQUE S PALOMO ET UX | SPRING CRK | IRRG | 10 | 5 | 42 | |
| 3185-000 | 6 | Bandera | 2651700000 | W H THOMPSON JR | WILLIAMS CRK | IRRG | 15 | 5 | 2 | CURRENT OWNER UNKNOWN, 5/98 |
| 3186-000 | 6 | Bandera | 2651500000 | DOROTHY BAIRD MATTIZA | WILLIAMS CRK | IRRG | 128 | 88 | 73 | |
| 3187-000 | 6 | Bandera | 2651000000 | CHESTER N POSEY ET UX | WILLIAMS CRK | IRRG | 23 | 21 | 15 | |
| 3188-000 | 6 | Bandera | 2650000000 | W J SCHMIDT | HONDO CRK | IRRG | 24 | 47 | 16 | |
| 3693-000 | 1 | Bandera | 5887260000 | GERALD H PERSYN | UNNAMED TRIB BANDERA CRK | REC | | | 11 | |
| 3824-000 | 1 | Bandera | 5887295000 | CITY OF BANDERA | MEDINA RIVER | REC | | | 22 | |
| 3825-000 | 1 | Bandera | 7718000000 | ROBERT L PARKER SR ET AL | VERDE CRK | REC | | | 277 | |
| 3853-000 | 1 | Bandera | 5888230000 | ROCK CLIFF RESERVOIR LAND ASSN | SPIRES CRK | REC | | | 925.4 | AMENDED 2/17/98: IMPOUNDMENT AND EXP |
| 3909-000 | 1 | Bandera | 5888150000 | MAUDEEN M MARKS | MONTAGUE HOLLOW | REC | | | 500 | DOMESTIC, LIVESTOCK & REC |
| 3944-000 | 1 | Bandera | 5887120000 | CONOCO INCORPORATED | UNNAMED TRIB MEDINA RIVER | REC | | | 180 | 2 DAMS |
| 3949-000 | 1 | Bandera | 5886550000 | CASTLE LAND & LIVESTOCK CO INC | BEAR CRK | REC | 33 | | 33 | DOM & LIVESTOCK - SC |
| 4 | 1 | Bandera | 5887125000 | HILL COUNTRY MANAGEMENT CORP | SAN JULIAN | REC | | | 3 | ALSO DOM & LIVESTOCK |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 5097-000 | 1 | Bandera | 5890300000 | DON CODY ET UX | W PRONG MEDINA RIVER | IRRG | 120 | 72 | | EXP 2/2/2016 BY CONTRACT 1610;AMEND 9/94 |
| 5186-000 | 1 | Bandera | 2824000000 | HILL COUNTRY SPRING WATER TX | SPRING | MUNI | 161 | | | BOTTLED WATER, .049 RES |
| 5204-000 | 1 | Bandera | 2840000000 | ROGER E. CANTER ET UX | SABINAL RIVER | IRRG | 60 | 20 | | |
| 5305-000 | 1 | Bandera | 2621000000 | UTOPIA SPRING WATER INC | W SECO CRK | MUNI | 72 | | | |
| 5339-000 | 1 | Bandera | 5888089000 | YMCA/GREATER HOUSTON AREA | INDIAN CRK | REC | | | 30 | |
| 5342-000 | 1 | Bandera | 5890200000 | RENE H GRACIDA | W PRONG MEDIA | REC | | | 7 | |
| 5475-000 | 1 | Bandera | 2850600000 | GALLERIA HOLDING, LTD | JERNIGAN CRK | IRRG | 26 | 18 | 63 | 2 RESERVOIRS |
| 5575-000 | 1 | Bandera | 2850900000 | ALBERT R GAGE ET UX | MARLER CRK | IRRG | 12 | 6 | | SC: FLOW RESTRICTIONS |
| 1527-000 | 6 | Edwards | 1750010000 | ADDISON LEE PFLUGER | HUFFMAN SPRING | IRRG | 32 | 20 | 1 | |
| 1528-000 | 6 | Edwards | 1735000000 | RUTH MCLEAN BOWERS | PAINT CREEK | IRRG | 60 | 54 | 58 | CO 134, 2 RES |
| 2451-000 | 6 | Edwards | 1750000000 | ADDISON LEE PFLUGER ET AL | S LLANO RIVER | IRRG | 88 | 74 | 7 | AMEND 5/9/83 |
| 3017-000 | 6 | Edwards | 9520000000 | RAY H EUBANK | RUTH DRAW | IRRG | 50 | 50 | | AMEND 7/3/84 |
| 3023-000 | 6 | Edwards | 9195000000 | DONALD P TARPEY | NUECES RIVER | IRRG | 108 | 27 | | |
| 3024-000 | 6 | Edwards | 9170000000 | DOUGLAS B & MARGARET MARSHALL | NUECES RIVER | IRRG | 65 | 43 | | |
| 3038-000 | 6 | Edwards | 8900000000 | ROYCE I REID ESTATE | PULLIAM CRK | IRRG | 48 | 20 | | |
| 3039-000 | 6 | Edwards | 8800000000 | OLGA H. CLOUDT, ET AL | PULLIAM CRK | IRRG | 75 | 50 | 8 | |
| 3039-000 | 6 | Edwards | 8800000000 | OLGA H. CLOUDT, ET AL | PULLIAM CRK | IRRG | 30 | 20 | | |
| 3040-000 | 6 | Edwards | 8790000000 | J R WILLIAMS ET AL | PULLIAM CRK | IRRG | 34 | 17 | | |
| 3041-000 | 6 | Edwards | 8780000000 | JOSEPH C WILLIAMS | PULLIAM CRK | IRRG | 60 | 44 | | 1/2 INTEREST IN 60 AF FOR IRR OF 44 AC |
| 3042-000 | 6 | Edwards | 8779000000 | J R WILLIAMS ET AL | PULLIAM CRK | IRRG | 22 | 13 | | |
| 3043-000 | 6 | Edwards | 8760000000 | JOY JERNIGAN OWENS | PULLIAM CRK | IRRG | 32 | 16 | | |
| 3044-000 | 6 | Edwards | 8700010000 | SUSAN PETTY ARNIM ET AL | CEDAR CRK | IRRG | 6 | 12 | | |
| 3044-000 | 6 | Edwards | 8700010000 | SUSAN PETTY ARNIM ET AL | CEDAR CRK | IRRG | 20 | | | |
| 3044-000 | 6 | Edwards | 8700010000 | SUSAN PETTY ARNIM ET AL | CEDAR CRK | IRRG | 4 | 20 | | |
| 3046-000 | 6 | Edwards | 8460500000 | NORMA JEAN EASLEY | PULLIAM CRK | IRRG | 30 | 59 | | |
| 3047-000 | 6 | Edwards | 8400000000 | BRUCE I HENDRICKSON ET UX | CLEAR CRK | IRRG | 6 | 6 | 11 | |
| 3048-000 | 6 | Edwards | 8340000000 | L A MALACHEK ET AL | PULLIAM CRK | IRRG | 27 | 14 | | |
| 3049-000 | 6 | Edwards | 7630010000 | EDWARDS CO INVEST. PARTNER | PULLIAM CRK | IRRG | 250 | 400 | | |
| 3049-000 | 6 | Edwards | 7630010000 | BRUCE I HENDRICKSON ET UX | PULLIAM CRK | IRRG | 350 | 150 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 3070-000 | 6 | Edwards | 7041600000 | E B CARRUTH, JR, TRUST | W NUECES RIVER | IRRG | 200 | 184 | | |
| 3070-000 | 6 | Edwards | 7041600000 | E B CARRUTH, JR, TRUST | W NUECES RIVER | REC | | | 19 | |
| 3957-000 | 1 | Edwards | 8550000000 | S A WILLIAMS | CEDAR CRK | IRRG | 40 | 40 | | AMEND 1/13/87 |
| 4006-000 | 1 | Edwards | 8790100000 | BAY-HOUSTON TOWING CO | PULLIAM | IRRG | 150 | 75 | | |
| 4278-000 | 1 | Edwards | 8920000000 | BERRYMAN INVESTMENTS INC | PULLIAM CRK | IRRG | 4.34 | 7.38 | | OWNS DAM & RESERVOIR |
| 4278-000 | 1 | Edwards | 8920000000 | SAM P WORDEN ET UX | PULLIAM CRK | IRRG | 5.66 | 9.62 | | |
| 1930-000 | 6 | Kerr | 9570000000 | HERSHEL REID ET UX | FLAT ROCK CRK | IRRG | 69 | 66 | 35 | |
| 1932-000 | 6 | Kerr | 9560000000 | PRESBYTERIAN MO-RANCH ASSEMBLY | N FRK GUADALUPE RIVER | MUNI | 60 | | | AMEND 6/7/94 |
| 1932-000 | 6 | Kerr | 9560000000 | PRESBYTERIAN MO-RANCH ASSEMBLY | N FRK GUADALUPE RIVER | IRRG | 14 | 7 | | AMEND 6/7/94 |
| 1932-000 | 6 | Kerr | 9560000000 | PRESBYTERIAN MO-RANCH ASSEMBLY | N FRK GUADALUPE RIVER | REC | 25 | | 20 | AMEND 6/7/94 |
| 1934-000 | 6 | Kerr | 9527000000 | CHARLES K HICKEY JR ET AL | DRY CRK | IRRG | 0.45 | 0.68 | | |
| 1934-000 | 6 | Kerr | 9527000000 | KATHY JAN FREEMAN | DRY CRK | IRRG | 1.55 | 2.32 | | |
| 1935-000 | 6 | Kerr | 9525100000 | CHARLES K HICKEY JR ET AL | N FRK GUADALUPE RIVER | IRRG | 8 | 8 | | |
| 1936-000 | 6 | Kerr | 9523000000 | WILLIAM H ARLITT JR ET UX | N FRK GUADALUPE RIVER | IRRG | 17 | 6 | 5 | |
| 1936-000 | 6 | Kerr | 9523000000 | WILLIAM H ARLITT JR ET UX | INDIAN CRK | IRRG | 134 | 48 | | |
| 1937-000 | 6 | Kerr | 9515200000 | BOY SCOUTS- ALAMO AREA | BEAR CRK | REC | | | 10 | |
| 1938-000 | 6 | Kerr | 9515000000 | LOUIS H STUMBERG | N FRK GUADALUPE RIVER | IRRG | 2 | 4 | | |
| 1938-000 | 6 | Kerr | 9515000000 | LOUIS H STUMBERG | N FRK GUADALUPE RIVER | IRRG | 15 | 22 | | |
| 1939-000 | 6 | Kerr | 9512000000 | LOUIS H STRUMBERG | GRAPE CRK | IRRG | 3 | 6 | 6 | |
| 1940-000 | 6 | Kerr | 9511000000 | B E QUINN III ET AL | N FRK GUADALUPE RIVER | IRRG | 32 | 16 | 10 | |
| 1941-000 | 6 | Kerr | 8154502000 | DELMAR SPIER AGENT | TURTLE CRK | IRRG | 6 | 9 | 5 | |
| 1943-000 | 6 | Kerr | 9505000000 | J CONRAD PYLE, ET AL | N FRK GUADALUPE RIVER | MUNI | 14 | | | |
| 1945-000 | 6 | Kerr | 9485010000 | JOHN P HILL | N FRK GUADALUPE RIVER | IRRG | 25 | 20 | | |
| 1946-000 | 6 | Kerr | 9485000000 | JOHN P HILL ADMINISTRATOR | N FRK GUADALUPE RIVER | IRRG | 11 | 9 | | |
| 1947-000 | 6 | Kerr | 9480000000 | GUAD VALLEY LOT OWNERS ASSN | N FRK GUADALUPE RIVER | IRRG | 6 | 10 | | AMEND 3/6/91 |
| 1947-000 | 6 | Kerr | 9480000000 | GUAD VALLEY LOT OWNERS ASSN | N FRK GUADALUPE RIVER | MUNI | 3 | | | |
| 1948-000 | 6 | Kerr | 9489000000 | JOHN H DUNCAN | BRUSHY CRK | IRRG | 7 | 7 | | |
| 1949-000 | 6 | Kerr | 9488000000 | WILLIAM O CARTER, TRUSTEE | HONEY CRK | IRRG | 6 | 2 | | OUT OF A 80 ACRE TRACT |
| 1949-000 | 6 | Kerr | 9488000000 | WILLIAM O CARTER, TRUSTEE | HONEY CRK | IRRG | 27 | 9 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1950-000 | 6 | Kerr | 9487000000 | JOHN H DUNCAN | HONEY CRK | IRRG | 6 | 20 | 13 | ALSO USE 7 |
| 1953-000 | 6 | Kerr | 9476000000 | LAURA B LEWIS ET VIR | N FRK GUADALUPE RIVER | IRRG | 40 | 24 | | |
| 1956-000 | 6 | Kerr | 9897000000 | RIVER INN ASSOC OF UNIT OWNERS | S FRK GUADALUPE RIVER | REC | | | 50 | |
| 1956-000 | 6 | Kerr | 9897000000 | RIVER INN ASSOC OF UNIT OWNERS | S FRK GUADALUPE RIVER | MUNI | 10 | | | AMEND 4/19/84, 1/4/85 |
| 1957-000 | 6 | Kerr | 9880000000 | BILLIE R VALICEK | S FRK GUADALUPE RIVER | REC | | | 10 | |
| 1958-000 | 6 | Kerr | 9780000000 | T J MOORE ESTATE | CYPRESS CRK | IRRG | 20 | 10 | 100 | |
| 1961-000 | 6 | Kerr | 9670000000 | LAVERNE CRIDER MOORE ET VIR | S FRK GUADALUPE RIVER | MUNI | 3 | | | |
| 1961-000 | 6 | Kerr | 9670000000 | LAVERNE CRIDER MOORE ET VIR | S FRK GUADALUPE RIVER | IRRG | 1 | 3 | | |
| 1963-000 | 6 | Kerr | 9620000000 | LAWRENCE L GRAHAM ET AL | S FRK GUADALUPE RIVER | IRRG | 2 | 12 | 21 | AMEND 9/10/85 |
| 1963-000 | 6 | Kerr | 9620000000 | LAWRENCE L GRAHAM ET AL | S FRK GUADALUPE RIVER | REC | | | 16 | AMENDS 5/26/83 CHG PUR USE & ADD RES |
| 1964-000 | 6 | Kerr | 9400000000 | VIRGINIA MOORE JOHNSTON | TEGENER | IRRG | 10 | 10 | 12 | |
| 1967-000 | 6 | Kerr | 9305000000 | SARAH HICKS BUSS | UNNAMED TRIB GUADALUPE RIVER | REC | 20 | | | ALSO USE 1, AMEND 3/19/91 |
| 1968-000 | 6 | Kerr | 9261000000 | LOUIS DOMINGUES | GUADALUPE RIVER | IRRG | 10 | 20 | | |
| 1969-000 | 6 | Kerr | 9260000000 | TOMMIE SMITH BLACKBURN | GUADALUPE RIVER | INDU | 15 | | 15 | USE 2: MILLING |
| 1969-000 | 6 | Kerr | 9260000000 | TOMMIE SMITH BLACKBURN | KELLY CRK | IRRG | 49 | 80 | | USE 3 - DIVERTING FROM KELLY CREEK |
| 1969-000 | 6 | Kerr | 9260000000 | TOMMIE SMITH BLACKBURN | GUADALUPE RIVER | IRRG | 59 | | | USE 3 - DIVERTING FROM GUADALUPE RIVER |
| 1969-000 | 6 | Kerr | 9260000000 | TOMMIE SMITH BLACKBURN | GUADALUPE RIVER | HYDRO | | | | USE 5; NONCONSUMPTIVE |
| 1970-000 | 6 | Kerr | 9220000000 | CARL HAWKINS | GUADALUPE RIVER | MUNI | 10 | | | |
| 1970-000 | 6 | Kerr | 9220000000 | CARL HAWKINS | GUADALUPE RIVER | IRRG | 32 | 25 | | |
| 1971-000 | 6 | Kerr | 9140000000 | COUNTY OF KERR | GUADALUPE RIVER | REC | | | 450 | |
| 1972-000 | 6 | Kerr | 9110000000 | WESLEY ELLEBRACHT | WELSH BR | IRRG | 0.8 | 0.8 | | |
| 1972-000 | 6 | Kerr | 9110000000 | WELCH CREEK PARTNERS LTD | WELSH BR | IRRG | 5.15 | 5.15 | | |
| 1972-000 | 6 | Kerr | 9110000000 | ARANSAS BAY COMPANY | WELSH BR | IRRG | 0.05 | 0.05 | | |
| 1973-000 | 6 | Kerr | 9100000000 | SHELTON RANCHES INC | SMITHS BR | IRRG | 10 | 10 | 6 | |
| 1974-000 | 6 | Kerr | 9050000000 | SHELTON RANCHES INC | SMITHS BR | IRRG | 70 | 35 | 15 | ALSO JOHNSON CREEK |
| 1975-000 | 6 | Kerr | 9025000000 | TEXAS PARKS & WILDLIFE DEPT | FESSENDEN BR | INDU | 400 | | | FISH HATCHERY & GAME PRESERVE |
| 1975-000 | 6 | Kerr | 9025000000 | TEXAS PARKS & WILDLIFE DEPT | FESSENDEN BR | INDU | 5780 | | 72 | 2 IMP & A POND; USES 3, 1 & 7; EXP 2012 |
| 1976-000 | 6 | Kerr | 8950000000 | F P ZOCH III TRUST & ZEE RANCH | FESSENDEN BR | IRRG | 29 | 14 | | |
| 1976-000 | 6 | Kerr | 8950000000 | F P ZOCH III TRUST & ZEE RANCH | FESSENDEN BR | REC | | | 184 | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977-000 | 6 | Kerr | 8839000000 | TEXAS CATHOLIC BOYS' HOME | JOHNSON CRK | IRRG | 23 | 23 | 23 | |
| 1978-000 | 6 | Kerr | 8815000000 | A J RUST | JOHNSON CRK | IRRG | 33 | 65 | | |
| 1979-000 | 6 | Kerr | 8808000000 | KEITH S MEADOW | BYAS CRK | IRRG | 18 | 6 | | |
| 1980-000 | 6 | Kerr | 8805000000 | A L MOORE | JOHNSON CRK | IRRG | 12 | 6 | | |
| 1981-000 | 6 | Kerr | 8800000000 | JACK D CLARK JR ET AL | JOHNSON CRK | IRRG | 32 | 16 | | |
| 1981-000 | 6 | Kerr | 8800000000 | JACK D CLARK JR ET AL | JOHNSON CRK | IRRG | 143 | 76 | | OUT OF A 111.9 ACRE TRACT |
| 1982-000 | 6 | Kerr | 8775000000 | LOLA DEAN SMITH | JOHNSON CRK | IRRG | 133 | 50 | 12 | |
| 1983-000 | 6 | Kerr | 8770000000 | N V MAMIMAR | JOHNSON CRK | IRRG | 32 | 17 | | JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC |
| 1983-000 | 6 | Kerr | 8770000000 | N V MAMIMAR | JOHNSON CRK | IRRG | 67 | 35 | | JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC |
| 1983-000 | 6 | Kerr | 8770000000 | DAVID J COPELAND ET UX | JOHNSON CRK | IRRG | | | | JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC |
| 1983-000 | 6 | Kerr | 8770000000 | DAVID J COPELAND ET UX | JOHNSON CRK | IRRG | | | | JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC |
| 1984-000 | 6 | Kerr | 8750000000 | MICHAEL E & GAIL SEARS | JOHNSON CRK | IRRG | 1 | 2 | | |
| 1985-000 | 6 | Kerr | 8746000000 | ROBERT B O'CONNOR JR ET UX | JOHNSON CRK | IRRG | 80 | 31 | | |
| 1987-000 | 6 | Kerr | 8744000000 | REGINALD E WARREN JR | JOHNSON CRK | IRRG | 90 | 30 | | |
| 1988-000 | 6 | Kerr | 8720000000 | JIMMIE L QUERNER SR ESTATE | FALL BR | IRRG | 128 | 64 | | ALSO GILLESPIE CO |
| 1990-000 | 6 | Kerr | 8650000000 | DOROTHY L JENKINS ET AL | JOHNSON CRK | IRRG | 3 | 1 | | |
| 1991-000 | 6 | Kerr | 8615001000 | LAZY HILLS GUEST RANCH INC | HENDERSON BR | IRRG | 21 | 28 | | |
| 1992-000 | 6 | Kerr | 8600000000 | MARK A RYLANDER ET AL | JOHNSON CRK | IRRG | 23 | 15 | | |
| 1993-000 | 6 | Kerr | 8550000000 | ROY LITTLEFIELD | JOHNSON CRK | IRRG | 50 | 50 | 4 | |
| 1994-000 | 6 | Kerr | 8500000000 | M H & MARY FRANCES MONTGOMERY | GUADALUPE RIVER | IRRG | 5 | 4 | | |
| 1995-000 | 6 | Kerr | 8451000000 | HENRY GRIFFIN CONSTRUCTION CO | GOAT CRK | IRRG | 11 | 11 | 6 | |
| 1996-000 | 6 | Kerr | 8287000000 | KERRVILLE, CITY OF | GUADALUPE RIVER | MUNI | 150 | | | AMEND 3/19/91, 4/10/98: DIV PT #4.SC. |
| 1996-000 | 6 | Kerr | 8287000000 | KERRVILLE, CITY OF | GUADALUPE RIVER | IRRG | 75 | 44 | 75 | AMEND 3/19/91, 4/10/98: DIV PT #4.SC. |
| 1997-000 | 6 | Kerr | 8310000000 | DARRELL G LOCHTE ET AL | GUADALUPE RIVER | MINE | 143 | | | |
| 1997-000 | 6 | Kerr | 8310000000 | DARRELL G LOCHTE ET AL | GUADALUPE RIVER | INDU | 2 | | | |
| 1998-000 | 6 | Kerr | 8295000000 | C W SUNDAY | TOWN CRK | IRRG | 22.3 | 22.3 | 10 | |
| 1998-000 | 6 | Kerr | 8295000000 | JOSE A LOPEZ ET UX | TOWN CRK | IRRG | 4.18 | 4.18 | | |
| 1999-000 | 6 | Kerr | 8297000000 | KERRVILLE STATE HOSPITAL | UNNAMED TRIB GUADALUPE RIVER | REC | 44 | | 44 | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2000-000 | 6 | Kerr | 8260010000 | RIVERHILL COUNTRY CLUB INC | GUADALUPE RIVER | IRRG | 350 | 160 | 70 | 8/31/87 |
| 2001-000 | 6 | Kerr | 8255000000 | CARL D. MEEK | GUADALUPE RIVER | IRRG | 295 | 194 | | AMEND 4/9/92,5/12/95.DIFF PRIORITY DATES |
| 2002-000 | 6 | Kerr | 8230000000 | COMANCHE TRACE RANCH & GOLF CL | GUADALUPE RIVER | IRRG | 136 | 99 | | |
| 2003-000 | 6 | Kerr | 8250000000 | WHEATCRAFT, INC. | GUADALUPE RIVER | IRRG | 42 | 21 | | |
| 2003-000 | 6 | Kerr | 8250000000 | SHELTON RANCH CORPORATION | GUADALUPE RIVER | MINE | 10 | | | |
| 2004-000 | 6 | Kerr | 8200000000 | COUNTY OF KERR | GUADALUPE RIVER | REC | | | 720 | ALSO USE 8 |
| 2005-000 | 6 | Kerr | 8185500000 | HARRIET BOCKHOFF ESTATE | GUADALUPE RIVER | IRRG | 59 | 98 | | |
| 2006-000 | 6 | Kerr | 8174000000 | FARM CREDIT BANK OF TEXAS | GUADALUPE RIVER | IRRG | 179.06 | 512.55 | | AMEND 2/3/88,6/18/90. MAX COMB. CFS:4.0 |
| 2006-000 | 6 | Kerr | 8174000000 | FARM CREDIT BANK OF TEXAS | GUADALUPE RIVER | IRRG | 83.94 | | | AMEND 2/3/88, 6/18/90 |
| 2006-000 | 6 | Kerr | 8174000000 | 1967 SHELTON TRUSTS PART ET AL | GUADALUPE RIVER | IRRG | 106.9 | 78.55 | | AMEND 2/3/88, 6/18/90 |
| 2006-000 | 6 | Kerr | 8174000000 | 1967 SHELTON TRUSTS PART ET AL | GUADALUPE RIVER | IRRG | 50.1 | | | AMEND 2/3/88, 6/18/90 |
| 2006-000 | 6 | Kerr | 8174000000 | KENNETH W WHITEWOOD ET UX | GUADALUPE RIVER | IRRG | 34.04 | | | AMEND 2/3/88, 6/18/90, 11/22/96 |
| 2006-000 | 6 | Kerr | 8174000000 | KENNETH W WHITEWOOD ET UX | GUADALUPE RIVER | IRRG | 15.96 | | | AMEND 2/3/88, 6/18/90, 11/22/96 |
| 2006-000 | 6 | Kerr | 8174000000 | KENNETH W WHITEWOOD ET UX | GUADALUPE RIVER | IRRG | 100 | 76 | | AMEND 2/3/88, 6/18/90, 11/22/96 |
| 2007-000 | 6 | Kerr | 8160000000 | RAY ELLISON JR | SPRING CRK | IRRG | 31 | 31 | 50 | |
| 2008-000 | 6 | Kerr | 8156160000 | LUTHERAN CAMP CHRYSALIS | TURTLE CRK | MUNI | 11 | | 12 | |
| 2009-000 | 6 | Kerr | 8155750000 | FRANCIS C & WILLADEAN BOLEN | BUSHWACK CRK | IRRG | 5 | 5 | 5 | |
| 2010-000 | 6 | Kerr | 8155700000 | G ROBERT SWANTNER JR ET UX | BUSHWACK CRK | IRRG | 7 | 5 | 5 | OUT OF 68.8 ACRE TRACT |
| 2011-000 | 6 | Kerr | 8155000000 | H J GRUY | TURTLE CRK | IRRG | 80 | 50 | 10 | |
| 2012-000 | 6 | Kerr | 8154501000 | SANDRA BLAIR | TURTLE CRK | IRRG | 1 | 1 | 5 | |
| 2013-000 | 6 | Kerr | 8154500000 | FELIX R & LILLIAN STEILER REAL | WEST CRK | IRRG | 11 | 12 | | |
| 2014-000 | 6 | Kerr | 8152000000 | LEAH MARTHA STEPHENS | TURTLE CRK | IRRG | 6.36 | 5.63 | | |
| 2014-000 | 6 | Kerr | 8152000000 | BENNO OOSTERMAN ET UX | TURTLE CRK | IRRG | 6.36 | 5.63 | | |
| 2014-000 | 6 | Kerr | 8152000000 | JOHN M LEBOLT TRUSTEE | TURTLE CRK | IRRG | 9.02 | 7.98 | | |
| 2015-000 | 6 | Kerr | 8151000000 | JAMES E NUGENT | GUADALUPE RIVER | IRRG | 27 | 21 | | |
| 2016-000 | 6 | Kerr | 8150500000 | DORIS J HODGES | GUADALUPE RIVER | IRRG | 8 | 8 | | |
| 2017-000 | 6 | Kerr | 8050000000 | COUNTY OF KERR | GUADALUPE RIVER | REC | | | 87 | ALSO USE 8 |
| 2018-000 | 6 | Kerr | 8049000000 | LEE ANTHONY MOSTY | GUADALUPE RIVER | IRRG | 154 | 94 | | |
| 2020-000 | 6 | Kerr | 7970000000 | ROBERT LEE MOSTY | GUADALUPE RIVER | IRRG | 60 | 30 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2021-000 | 6 | Kerr | 7940000000 | RAYMOND F MOSTY ET AL | GUADALUPE RIVER | IRRG | 103 | 45 | 5 | |
| 2022-000 | 6 | Kerr | 7950000000 | ROBERT LEE MOSTY | GUADALUPE RIVER | IRRG | 17 | 119 | 20 | |
| 2023-000 | 6 | Kerr | 7935000000 | ROY A GREEN | GUADALUPE RIVER | IRRG | 7 | 3 | | |
| 2024-000 | 6 | Kerr | 7924990000 | CARL E RHODES | GUADALUPE RIVER | IRRG | 114 | 125 | | |
| 2025-000 | 6 | Kerr | 7925000000 | HARRY J WRAY | GUADALUPE RIVER | IRRG | 155 | 80 | | JOINTLY OWNS 155 AF TO IRR 80 ACRES |
| 2025-000 | 6 | Kerr | 7925000000 | DAVID B WRAY | GUADALUPE RIVER | IRRG | | | | JOINTLY OWNS 155 AF TO IRR 80 ACRES |
| 2025-000 | 6 | Kerr | 7925000000 | BYNO SALSMAN ET UX | GUADALUPE RIVER | IRRG | | | | JOINTLY OWNS 155 AF TO IRR 80 ACRES |
| 2026-000 | 6 | Kerr | 7920000000 | ELGIN JUNG | GUADALUPE RIVER | IRRG | 3.309 | 2.118 | | |
| 2026-000 | 6 | Kerr | 7920000000 | ZANE H ROBINSON ET UX | GUADALUPE RIVER | IRRG | 53.945 | 34.52 | | |
| 2026-000 | 6 | Kerr | 7920000000 | RONNIE W SCHLOTTMAN ET UX | GUADALUPE RIVER | IRRG | 17.83 | 11.41 | | |
| 2026-000 | 6 | Kerr | 7920000000 | KENNETH W WHITEWOOD ET UX | GUADALUPE RIVER | IRRG | 149.916 | 44.72 | | AMENDED 11/22/96 |
| 2029-000 | 6 | Kerr | 7710000000 | ROLAND WALTERS | PRISON CANYON | IRRG | 25 | 200 | 420 | & CO 010, 10/5/82 ADD DIV PT |
| 2030-000 | 6 | Kerr | 7704000000 | JAMES S ERNST | UNNAMED TRIB VERDE CRK | IRRG | 247 | | 120 | |
| 2030-000 | 6 | Kerr | 7704000000 | PETE R SMITH | UNNAMED TRIB VERDE CRK | IRRG | 19 | | | |
| 2031-000 | 6 | Kerr | 7701000000 | JOSEPH PAUL MILLER ET UX | GUADALUPE RIVER | IRRG | 115 | 80 | | AMEND 11/4/85 |
| 2032-000 | 6 | Kerr | 7700700000 | DAVID M LEIBOWITZ ET UX | GUADALUPE RIVER | IRRG | 10 | 6 | | |
| 2033-000 | 6 | Kerr | 7699900000 | JAVIER G REYES ET UX | GUADALUPE RIVER | IRRG | 90 | 90 | | |
| 2034-000 | 6 | Kerr | 7699500000 | CHESTER P HEINEN ET AL | GUADALUPE RIVER | IRRG | 2 | 6 | | |
| 2037-000 | 6 | Kerr | 7652500000 | GENE ARTHUR ALLERKAMP | CYPRESS CRK | IRRG | 5 | 6.33 | | |
| 2037-000 | 6 | Kerr | 7652500000 | JANICE CHARLOTTE BULLARD | CYPRESS CRK | IRRG | 5 | 6.34 | | |
| 2037-000 | 6 | Kerr | 7652500000 | ROMAN LUNA ET UX | CYPRESS CRK | IRRG | 10 | 12.67 | | |
| 2037-000 | 6 | Kerr | 7652500000 | CURTIS BERNARD ALLERKAMP | CYPRESS CRK | IRRG | 5 | 6.33 | | |
| 2037-000 | 6 | Kerr | 7652500000 | WERNER WAYNE ALLERKAMP | CYPRESS CRK | IRRG | 5 | 6.33 | | |
| 2038-000 | 6 | Kerr | 7652000000 | HARRY E REEH | CYPRESS CRK | IRRG | 15 | 15 | | |
| 2039-000 | 6 | Kerr | 7650500000 | FRED SAUR | CYPRESS CRK | IRRG | 7 | 7 | | |
| 2040-000 | 6 | Kerr | 7650000000 | A C & DOROTHY PFEIFFER | CYPRESS CRK | IRRG | 10 | 5 | | |
| 2041-000 | 6 | Kerr | 7645000000 | THOMAS L BRUNDAGE ET AL | CYPRESS CRK | IRRG | 134 | 57 | | AMEND 2/1/85 |
| 2042-000 | 6 | Kerr | 7644800000 | E J & VIRGINIA DOWER | CYPRESS CRK | IRRG | 209 | 125 | | |
| 2043-000 | 6 | Kerr | 7644600000 | MARY LEE EDWARDS | CYPRESS CRK | IRRG | 19.57 | 14.68 | | |
| 2043-000 | 6 | Kerr | 7644600000 | EDGAR SEIDENSTICKER ET UX | CYPRESS CRK | IRRG | 16.85 | 12.63 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2043-000 | 6 | Kerr | 7644600000 | L J MANNERING ET UX | CYPRESS CRK | IRRG | 3.58 | 2.69 | | |
| 2437-000 | 6 | Kerr | 9550000000 | CHLOE CULLUM KEARNEY ET AL | N FRK GUADALUPE RIVER | REC | | | 100 | D&L. RESERVOIR JOINTLY OWNED BY SEVERAL. |
| 2437-000 | 6 | Kerr | 9550000000 | DAN W BACON ET UX | N FRK GUADALUPE RIVER | REC | | | | D&L. RESERVOIR JOINTLY OWNED BY SEVERAL. |
| 2438-000 | 6 | Kerr | 9528000000 | LUTZ ISSLIEB ET AL | N FRK GUADALUPE RIVER | IRRG | 30 | 18 | 30 | |
| 2439-000 | 6 | Kerr | 9510000000 | DALE B AND MARSHA G ELMORE | N FRK GUADALUPE RIVER | IRRG | 8 | 8 | 20 | AMEND 10/29/90 |
| 2440-000 | 6 | Kerr | 9507000000 | L F SCHERER | N FRK GUADALUPE RIVER | IRRG | 1 | 1 | | |
| 2441-000 | 6 | Kerr | 9490000000 | SILAS B RAGSDALE | N FRK GUADALUPE RIVER | IRRG | 21 | 105 | | |
| 2442-000 | 6 | Kerr | 9486000000 | LUTHER GRAHAM | HONEY CRK | IRRG | 28 | 14 | 17 | |
| 2443-000 | 6 | Kerr | 9476500000 | JOHN H DUNCAN | HONEY CRK | IRRG | 40 | 20 | 25 | |
| 2444-000 | 6 | Kerr | 9980000000 | BRUCE F. HARRISON | S FRK GUADALUPE RIVER | IRRG | 6 | 3 | 10 | |
| 2444-000 | 6 | Kerr | 9980000000 | BRUCE F. HARRISON | S FRK GUADALUPE RIVER | REC | | | 17 | |
| 2445-000 | 6 | Kerr | 9680000000 | CAMP MYSTIC INC | CYPRESS CRK | IRRG | 12 | 15 | | |
| 2445-000 | 6 | Kerr | 9680000000 | CAMP MYSTIC INC | CYPRESS CRK | MUNI | 14 | | 20 | |
| 2446-000 | 6 | Kerr | 9675000000 | BOB/KAT INC | S FRK GUADALUPE RIVER | IRRG | 10 | 10 | | |
| 2446-000 | 6 | Kerr | 9675000000 | BOB/KAT INC | S FRK GUADALUPE RIVER | MUNI | 10 | | | |
| 2447-000 | 6 | Kerr | 9625000000 | CAMP LA JUNTA INC | S FRK GUADALUPE RIVER | IRRG | 26 | 15 | 30 | |
| 2447-000 | 6 | Kerr | 9625000000 | CAMP LA JUNTA INC | S FRK GUADALUPE RIVER | MUNI | 14 | | | & RECREATION |
| 2448-000 | 6 | Kerr | 9350000000 | ALICE CYNTHIA SIMKINS | TEGENER CRK | IRRG | 6 | 5 | | |
| 2449-000 | 6 | Kerr | 9310000000 | BILLIE ZUBER ET AL | GUADALUPE RIVER | IRRG | 17 | 25.5 | | AMEND 9/24/93:ADD ACREAGE.JUNIOR PRIORTY |
| 2450-000 | 6 | Kerr | 7999000000 | ROBERT L MOSTY ET AL | GUADALUPE RIVER | IRRG | 158 | 117 | | |
| 3769-000 | 1 | Kerr | 8300010000 | CITY OF KERRVILLE | GUADALUPE RIVER | MUNI | 3603 | | 840 | |
| 3769-000 | 1 | Kerr | 8300010000 | CITY OF KERRVILLE | GUADALUPE RIVER | IRRG | | 192 | | USING 2450 AF WASTEWATER FROM SEWAGE.SC |
| 3846-000 | 1 | Kerr | 7715000000 | T & R PROPERTIES | PALMER CRK | REC | 322 | | 322 | |
| 3896-000 | 1 | Kerr | 8276000000 | KENNETH W & MARCIA C MULFORD | RATTLESNAKE | MUNI | | | 13 | 3 TRACTS 34.55 AC, ALSO REC |
| 3904-000 | 1 | Kerr | 8275500000 | CITY OF KERRVILLE | QUINLAN CRK | IRRG | 80 | 56 | 10 | & REC-2 RES-146-AC TR-EXPIRES 20 YEARS |
| 4007-000 | 1 | Kerr | 7703100000 | PECAN VALLEY RANCH OWNERS ASSO | ELM CRK | REC | | | 157 | ALSO DOMESTIC & LIVESTOCK |
| 4034-000 | 1 | Kerr | 9040000000 | SHELTON RANCHES INC | JOHNSON CRK | REC | | | 122 | 2 RES, SEE FILE, & ADJ 1974 |
| 4223-000 | 1 | Kerr | 9105000000 | SHELTON RANCHES INC | JOHNSON CRK | IRRG | 20 | 14 | 39 | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 4298-000 | 1 | Kerr | 8294800000 | ALISON B MENCAROW LIVING TRUST | TOWN CRK | IRRG | 12 | 18 | | AMEND 12/10/91 |
| 4486-000 | 1 | Kerr | 7644900000 | JAY & HILDA POTH | CYPRESS CRK | IRRG | 70 | 35 | | RATE SEE 18-2041 |
| 5060-000 | 1 | Kerr | 8710000000 | HORACE COFER ASSOCIATES, INC | FALL BR CRK | IRRG | 10 | 12 | | |
| 5122-000 | 1 | Kerr | 8150800000 | JAMES C STORM | GUADALUPE RIVER | IRRG | 75 | 50 | 8 | |
| 5208-000 | 1 | Kerr | 7701500000 | JAMES F HAYES & MARY K HAYES | VERDE CRK | IRRG | 40 | 40 | | |
| 5315-000 | 1 | Kerr | 8294000000 | DANA G KIRK TRUSTEE | E TOWN CRK | OTHER | | | | PRIVATE WATER |
| 5322-000 | 1 | Kerr | 8705000000 | E RAND SOUTHARD ET UX | FALL BR | REC | | | | |
| 5331-000 | 1 | Kerr | 9660000000 | KATHLEEN B FLOURNOY, ET AL | S FRK GUADALUPE RIVER | MUNI | 15 | | 30 | & RECREATION |
| 5331-000 | 1 | Kerr | 9660000000 | KATHLEEN B FLOURNOY, ET AL | S FRK GUADALUPE RIVER | IRRG | 96 | 30 | | |
| 5348-000 | 1 | Kerr | 9526000000 | BRYON DONZIS | N FRK GUADALUPE RIVER | IRRG | 5 | 4 | | |
| 5352-000 | 1 | Kerr | 9650000000 | BONITA OWNERS ASSOC INC | S FRK GUADALUPE RIVER | IRRG | 2 | 2 | | |
| 5394-000 | 1 | Kerr | 8300010000 | UPPER GUADALUPE RIVER AUTH | GUADALUPE RIVER | MUNI | 1661 | | | FIRM YIELD BASIS. AMENDED 4/10/98. SCS. |
| 5394-000 | 1 | Kerr | 8300010000 | UPPER GUADALUPE RIVER AUTH | GUADALUPE RIVER | MUNI | 339 | | | FIRM YIELD BASIS. AMENDED 4/10/98. SCS. |
| 5394-000 | 1 | Kerr | 8300010000 | CITY OF KERRVILLE | GUADALUPE RIVER | MUNI | 761 | | | FIRM YIELD BASIS. AMENDED 4/10/98. SCS. |
| 5394-000 | 1 | Kerr | 8300010000 | CITY OF KERRVILLE | GUADALUPE RIVER | MUNI | 339 | | | RUN OF RIVER BASIS. AMENDED 4/10/98.SCS |
| 5394-000 | 1 | Kerr | 8300010000 | CITY OF KERRVILLE | GUADALUPE RIVER | MUNI | 1069 | | | RUN OF RIVER BASIS. AMENDED 4/10/98.SCS |
| 5401-000 | 1 | Kerr | 8156130000 | H E BUTT GROCERY CO | TURTLE CRK | REC | | | 16 | EXP 12/31/2012 |
| 5402-000 | 1 | Kerr | 8155300000 | TURTLE CREEK INDUSTRIES INC | TURTLE CRK | REC | | | | |
| 5444-000 | 1 | Kerr | 8490000000 | EUGENE D ELLIS ET UX | GUADALUPE RIVER | IRRG | 10 | 25.5 | | |
| 5479-000 | 1 | Kerr | 7701250000 | CITY SOUTH MANAGEMENT CORP | GUADALUPE RIVER | IRRG | 566 | 283 | | AMENDED 3/13/98 |
| 5495-000 | 1 | Kerr | 9800000000 | LOIS & JOSEPH WESSENDORF ET AL | S FRK GUADALUPE RIVER | REC | | | 9 | |
| 5521-000 | 1 | Kerr | 8300050000 | DON D WILSON | GUADALUPE LAKE | IRRG | 30 | 30 | | GUADALUPE RIVER |
| 5531-000 | 1 | Kerr | 8185700000 | LEE ROY COSPER ET UX | GUADALUPE RIVER | IRRG | 80 | 40 | | |
| 5536-000 | 1 | Kerr | 7701350000 | ROBERT H & CHARLOTTE JENNINGS | GUADALUPE RIVER | IRRG | 400 | 200 | | |
| 5541-000 | 1 | Kerr | 9476150000 | BASHARDT LTD | N FRK GUADALUPE RIVER | IRRG | 14 | 15 | | |
| 2671-000 | 6 | Kinney | 4950000000 | MAVERICK CO WCID 1 | RIO GRANDE | IRRG | 134900 | 45000 | | & CO 162, AMEND 8/22/86,9/22/88,10/30/98 |
| 2671-000 | 6 | Kinney | 4950000000 | MAVERICK CO WCID 1 | RIO GRANDE | MUNI | 2049 | | | AMEND 8/22/86,9/22/88,10/30/98 |
| 2671-000 | 6 | Kinney | 4950000000 | MAVERICK CO WCID 1 | RIO GRANDE | REC | 196 | | | AMEND 8/22/86,9/22/88,10/30/98 |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2671-000 | 6 | Kinney | 4950000000 | MAVERICK CO WCID 1 | RIO GRANDE | HYDRO | 1085966 | | | AMEND 8/22/86,9/22/88,10/30/98 |
| 2673-000 | 6 | Kinney | 4950000000 | LENDELL MARTIN ET UX | MUD CRK | IRRG | 52 | 35 | 16 | |
| 2674-000 | 6 | Kinney | 4950000000 | CLYDE M BRADLEY | MUD CRK | IRRG | 20 | 15 | | RATE SEE 23-2673 |
| 2675-000 | 6 | Kinney | 4950000000 | SHERWOOD GAINES TRUSTEE | MUD CRK | IRRG | 60 | 30 | | RATE SEE 23-2673 |
| 2676-000 | 6 | Kinney | 4950000000 | JEWEL FOREMAN ROBINSON | PINTO CRK | IRRG | 252 | 126 | | |
| 2677-000 | 6 | Kinney | 4950000000 | MARLIN E BRAUCHLE | PINTO CRK | IRRG | 21 | 14 | | |
| 2678-000 | 6 | Kinney | 4950000000 | JOHNNY E RUTHERFORD | PINTO CRK | IRRG | 135 | 90 | | |
| 2679-000 | 6 | Kinney | 4950000000 | CITY OF BRACKETTVILLE | LAS MORAS SPRING | MUNI | 3 | | | |
| 2680-000 | 6 | Kinney | 4950000000 | ELISE AULGUR HUNTSMAN ET AL | LAS MORAS CRK | IRRG | 15 | 15 | | JOINT OWNER OF 15 AF TO IRR 15 ACRES |
| 2680-000 | 6 | Kinney | 4950000000 | ANN A LEGG & ERNESTINE A LOPEZ | LAS MORAS CRK | IRRG | | | | JOINT OWNER OF 15 AF TO IRR 15 ACRES |
| 2681-000 | 6 | Kinney | 4950000000 | EARL H NOBLES | LAS MORAS CRK | IRRG | 10 | 10 | | |
| 2682-000 | 6 | Kinney | 4950000000 | BERNARD C MEISCHEN ET AL | LAS MORAS CRK | IRRG | 25 | 25 | | |
| 2682-000 | 6 | Kinney | 4950000000 | CHARLES W GAEBLER ET AL | LAS MORAS CRK | IRRG | 75 | 75 | | +50 AF FROM 7 RES FOR STOCK RAISING |
| 2683-000 | 6 | Kinney | 4950000000 | ANDREW P MALINOVSKY JR | LAS MORAS CRK | IRRG | 60 | 30 | | |
| 2684-000 | 6 | Kinney | 4950000000 | BEN S JONES | ELM CRK | IRRG | 47 | 26 | 6 | |
| 2685-000 | 6 | Kinney | 4950000000 | EARL A KELLEY | ELM CRK | IRRG | 53 | 35 | 15 | |
| 2686-000 | 6 | Kinney | 4950000000 | ROBERT H MEISCHEN, ET AL | LAS MORAS CRK | IRRG | 300 | 300 | | |
| 2686-000 | 6 | Kinney | 4950000000 | ROBERT H MEISCHEN, ET AL | LAS MORAS CRK | MUNI | 50 | | | 4 RESERVOIRS |
| 2687-000 | 6 | Kinney | 4950000000 | CELIA R DE PLAZA, ET AL | LAS MORAS CRK | IRRG | 110 | 55 | | |
| 2913-000 | 6 | Kinney | 4950000000 | MOODY RANCHES INC | RIO GRANDE | IRRG | 5500 | 3000 | 17 | |
| 2913-000 | 6 | Kinney | 4950000000 | MOODY RANCHES INC | RIO GRANDE | IRRG | 500 | 250 | | |
| 3071-000 | 6 | Kinney | 7023010000 | LLOYD L DAVIS | W NUECES RIVER | OTHER | | | 25 | IMPOUNDMENT |
| 4365-000 | 1 | Kinney | 7028000000 | ROBERT L MOODY JR | SPRING BR | REC | 10 | | 42 | 4 RES |
| 4389-000 | 1 | Kinney | 4950000000 | FORT CLARK SPRINGS ASSOC INC | LAS MORAS CRK | REC | | | | |
| 4517-000 | 1 | Kinney | 4950000000 | FORT CLARK SPRINGS ASSOC INC | LAS MORAS CRK | REC | | | 3 | |
| 1610-000 | 9 | Medina | 5700000000 | L KEN EVANS | MEDINA RIVER | IRRG | 20 | | | LAKE MEDINA, EXP 2016 |
| 3016-000 | 6 | Real | 9615000000 | JOHN H WATTS III ET UX | E PRONG NUECES RIVER | IRRG | 4 | 2 | | SC. TWO PRIORITY DATES. AMEND 7/10/98 |
| 3016-000 | 6 | Real | 9615000000 | JOHN H WATTS III ET UX | E PRONG NUECES RIVER | IRRG | 54 | 27 | | SC. TWO PRIORITY DATES. AMEND 7/10/98 |
| 3018-000 | 6 | Real | 9450000000 | LEWIS CLECKLER ET UX | SPRING CRK | IRRG | 22.7 | 12.1 | | BULLHEAD HOLLOW |
| 3018-000 | 6 | Real | 9450000000 | EL CAMINO GIRL SCOUT COUNCIL | SPRING CRK | IRRG | 7.3 | 3.9 | | BULLHEAD HOLLOW |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 3019-000 | 6 | Real | 9410000000 | SARAH M DAVIS | BULLHEAD CRK | IRRG | 80 | 40 | | |
| 3019-000 | 6 | Real | 9410000000 | SARAH M DAVIS | BULLHEAD CRK | IRRG | | 13 | | |
| 3020-000 | 6 | Real | 9320000000 | H C MCCARTY JR ET UX | BULLHEAD CRK | IRRG | 34.736 | 17.368 | | |
| 3020-000 | 6 | Real | 9320000000 | F WALTER CONRAD JR ET UX | BULLHEAD CRK | IRRG | 85.264 | 42.632 | | |
| 3021-000 | 6 | Real | 9198500000 | DSD, INC | BULLHEAD CRK | IRRG | 418 | 210 | | |
| 3022-000 | 6 | Real | 9190000000 | MARVIN L BERRY | UNNAMED TRIB NUECES RIVER | IRRG | 259 | 300 | 14 | TRIB OF NUECES RIVER |
| 3022-000 | 6 | Real | 9190000000 | MARVIN L BERRY | UNNAMED TRIB NUECES RIVER | IRRG | 485 | | | |
| 3025-000 | 6 | Real | 9150000000 | WILLIAM C & WANDA LEA LANE | DRY CRK | IRRG | 40 | 20 | 1 | |
| 3026-000 | 6 | Real | 9075000000 | JOHN A DANIEL ET UX | DRY CRK | IRRG | 16 | 8 | 90 | |
| 3027-000 | 6 | Real | 9050000000 | J F ALSOP | DRY CRK | IRRG | 20 | 10 | | |
| 3028-000 | 6 | Real | 9040000000 | CLARENCE W HARRISON ET UX | DRY CRK | IRRG | 15.43 | 7.72 | 43 | |
| 3028-000 | 6 | Real | 9040000000 | CLARENCE W HARRISON ET UX | DRY CRK | REC | | | 4 | |
| 3028-000 | 6 | Real | 9040000000 | W THOMAS TAYLOR ET UX | DRY CRK | IRRG | 4.36 | 2.18 | | |
| 3029-000 | 6 | Real | 9008000000 | HENRY D ENGELKING | NUECES RIVER | IRRG | 43 | 52 | | |
| 3034-000 | 6 | Real | 9004000000 | HERBERT C JEFFRIES ET UX | NUECES RIVER | IRRG | | 2 | | SEE ADJ 3030 |
| 3036-000 | 6 | Real | 9000000000 | SALVADOR ORTIZ ET AL | NUECES RIVER | IRRG | 125 | 50 | | |
| 3037-000 | 6 | Real | 8950000000 | DAVID WELDON TINDLE | NUECES RIVER | IRRG | 25 | 25 | | |
| 3050-000 | 6 | Real | 8000000000 | W A MALEY | E CAMP WOOD CRK | IRRG | 28 | 14 | | |
| 3051-000 | 6 | Real | 7980000000 | ROBERT J LLOYD ET UX | E CAMP WOOD CRK | IRRG | 1.42 | 1.42 | | |
| 3051-000 | 6 | Real | 7980000000 | WANNA LOU LLOYD | E CAMP WOOD CRK | IRRG | 4.08 | 4.08 | | |
| 3052-000 | 6 | Real | 7970000000 | BARRY BLANKS MCHALEK ET UX | E CAMP WOOD CRK | IRRG | 5 | 5 | | SEE ADJ 3051 |
| 3053-000 | 6 | Real | 7960000000 | BARRY BLANKS MCHALEK ET UX | E CAMP WOOD CRK | IRRG | 1 | 1 | | SEE ADJ 3051 |
| 3054-000 | 6 | Real | 7950000000 | JOHN CHAMBERS ET AL | E CAMP WOOD CRK | IRRG | 10 | 10 | | SEE ADJ 3051 |
| 3055-000 | 6 | Real | 7900000000 | WILLIAM C & PATRICIA K SUTTON | E CAMP WOOD CRK | IRRG | 105 | 130 | 2 | |
| 3056-000 | 6 | Real | 7810000000 | ROY GIBBENS | E CAMP WOOD CRK | IRRG | 18 | 9 | 4 | |
| 3056-000 | 6 | Real | 7810000000 | ROY GIBBENS | E CAMP WOOD CRK | IRRG | 2 | | | |
| 3057-000 | 6 | Real | 7800000000 | MAGELEE V SWIFT | E CAMP WOOD CRK | IRRG | 21 | 16 | 8 | SEE ADJ 3056 |
| 3057-000 | 6 | Real | 7800000000 | MAGELEE V SWIFT | E CAMP WOOD CRK | IRRG | 10 | 4 | 4 | |
| 3058-000 | 6 | Real | 7740000000 | DOROTHY MERRITT ANDERSON | NUECES RIVER | IRRG | 8 | 8 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 3059-000 | 6 | Real | 7730000000 | F L JR & CHARLOTTE HATLEY | NUECES RIVER | IRRG | 11 | 7 | | |
| 3060-000 | 6 | Real | 7631000000 | E E GILDART | NUECES RIVER | IRRG | 42 | 21 | | |
| 3060-000 | 6 | Real | 7631000000 | E E GILDART | NUECES RIVER | IRRG | 54 | 26 | | |
| 3060-000 | 6 | Real | 7631000000 | E E GILDART | NUECES RIVER | IRRG | 35 | 46 | | |
| 3061-000 | 6 | Real | 7630000000 | E E GILDART | NUECES RIVER | IRRG | 31 | 31 | | |
| 3062-000 | 6 | Real | 7550000000 | JOANNE FRIEND | NUECES RIVER | IRRG | 46 | 46 | | |
| 3145-000 | 6 | Real | 3900000000 | GEORGE S HAWN INTERESTS ET AL | S P/L P W FRIO RIVER | REC | | | 27 | |
| 3145-000 | 6 | Real | 3900000000 | GEORGE S HAWN INTERESTS ET AL | S P/L P W FRIO RIVER | REC | | | 68 | |
| 3145-000 | 6 | Real | 3900000000 | GEORGE S HAWN INTERESTS ET AL | S P/L P W FRIO RIVER | IRRG | 156 | 78 | | |
| 3146-000 | 6 | Real | 3850000000 | JAMES W HALE ET AL | W FRIO RIVER | REC | | | 16 | |
| 3147-000 | 6 | Real | 3810000000 | DIAMOND J RANCH INC | W FRIO RIVER | IRRG | 165 | 55 | | |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 3.5 | | 10 | |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 6.5 | 2 | | UPPER SINGING HILLS RESERVOIR |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 11 | | 11 | UNNAMED DOWNSTREAM RESERVOIR (D-0340) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 34.8 | 12.9 | | UNNAMED RESERVOIR (D-0340) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 6.7 | 2.5 | | UNNAMED RESERVOIR (D-0340) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 25.08 | | 25.08 | LINNET'S WINGS DAM (D-0220);AMEND 3/91 |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 3.2 | 1.2 | | LINNET'S WINGS DAM (D-0220) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 34 | | 68.7 | LAITY LODGE DAM (D-0240):AF/WATERFALL |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 4 | 2 | | LAITY LODGE DAM (D-0240) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 5.51 | | 5.51 | LOWER SINGING HILLS DAM (D-0280) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | IRRG | 4.1 | 1.5 | | LOWER SINGING HILLS DAM (D-0280) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 2.64 | | 2.64 | SILVER CREEK DAM (D-0300) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 0.24 | | 0.24 | LOWER SILVER CREEK DAM (D-0320) |
| 3148-000 | 6 | Real | 3750000000 | H. E. BUTT FOUNDATION | E FRIO RIVER | REC | 17.86 | | 17.86 | ECHO VALLEY DAM (D-0360) |
| 3149-000 | 6 | Real | 3660000000 | ORA L ROGERS ESTATE | E FRIO RIVER | IRRG | 30 | 28 | | |
| 3150-000 | 6 | Real | 3655000000 | R F BINDOCK | E FRIO RIVER | IRRG | 3 | 11 | | |
| 3151-000 | 6 | Real | 3620000000 | KATHERINE MAXINE MORELAND | E FRIO RIVER | IRRG | 67 | 30 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 3152-000 | 6 | Real | 3600000000 | DAN AULD, JR | E FRIO RIVER | IRRG | 324 | 162 | | |
| 3153-000 | 6 | Real | 3490000000 | JOHN J BURDITT, ET AL | UNNAMED TRIB E FRIO RIVER | IRRG | 15 | 50 | | |
| 3153-000 | 6 | Real | 3490000000 | JOHN J BURDITT, ET AL | UNNAMED TRIB E FRIO RIVER | IRRG | 23 | | | |
| 3154-000 | 6 | Real | 3430000000 | JAMES TREES | YOUNGBLOOD SPRING | IRRG | 2 | 6 | | |
| 3155-000 | 6 | Real | 3420000000 | LOTTIE N WRIGHT | FRIO RIVER | IRRG | 164 | 43 | | |
| 3156-000 | 6 | Real | 3400000000 | H P COOPER ET AL | FRIO RIVER | IRRG | 20 | 22 | | |
| 3156-000 | 6 | Real | 3400000000 | H P COOPER ET AL | FRIO RIVER | IRRG | 2 | | | |
| 3157-000 | 6 | Real | 3350000000 | E F BAYOUTH, MD PENSION PLAN | FRIO RIVER | IRRG | 250 | 125 | | AMEND 1/9/85. CURRENT OWNER UNKNOWN 5/98 |
| 3158-000 | 6 | Real | 3375000000 | LOMBARDY IRRIGATION CO | FRIO RIVER | IRRG | 1600 | 800 | 6 | ALSO COUNTY 232 |
| 3159-000 | 6 | Real | 3294000000 | SAM G HARRISON | FRIO RIVER | IRRG | 140 | 70 | | |
| 3160-000 | 6 | Real | 3290000000 | GRACIA BASSETT HABY | FRIO RIVER | IRRG | 60 | 100 | | JOINTLY OWNS 60 AF TO IRR 100 ACRES |
| 3160-000 | 6 | Real | 3290000000 | THEODORE R REED TRUSTEE | FRIO RIVER | IRRG | | | | JOINTLY OWNS 60 AF TO IRR 100 ACRES |
| 3161-000 | 6 | Real | 3289500000 | R L HUBBARD | DRY FRIO CRK | IRRG | 17 | 21 | | |
| 3162-000 | 6 | Real | 3287500000 | CARL A. DETERING, JR., ET AL | UNNAMED TRIB BUFFALO CRK | IRRG | 5 | 25 | 15 | |
| 3180-000 | 6 | Real | 2799000000 | LANA J STORMONT | UNNAMED TRIB W SABINAL RIVER | IRRG | 5 | 10 | | |
| 3878-000 | 1 | Real | 3645000000 | C B SLABAUGH | CYPRESS CRK | IRRG | 40 | 30 | | 68-AC TR, SC, AMEND 11/12/84 |
| 3978-000 | 1 | Real | 9421000000 | N M FITZGERALD JR ESTATE | FLYNN CRK | IRRG | 187 | 63 | | 156.95-AC TR, SC |
| 4008-000 | 1 | Real | 9172500000 | DOUGLAS B & MARGARET MARSHALL | NUECES RIVER | IRRG | 400 | 200 | | AMEND 12/15/81 INCR AC-FT, ACRES, CFS |
| 4094-000 | 1 | Real | 3905500000 | GEORGE S HAWN INTERESTS ET AL | W FRIO RIVER | IRRG | 56 | 28 | 9 | OUT OF 1118 ACRES |
| 4169-000 | 1 | Real | 7910000000 | ROARING SPRINGS RANCH INC | CAMP WOOD CRK | IRRG | 15 | 10 | 41 | 6 RES & REC |
| 4169-000 | 1 | Real | 7910000000 | ROARING SPRINGS RANCH INC | CAMP WOOD CRK | MUNI | 15 | | | |
| 4405-000 | 1 | Real | 7760000000 | CITY OF CAMP WOOD | UNNAMED TRIB NUECES RIVER | MUNI | 1000 | | | |
| 4405-000 | 1 | Real | 7760000000 | CITY OF CAMP WOOD | UNNAMED TRIB NUECES RIVER | IRRG | 83 | 16 | | |
| 4413-000 | 1 | Real | 8240000000 | WILLIAM C SUTTON ET UX | CAMP WOOD CRK | REC | | | 2 | |
| 5009-000 | 1 | Real | 3830000000 | JACKSON L BABB ET AL | W FRIO RIVER | IRRG | 60 | 30 | | |
| 2653-000 | 6 | Val Verde | 4950000000 | PHIL B FOSTER | CIENEGAS CRK &/OR THE RIO GRANDE | IRRG | 122.25 | 61.13 | | AMEND 10/15/91 |
| 2653-000 | 6 | Val Verde | 4950000000 | DAVID B TERK ET AL | CIENEGAS CRK | IRRG | 27.75 | 13.87 | | AMEND 10/15/91 |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2654-000 | 6 | Val Verde | 4950000000 | THURMAN W OWENS | CIENEGAS CRK | IRRG | 26 | 13 | | RATE SEE 23-2653 |
| 2655-000 | 6 | Val Verde | 4950000000 | JOSE C OVIEDO ET UX | CIENEGAS CRK | IRRG | 28 | 14 | | RATE SEE 23-2653 |
| 2656-000 | 6 | Val Verde | 4950000000 | RANDOLPH J N & SHARON M ABBEY | CIENEGAS CRK | IRRG | 68 | 43 | | RATE SEE 23-2653 |
| 2657-000 | 6 | Val Verde | 4950000000 | RONALD J PERSYN ET UX | CIENEGAS CRK | IRRG | 150 | 75 | | RATE SEE 23-2653 |
| 2657-000 | 6 | Val Verde | 4950000000 | RONALD J. PERSYN, ET UX | CIENEGAS CRK | IRRG | 150 | 68 | | SEE 23-2653 RATE; AMEND 10/89 |
| 2657-000 | 6 | Val Verde | 4950000000 | RONALD J. PERSYN, ET UX | CIENEGAS CRK | IRRG | | 89 | | AMEND 8/2/94 |
| 2659-000 | 6 | Val Verde | 4950000000 | JOHN F QUALIA | CIENEGAS CRK | IRRG | 112 | 56 | | FOR RATE SEE 23-2653 |
| 2660-000 | 6 | Val Verde | 4950000000 | JOSE A CORTINAS ET AL | CIENEGAS CRK | IRRG | 16 | 5 | | |
| 2660-000 | 6 | Val Verde | 4950000000 | LJB ENTERPRISES | CIENEGAS CRK | IRRG | 296 | 99 | | |
| 2661-000 | 6 | Val Verde | 4950000000 | BARBARA GULICK RATHKE, ET AL | CIENEGAS CRK | IRRG | 120 | 40 | 10 | |
| 2662-000 | 6 | Val Verde | 4950000000 | CAPITOL AGGREGATES INC | CIENEGAS CRK | MINE | 166 | 17 | | AMEND 11/2/87 |
| 2663-000 | 6 | Val Verde | 4950000000 | ALFREDO GUTIERREZ JR | CIENEGAS CRK | IRRG | 24 | 8 | | |
| 2664-000 | 6 | Val Verde | 4950000000 | SAN FELIPE A MFG & I COMPANY | SAN FELIPE CRK | IRRG | 4950 | 1700 | | AMEND 12/16/88, 10/31/94 |
| 2664-000 | 6 | Val Verde | 4950000000 | SAN FELIPE A MFG & I COMPANY | SAN FELIPE CRK | IRRG | 6 | | 6 | IMPOUNDMENT #1 |
| 2664-000 | 6 | Val Verde | 4950000000 | SAN FELIPE A MFG & I COMPANY | SAN FELIPE CRK | IRRG | 6 | | 6 | IMPOUNDMENT #2 |
| 2664-000 | 6 | Val Verde | 4950000000 | SAN FELIPE A MFG & I COMPANY | SAN FELIPE CRK | INDU | 50 | | | AMENDMENT EXP 12/31/96 |
| 2665-000 | 6 | Val Verde | 4950000000 | JOSE OVIEDO JR ET UX | SAN FELIPE CRK | IRRG | 60 | 40 | | AMENDED 9/13/96 |
| 2666-000 | 6 | Val Verde | 4950000000 | PETRA ABREGO MUNOZ | SAN FELIPE CRK | IRRG | 23.56 | 7.85 | | |
| 2669-000 | 6 | Val Verde | 4950000000 | RODOLFO MOTA | SAN FELIPE CRK | IRRG | 6 | 2 | | |
| 2670-000 | 6 | Val Verde | 4950000000 | VICTOR D BOLNER | SAN FELIPE CRK | IRRG | 6 | 3 | | |
| 2672-000 | 6 | Val Verde | 4950000000 | CITY OF DEL RIO | SAN FELIPE CRK | MUNI | 4416 | | | |
| 2672-000 | 6 | Val Verde | 4950000000 | CITY OF DEL RIO | SAN FELIPE CRK | MUNI | 7000 | | | |
| 2811-000 | 6 | Val Verde | 4950000000 | RIO BRAVO INC | CIENEGAS CRK &/OR THE RIO GRANDE | IRRG | 51.08 | 997.97 | 47 | & REC/DOM, AMEND 1/84,6/91 |
| 2811-000 | 6 | Val Verde | 4950000000 | DAVID B TERK | CIENEGAS CRK | IRRG | 114.64 | 95.38 | | |

| Water Right Number | Type | County | River Order Permit | Name | Stream | Use | Amount in Ac-Ft/Yr | Acreage | Res Cap in Ac-Ft | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 2912-000 | 6 | Val Verde | 4950000000 | MOODY RANCHES INC | SAN FELIPE CRK | IRRG | 800 | 400 | 10 | |
| 3880-000 | 1 | Val Verde | 4950000000 | SOUTH TEXAS ELECTRIC CO-OP INC | RIO GRANDE | HYDRO | 1500000 | | | AMEND 12/14/87. POWER POOL WITH MEDINA. |
| 3880-000 | 1 | Val Verde | 4950000000 | MEDINA ELECTRIC CO-OP INC | RIO GRANDE | HYDRO | | | | AMEND 12/14/87. POWER POOL WITH S.TX.EL. |
| 5506-000 | 1 | Val Verde | 4950000000 | DEL RIO, CITY OF | SAN FELIPE CRK | REC | | | 0.19 | WATER PARK LANDING POOL |

4

# CHAPTER 4
# IDENTIFICATION OF WATER NEEDS

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# 4 IDENTIFICATION OF WATER NEEDS

Chapter 4 provides projections (Table 4-1) of water supply surpluses or deficits by decade based on a comparison of projected water demands by decade for each water-use entity from Chapter 2 (Table 2-2) with water supplies available to meet those demands from Chapter 3 (Table 3-2). Entities are then identified that, in any decade within the 50-year planning period, develop a water-supply need (deficit) that is greater than that entity's ability to provide a supply to meet that need. A water-supply deficit may develop for individual water-use entities for numerous reasons including supply availability limits, infrastructure limitations, or legal limits. Table 4-2 provides the needs/surpluses analyses for Del Rio wholesale water provider.

Municipal water supply deficits are identified for Rocksprings, Kerrville, Loma Vista, Camp Wood, and County-Other (rural) in Kerr County. Irrigation shortages are shown in Bandera and Kerr Counties; mining shortages in Edwards, Kerr, and Val Verde Counties; and livestock shortages in Bandera, Edwards, Kerr, Kinney, and Real Counties. Water management strategies developed for this *Plan* are intended to meet all projected water supply shortages.

A secondary water needs analysis for all water user groups and wholesale water providers for which conservation or direct reuse water management strategies are recommended is provided in Table 4-3. This secondary water needs analysis calculates the water needs that would remain after assuming all recommended conservation and reuse water management strategies are fully implemented. Table 4-4 presents unmet needs resulting from insufficient supplies to meet certain strategies.

Water supply strategy recommendations are then made in Chapter 5 for those water users that have projected water supply deficits based on the comparison between demand and supply. In addition, strategies are also developed for specific entities that although they are not projected to have future shortages, they do have anticipated water-supply projects that deserve to be recognized in the *Regional Plan*. A socioeconomic impact of unmet water needs analysis prepared by the Texas Water Development Board is provided in Appendix 6A.

It is important to note that the methodology used to estimate water needs/surpluses for County-Other use depicts water supply available to County-Other as a whole. The methodology assumes that all County-Other water supply is available to satisfy demand, whereas in reality, County-Other population and water demand are often concentrated in smaller areas of the county such as unincorporated communities, subdivisions and mobile home parks which cannot access water supply available in other areas of the county. The reflected surplus depicted in the tables may or may not be an accurate estimate depending on population densities. Increasing population density increases water demand by straining available local water supply resources though the County-Other as a whole reflects adequate supply.

**Table 4-1. Identified Water (Needs)/Surpluses**
**(Acre Feet per Year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **Bandera County** | | | | | | |
| **Guadalupe Basin** | | | | | | |
| County-Other | 4 | 2 | 1 | 1 | 1 | 1 |
| Livestock | (12) | (12) | (12) | (12) | (12) | (12) |
| **Nueces Basin** | | | | | | |
| County-Other | 7 | (9) | (18) | (21) | (23) | (24) |
| Livestock | 14 | 14 | 14 | 14 | 14 | 14 |
| Irrigation | 400 | 400 | 400 | 400 | 400 | 400 |
| **San Antonio Basin** | | | | | | |
| Bandera | 469 | 446 | 435 | 429 | 426 | 424 |
| County-Other | 37 | (226) | (360) | (407) | (446) | (469) |
| Livestock | (1) | (1) | (1) | (1) | (1) | (1) |
| Irrigation | (129) | (129) | (129) | (129) | (129) | (129) |
| **Edwards County** | | | | | | |
| **Colorado Basin** | | | | | | |
| Rocksprings | 722 | 726 | 729 | 729 | 730 | 730 |
| County-Other | 61 | 63 | 63 | 63 | 64 | 64 |
| Mining | 4 | 4 | 4 | 4 | 4 | 4 |
| Livestock | 6 | 6 | 6 | 6 | 6 | 6 |
| Irrigation | 44 | 47 | 50 | 53 | 56 | 58 |
| **Nueces Basin** | | | | | | |
| Rocksprings | (98) | (96) | (94) | (94) | (94) | (94) |
| County-Other | 173 | 175 | 178 | 178 | 178 | 178 |
| Mining | 18 | 18 | 18 | 18 | 18 | 18 |
| Livestock | (16) | (16) | (16) | (16) | (16) | (16) |
| Irrigation | 157 | 161 | 164 | 168 | 171 | 174 |
| **Rio Grande Basin** | | | | | | |
| County-Other | 32 | 32 | 33 | 33 | 33 | 33 |
| Mining | (22) | (22) | (22) | (22) | (22) | (22) |
| Livestock | 10 | 10 | 10 | 10 | 10 | 10 |
| Irrigation | 15 | 17 | 20 | 22 | 25 | 27 |
| **Kerr County** | | | | | | |
| **Colorado Basin** | | | | | | |
| County-Other | (5) | (5) | (5) | (5) | (6) | (7) |
| Mining | (12) | (13) | (17) | (17) | (19) | (21) |
| Livestock | (106) | (106) | (106) | (106) | (106) | (106) |
| Irrigation | 21 | 22 | 23 | 23 | 24 | 25 |
| **Guadalupe Basin** | | | | | | |
| Ingram | 387 | 392 | 397 | 399 | 398 | 397 |
| Kerrville | (3,194) | (3,263) | (3,281) | (3,334) | (3,396) | (3,450) |
| Loma Vista Water System | (30) | (37) | (38) | (44) | (51) | (57) |
| County-Other | 3,242 | 3,202 | 3,194 | 3,159 | 3,116 | 3,078 |
| Manufacturing | 9 | 7 | 5 | 4 | 2 | 0 |
| Mining | 42 | 39 | 23 | 21 | 14 | 7 |
| Livestock | 131 | 131 | 131 | 131 | 131 | 131 |
| Irrigation | 556 | 581 | 605 | 630 | 652 | 673 |
| **Nueces Basin** | | | | | | |
| County-Other | (1) | (1) | (1) | (1) | (1) | (1) |
| Livestock | (6) | (6) | (6) | (6) | (6) | (6) |
| **San Antonio Basin** | | | | | | |
| County-Other | 84 | 84 | 85 | 84 | 84 | 83 |
| Livestock | (18) | (18) | (18) | (18) | (18) | (18) |
| Irrigation | (14) | (14) | (13) | (13) | (12) | (12) |

**Table 4-1 (Continued). Identified Water (Needs)/Surpluses**
**(Acre Feet per Year)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Kinney County** | | | | | | |
| **Nueces Basin** | | | | | | |
| County-Other | 23 | 23 | 24 | 24 | 24 | 24 |
| Livestock | 22 | 22 | 22 | 22 | 22 | 22 |
| Irrigation | 338 | 338 | 338 | 338 | 338 | 338 |
| **Rio Grande Basin** | | | | | | |
| Brackettville | 106 | 111 | 118 | 119 | 120 | 120 |
| Fort Clark Springs MUD | 751 | 753 | 757 | 759 | 760 | 760 |
| County-Other | 173 | 175 | 176 | 177 | 177 | 177 |
| Livestock | (22) | (22) | (22) | (22) | (22) | (22) |
| Irrigation | 765 | 765 | 765 | 765 | 765 | 765 |
| **Real County** | | | | | | |
| **Colorado Basin** | | | | | | |
| County-Other | 11 | 11 | 11 | 11 | 11 | 11 |
| Livestock | 33 | 33 | 33 | 33 | 33 | 33 |
| Irrigation | 37 | 38 | 38 | 39 | 39 | 40 |
| **Nueces Basin** | | | | | | |
| Camp Wood | (134) | (131) | (128) | (127) | (126) | (126) |
| County-Other | 817 | 827 | 835 | 839 | 840 | 840 |
| Livestock | (33) | (33) | (33) | (33) | (33) | (33) |
| Irrigation | 2,090 | 2,099 | 2,108 | 2,117 | 2,127 | 2,134 |
| **Val Verde County** | | | | | | |
| **Rio Grande Basin** | | | | | | |
| Del Rio | 16,255 | 15,756 | 15,251 | 14,671 | 14,063 | 13,465 |
| Laughlin AFB | 1,287 | 1,192 | 1,091 | 1,030 | 1,031 | 1,031 |
| County-Other | 2,576 | 2,246 | 1,917 | 1,554 | 1,182 | 819 |
| Mining | (4) | (63) | (73) | (37) | (6) | 15 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 335 | 431 | 521 | 610 | 694 | 769 |

**Table 4-2. Del Rio Wholesale Water Provider Identified Water Needs/Surpluses**

| County | Basin | Water User Group | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Val Verde | Rio Grande | City of Del Rio | 16,255 | 15,756 | 15,251 | 14,671 | 14,063 | 13,465 |
| | | Laughlin AFB | 0 | 0 | 0 | 0 | 0 | 0 |
| | | County Other | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4-3. Second-Tier Identified Water Needs**
**(Acre Feet per Year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **Bandera County** | | | | | | |
| **Guadalupe Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 12 | 12 | 12 | 12 | 12 | 12 |
| **Nueces Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **San Antonio Basin** | | | | | | |
| Bandera | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 1 | 1 | 1 | 1 | 1 | 1 |
| Irrigation | 129 | 129 | 129 | 129 | 129 | 129 |
| **Edwards County** | | | | | | |
| **Colorado Basin** | | | | | | |
| Rocksprings | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Nueces Basin** | | | | | | |
| Rocksprings | 98 | 96 | 94 | 94 | 94 | 94 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 16 | 16 | 16 | 16 | 16 | 16 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Rio Grande Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 22 | 22 | 22 | 22 | 22 | 22 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Kerr County** | | | | | | |
| **Colorado Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 12 | 13 | 17 | 17 | 19 | 21 |
| Livestock | 106 | 106 | 106 | 106 | 106 | 106 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Guadalupe Basin** | | | | | | |
| Ingram | 0 | 0 | 0 | 0 | 0 | 0 |
| Kerrville | 3,047 | 3,116 | 3,134 | 3,187 | 3,249 | 3,303 |
| Loma Vista Water System | 26 | 33 | 34 | 40 | 47 | 53 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4-3. (Continued) Second-Tier Identified Water Needs**
**(Acre Feet per Year)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Guadalupe Basin** | | | | | | |
| Manufacturing | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Nueces Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 6 | 6 | 6 | 6 | 6 | 6 |
| **San Antonio Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 18 | 18 | 18 | 18 | 18 | 18 |
| Irrigation | 14 | 14 | 13 | 13 | 12 | 12 |
| **Kinney County** | | | | | | |
| **Nueces Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Rio Grande Basin** | | | | | | |
| Brackettville | 0 | 0 | 0 | 0 | 0 | 0 |
| Fort Clark Springs MUD | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 22 | 22 | 22 | 22 | 22 | 22 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Real County** | | | | | | |
| **Colorado Basin** | | | | | | |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Nueces Basin** | | | | | | |
| Camp Wood | 133 | 130 | 127 | 126 | 125 | 125 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Livestock | 33 | 33 | 33 | 33 | 33 | 33 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Val Verde County** | | | | | | |
| **Rio Grande Basin** | | | | | | |
| Del Rio | 0 | 0 | 0 | 0 | 0 | 0 |
| Laughlin AFB | 0 | 0 | 0 | 0 | 0 | 0 |
| County-Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | 4 | 63 | 73 | 37 | 6 | 0 |
| Livestock | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4-4. WUG Unmet Needs**
**(Acre-Feet per Year)**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **Kerr County** | | | | | | |
| **Guadalupe Basin** | | | | | | |
| Manufacturing | 0 | 2 | 4 | 5 | 7 | 9 |
| Mining | 47 | 50 | 66 | 68 | 75 | 82 |
| Irrigation | 375 | 350 | 326 | 301 | 279 | 258 |

5

# CHAPTER 5

# WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

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# 5 WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

The Plateau Water Planning Group (PWPG) has identified and evaluated a total of 67 water management strategies. Of this total, 66 strategies have been identified as recommended water management strategies and one alternate strategy was evaluated for the *2016 Plan*. Water management strategies are developed for entities where future water supply needs exist [as required by statute and administrative rules 31 TAC §357.34; 357.35]. A need for water is identified when existing water supplies are less than projected water demands for that same WUG within any planning decade. In addition, water management strategies were developed for other entities requesting specific water supply projects, even though these entities did not have a projected water supply shortage.

# 5.1 IDENTIFICATION OF POTENTIALLY FEASIBLE WATER MANAGEMENT STRATEGIES

## 5.1.1 Selection Process

The first step in developing a list of recommended water management strategies is to take a "big picture" look at possible projects that could reasonably be expected to result in water-supply improvements. As required by Texas Water Code 16.053(d)(5), the *Regional Water Plan* shall consider, but not be limited to, the following potentially feasible water management strategies:

- Improved conditions
- Reuse
- Management of existing water supplies
- Conjunctive use
- Acquisition of available existing water supplies
- Development of new water supplies
- Developing regional water supply facilities or providing regional management of water supply facilities
- Voluntary transfer of water within a region using, but not limited to, regional water banks, sales, leases, options, subordination agreements, and financing agreements
- Emergency transfer of water

Other potential projects considered for the initial list included:

- Appropriate strategies from the *2011 Plan*
- Conservation practices
- Water-loss audits and line replacement
- Vegetative management
- Projects suggested by municipalities through a survey
- Projects that are currently or have recently applied to the TWDB for funding

The following process was used by the PWPG to identify *potentially feasible water management strategies.*

1. Receive a *Needs Analysis Report* (Table 4-1) from the TWDB, which provides a comparison of existing water supplies and projected water demands for each water user group (WUG) and wholesale water provider (WWP) in the Region. Based on this comparison, the report identifies WUGs and WWPs that are expected to experience needs for additional water supplies within the 50-year time frame of the *Regional Water Plan*. Using the following process, identify and select potentially feasible water management strategies for each of these entities.
2. Review and consider recommended water management strategies adopted by the water planning group for the *2011 Plateau Region Water Plan.*
3. Review and consider any issues identified in the most current TWDB Water Loss Audit Report, including leak detection and supply side analysis.
4. Solicit current water planning information, including specific water management strategies of interest from WUGs and WWPs with identified needs.
5. Review and consider the most recent Water Supply Management, Water Conservation, and/or Drought Contingency Plans, where available, from WUGs and WWPs with identified needs.
6. Consider potentially feasible water management strategies that may include, but are not limited to (Chapter 357 Subchapter C §357.34):
    - Extended use of existing supplies including:
        a. System optimization and conjunctive use of water resources
        b. Reallocation of reservoir storage to new uses
        c. Voluntary redistribution of water resources including contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements
        d. Subordination of existing water rights through voluntary agreements
        e. Enhancement of yields of existing sources
        f. Improvement of water quality including control of naturally occurring chlorides
    - New supply development including:
        a. Construction and improvement of surface water and groundwater resources
        b. Brush control
        c. Precipitation enhancement
        d. Desalination
        e. Water supply that could be made available by cancellation of water rights
        f. Rainwater harvesting
        g. Aquifer storage and recovery
    - Conservation and drought management measures including demand management
    - Reuse of wastewater
    - Interbasin transfers of surface water

- Emergency transfers of surface water

7. Consider other potentially feasible water management strategies suggested by planning group members, stakeholders, and the public.
8. Based on the above reviews and considerations, establish a preliminary list of potentially feasible water management strategies. At a discussion level, consider the following feasibility concerns for each strategy:
    - Water supply source availability during drought-of-record conditions
    - Cost/benefit
    - Water quality
    - Threats to agriculture and natural resources
    - Impacts to the environment, other water resources, and basin transfers
    - Socio-economic impacts
9. Based on the above discussion level analysis, select a final list of potentially feasible water management strategies for further technical evaluation using detailed analysis criteria.

Using the above criteria and process, the PWPG selected the initial potentially feasible water management strategies listed in Table 5-1 for further detailed analysis. All strategy analysis recognize and protect existing water rights, water contracts, and option agreements. As the water management strategy analysis progressed, it became evident that the initial list would require modification of project descriptive names, and the possible addition of new strategies and the elimination or transfer of others. Much time was spent in communication with individual WUGs (municipalities, irrigation districts, etc.) to insure that the strategies discussion met with their approval. The evaluation and final recommendation of water management strategies are provided in Appendix 5A at the end of this chapter.

**Table 5-1. Potentially Feasible Water Management Strategies**

| County | WUGs and WWP Entities Potentially Served by WMSs | WMS Number | Water Management Strategy Title |
|---|---|---|---|
| Bandera | City of Bandera | 1 | Surface water acquisition, treatment and ASR. |
| | | 2 | Drill additional wells outside of current cone-of-depression and lay pipeline back to city. |
| | | 3 | Drill additional wells completed in Middle Trinity Aquifer inside of city limits. |
| | | 4 | Promote, design and install rainwater harvesting systems on public buildings. |
| | | 5 | Provide public with conservation information. |
| | Bandera County Other | 6 | Water loss audit and replace necessary distribution lines. |
| | | 7 | Water loss audit and replace necessary distribution lines. |
| | | 8 | Water loss audit and replace necessary distribution lines. |
| | | 9 | Drill additional wells, renovate existing wells, and build treatment facility (possibly to include dasal). |
| | | 10 | Drill two wells to PWS standards at VFD or other suitable locations to provide emergency supply in rural areas and firefighting supply. Wells would also be used as county drought monitoring sites. |
| | | 11 | Drill wells to PWS standards and create distribution lines to help mitigate supply shortage around Medina Lake. |
| | | 12 | Build wastewater collection and treatment system to help mitigate problems in Medina Lake area. |
| | | 13 | Brush management and invasive species (*i.e. Arundo donax*) control. |
| Edwards | City of Rocksprings | 14 | Drill additional wells, renovate existing wells, and build treatment facility. |
| | | 15 | Increase storage facility. |
| | | 16 | Water loss audit and replace necessary distribution lines. |
| | Community of Barksdale | 17 | Drill additional groundwater wells. |
| | | 18 | Replace pressure tank. |
| | | 19 | Water loss audit and replace necessary distribution lines. |
| | | 20 | Provide public with conservation information. |
| | Edwards County Other | 21 | Brush management and invasive species (*i.e. Arundo donax*) control. |
| Kerr | City of Kerrville | 22 | Surface water acquisition from UGRA. |
| | | 23 | Increased water treatment and ASR capacity. |
| | | 24 | Water loss audit and replace necessary distribution lines. |
| | | 25 | Increase wastewater reuse and identify potential end users. |
| | | 26 | Provide public with conservation information. |
| | Loma Vista WS | 27 | Drill additional groundwater wells. |
| | | 28 | Provide public with conservation information. |
| | Kerr County Other | 29 | Evaluation of existing water rights, and potential diversion points for Eastern Kerr County Regional Water Supply Project. |
| | | 30 | Construction of surface water treatment and ASR facilities, and distribution lines. |
| | | 31 | Develop off-channel surface water storage. |
| | | 32 | Evaluate potential for water transfer pipeline from Canyon Lake to project site. |
| | | 33 | Establish a wellfield to provide groundwater to densely populated rural areas. |
| | | 34 | Exploratory test well to evaluate groundwater availability in the Ellenburger Aquifer. |
| | | 35 | Develop a desalination facility to treat brackish and/or elevated radionuclide groundwater. |
| | | 36 | Brush management - Ashe Juniper control. |
| | | 37 | Provide public with conservation information. |
| | | 38 | Water loss audit and replace necessary distribution lines. |
| | Kerr Mining | 39 | Drill additional groundwater wells. |

**Table 5-1. (Continued) Potentially Feasible Water Management Strategies**

| County | WUGs and WWP Entities Potentially Served by WMSs | WMS Number | Water Management Strategy Title |
|---|---|---|---|
| Kinney | City of Brackettville | 40 | Water loss audit and replace necessary distribution lines. |
| | | 41 | Water loss audit and replace necessary distribution lines to Spofford. |
| | | 42 | Increase storage facility. |
| | Community of Fort Clark Springs | 43 | Water loss audit and replace necessary distribution lines. |
| | | 44 | Repair or upgrade pumps in wells and distribution network. |
| | | 45 | Increase storage facility. |
| | Kinney County Other | 46 | Brush management and invasive species (*i.e. Arundo donax*) control. |
| Real | City of Leakey | 47 | Drill additional or renovate existing groundwater wells. |
| | | 48 | Water loss audit and replace necessary distribution lines. |
| | | 49 | Develop emergency interconnects with surrounding utilities. |
| | City of Camp Wood | 50 | Drill additional groundwater wells. |
| | | 51 | Water loss audit and replace necessary distribution lines. |
| | | 52 | Develop a regional water supply system to serve communities outside of city. |
| | | 53 | Provide public with conservation information. |
| | Real County Other | 54 | Water loss audit and replace necessary distribution lines. |
| | | 55 | Brush management and-invasive species (*i.e. Arundo donax*) control. |
| Val Verde | City of Del Rio | 56 | Water loss audit and replace necessary distribution lines. |
| | | 57 | Increase storage facility. |
| | | 58 | Expand and renovate treatment plant facilities. |
| | | 59 | Drill and equip new wells and connect to distribution system. |
| | | 60 | Develop a wastewater reuse program. |
| | Laughlin AFB | 61 | Receive reuse supply from City of Del Rio for public area irrigation use. |
| | Val Verde County Other | 62 | Brush management and invasive species (*i.e. Arundo donax*) control. |
| | Val Verde Mining | 63 | Drill additional groundwater wells. |

# 5.2 EVALUATION AND RECOMMENDATION OF WATER MANAGEMENT STRATEGIES

## 5.2.1 Strategy Evaluation Procedure

The strategy evaluation procedure is designed to provide a side-by-side comparison such that all strategies can be assessed based on the same quantifiable factors as shown in Tables 5-2, 5-3 and 5-4. An explanation of the qualitative and quantifiable rankings is provided in Appendix 5C. All strategy analyses recognize and protect existing water rights, water contracts, and option agreements. For planning purposes, it is assumed that all strategies experience a two percent water loss over the life of the strategy project. Specific factors considered in each Table were:

<u>Table 5-2</u>

- Quantity
- Quality
- Reliability
- Impacts to water, agricultural, and natural resources.

<u>Table 5-3</u>

- Financial cost (total capital cost, annual cost, and cost per acre-foot)

<u>Table 5-4</u>

- Environmental impacts
    - Environmental water needs
    - Wildlife habitat
    - Cultural resources
    - Environmental water quality
    - Inflows to bays and estuaries

Cost evaluations for all strategies include capital cost, debt service, and annual operating and maintenance (O&M) expenses. Capital costs are estimated based on September 2013 US dollars. The length of debt service is 20 years unless otherwise stated. An annual unit cost is also calculated based on the O&M cost per acre-foot of water supplied. The TWDB Unified Costing tool was used for all strategy evaluations except for when specific municipalities provided engineering design studies that included cost estimates.

Water quality is recognized as an important component in this 50-year water plan. To insure that this Plan fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water management strategies and water quality impacts. Development of water management strategies were also guided by the principal that the designated water quality and related water uses described in the Water Quality Management Plans (WQMPs) of TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) were improved or maintained. TCEQ's WQMP is tied to the State's water quality assessments that identify and direct planning for implementation measures that control and/or prevent priority water quality problems. Elements contained in the WQMP include effluent limitations of wastewater facilities, total maximum daily loads (TMDLs), nonpoint source management controls, identification of designated management agencies, and ground water and source water protection planning. TSSWCB's WQMP is a site-specific plan developed through and approved by soil and water conservation districts for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measures, and technologies.

The development of water management strategies is intended to assist entities with their future water supply needs based on drought-of-record conditions. Recommendations of the Drought Preparedness Council are considered in this *Plan* and consist of four activities: (1) Drought Monitoring; (2) Impact Assessment; (3) Research and Educational Programs; and (4) Drought Mitigation Strategies. Also, WUGs conservation and drought management plans (see Chapters 6 and 7) were reviewed to identify potential strategies that are currently under consideration by the entity.

A number of strategies are considered integral or interconnected to the new supply goal for a specified WUG or cooperation between WUGs. Strategies J-35 through J-41 all are potential supply options that may funnel through a regional treatment and distribution system (Strategy J-37) serving small communities and the rural population of eastern Kerr County. Strategies J-48 and J-49 combined will serve to produce a new water supply for the Spoford area of southern Kinney County. These strategies are developed independently and their interactions do not impact the water supply availability and yield associated with each individual strategy.

### 5.2.2 Emphasis on Conservation and Reuse

In terms of recommending strategies to meet future water needs, it is most practical and often most economical to consider potential conservation and reuse projects. Conservation generally includes best management practices that are undertaking either voluntarily by water customers or as mandated by a water suppliers. Existing WUG conservation and drought management plans were reviewed, and conservation strategies selected for this *Plan* were often identified from these plans.

Reported municipal use generally includes a variable amount of water that does not reach the intended consumer due to water leaks in the distribution lines, unauthorized consumption, storage tank overflows, and other wasteful factors. For some communities, attending to these issues can be a proactive conservation strategy that may result in significant water savings. To address the lack of information on water loss, the 78th Texas Legislature passed House Bill 3338, which required retail public utilities that provide potable water to perform and file with the TWDB a water audit computing the utility's most recent annual system water loss every five years (see further discussion in Chapter 1, Section 1.6). Entities reporting more than a 10 percent water loss were selected to receive a water-loss audit and line replacement strategy. Reuse of treated wastewater is also an excellent strategy for producing additional water supplies from existing developed sources, or for use in areas where drinking water is not required such as irrigation.

### 5.2.3 Recommended and Alternate Water Management Strategies

Table 5-2 provides a comparative listing of all the recommended and alternate water management strategies that the PWPG subsequently evaluated in total for inclusion in the *2016 Plateau Region Water Plan*. Table 5-3 provides a breakdown of the cost estimate for each strategy. Where applicable, capital costs include the following: construction; engineering; easement; environmental; interest during construction; and purchased water. Engineering, contingency, construction management, financial and legal costs are estimated at 30 percent of construction costs for pipelines and 35 percent for all other facilities. Annual costs include operations and maintenance at one percent of the facility cost, power costs at 0.09$ per kilowatt-hour, and debt service at 5.5 percent over 20 years. Capital costs are estimated based on September 2013 US dollars.

Table 5-4 shows the potential impacts on the environment of enacting each strategy. Strategy evaluations are presented in Appendix 5A at the end of this chapter. The total capital cost for development of the 67 water management strategies is $146,202,577. Appendix 5C provides additional tables that summarize strategy attributes.

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**Table 5-2. Summary of Recommended and Alternate Water Management Strategy Evaluation**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2011 Strategy ID | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) | Quantity [a] | Quality [b] | Reliability [c] | Strategy Impacts [d] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | | (1-3) | (1-3) | (1-3) | Water Resources (1-5) | Agricultural Resources (1-5) | Natural Resources (1-5) |
| Bandera | City of Bandera | San Antonio | Reuse treated wastewater effluent for irrigation use | | J-1 | 310 | 310 | 310 | 310 | 310 | 310 | $450,000 | NA | 3 | 1 | 1 | 2 | 2 |
| | | | Promote, design & install rainwater harvesting systems | | J-2 | 1 | 1 | 1 | 1 | 1 | 1 | $56,000 | NA | NA | NA | 1 | 2 | 1 |
| | | | Additional Lower Trinity well and lay necessary pipeline | | J-4 | 323 | 323 | 323 | 323 | 323 | 323 | $2,284,000 | NA | 1 | 1 | 4 | 2. | 2 |
| | | | Additional Middle Trinity wells within City water infrastructure | | J-5 | 161 | 161 | 161 | 161 | 161 | 161 | $779,000 | NA | 1 | 1 | 3 | 2 | 2 |
| | *Bandera County-Other | San Antonio | Water loss audit and main-line repair for Bandera County FWSD #1 | | J-6 | 1 | 1 | 1 | 1 | 1 | 1 | $163,000 | NA | NA | NA | NA | NA | NA |
| | | | Water loss audit and main-line repair for Bandera River Ranch #1 | | J-7 | 1 | 1 | 1 | 1 | 1 | 1 | $463,000 | NA | NA | NA | NA | NA | NA |
| | | | Water loss audit and main-line repair for Medina Water Supply Corporation | | J-8 | 1 | 1 | 1 | 1 | 1 | 1 | $447,000 | NA | NA | NA | NA | NA | NA |
| | | | ** Vegetative Management | | J-9 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | NA | NA | NA | 1 | 1 | 1 |
| | | | Drought Management (BCRAGD) | | J-68 | 467 | 519 | 546 | 556 | 563 | 568 | $0 | NA | NA | NA | 2 | 2 | 2 |
| | | | Additional well for Pebble Beach Subdivision | | J-10 | 161 | 161 | 161 | 161 | 161 | 161 | $3,717,000 | NA | 1 | 2 | 4 | 2 | 2 |
| | | | Additional wells to provide emergency supply to VFD | | J-11 | 189 | 189 | 189 | 189 | 189 | 189 | $2,824,000 | NA | 1 | 2 | 3 | 2 | 2 |
| | | | Additional wells to help Medina Lake area | | J-12 | 27 | 27 | 27 | 27 | 27 | 27 | $1,377,000 | NA | 1 | 2 | 4 | 2 | 2 |
| | | Nueces | Drought Management (BCRAGD) | | J-69 | 29 | 32 | 34 | 34 | 35 | 35 | $0 | NA | NA | NA | 2 | 2 | 2 |
| | *Bandera County Irrigation | Nueces | Additional groundwater wells | | J-13 | 130 | 130 | 130 | 130 | 130 | 130 | $244,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| | *Bandera County Livestock | San Antonio | Additional groundwater well | | J-14 | 20 | 20 | 20 | 20 | 20 | 20 | $103,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| Edwards | *City of Rocksprings | Colorado | Water loss audit and main-line repair | | J-15 | 1 | 1 | 1 | 1 | 1 | 1 | $129,000 | 3 | NA | NA | NA | NA | NA |
| | | Nueces | Additional groundwater well | | J-16 | 121 | 121 | 121 | 121 | 121 | 121 | $650,000 | 1 | 1 | 1 | 2 | 2 | 2 |
| | Edwards County-Other | Nueces | Water loss audit and main-line repair for Barksdale WSC | | J-17 | 1 | 1 | 1 | 1 | 1 | 1 | $203,000 | NA | NA | NA | NA | NA | NA |
| | | | Additional well in the Nueces River Alluvium Aquifer | J-3 | J-18 | 54 | 54 | 54 | 54 | 54 | 54 | $114,000 | NA | 1 | 2 | 3 | 2 | 2 |
| | | | ** Vegetative Management | | J-19 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | NA | NA | NA | 1 | 1 | 1 |
| | *Edwards County Livestock | Nueces | Additional groundwater wells | | J-20 | 20 | 20 | 20 | 20 | 20 | 20 | $105,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| | *Edwards County Mining | Rio Grande | Additional groundwater wells | | J-21 | 30 | 30 | 30 | 30 | 30 | 30 | $109,000 | 1 | 3 | 1 | 2 | 2 | 2 |
| Kerr | *City of Kerrville | Guadalupe | Increase wastewater reuse | | J-22 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $23,000,000 | 1 | 3 | 1 | 1 | 2 | 2 |
| | | | Water loss audit and main-line repair | J-8 | J-23 | 147 | 147 | 147 | 147 | 147 | 147 | $9,339,000 | 3 | NA | NA | NA | NA | NA |
| | | | Purchase water from UGRA | J-6 | J-24 | | 0 | 0 | 0 | 0 | 0 | $4,103,791 | 1 | 2 | 2 | 2 | 2 | 2 |
| | | | Increased water treatment and ASR capacity | J-7 | J-25 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 3360 | $11,543,000 | 2 | 2 | 2 | 2 | 2 | 2 |

**Table 5-2. (Continued) Summary of Recommended and Alternate Water Management Strategy Evaluation**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2011 Strategy ID | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | Total Capital Cost (Table 5-3) | Quantity [a] (1-3) | Quality [b] (1-3) | Reliability [c] (1-3) | Strategy Impacts [d]: Water Resources (1-5) | Agricultural Resources (1-5) | Natural Resources (1-5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kerr | *Loma Vista WSC | Guadalupe | Conservation: Public information | | J-26 | 4 | 4 | 4 | 4 | 4 | 4 | $0 | 3 | NA | NA | NA | NA | NA |
| | | | Additional groundwater well | | J-27 | 57 | 57 | 57 | 57 | 57 | 57 | $728,000 | 2 | 1 | 1 | 3 | 2 | 2 |
| | *Kerr County-Other | Guadalupe | Water loss audit and main-line repair for Center Point WWW | | J-28 | 1 | 1 | 1 | 1 | 1 | 1 | $33,000 | 3 | NA | NA | NA | NA | NA |
| | | | Water loss audit and main-line repair for Hills and Dales WWW | | J-29 | 1 | 1 | 1 | 1 | 1 | 1 | $138,000 | 3 | NA | NA | NA | NA | NA |
| | | | Water loss audit and main-line repair for Rustic Hills Water | | J-30 | 1 | 1 | 1 | 1 | 1 | 1 | $99,000 | 3 | NA | NA | NA | NA | NA |
| | | | Water loss audit and main-line repair for Verde Park Estates WWW | | J-31 | 1 | 1 | 1 | 1 | 1 | 1 | $102,000 | 3 | NA | NA | NA | NA | NA |
| | | | Conservation: Public information | J-13 | J-32 | 9 | 9 | 9 | 10 | 9 | 8 | $0 | 1 | NA | NA | NA | NA | NA |
| | | Colorado | Conservation: Public information - Water shortage met with J-32 | | J-32A | 5 | 5 | 5 | 5 | 6 | 7 | $0 | 1 | NA | NA | NA | NA | NA |
| | | Nueces | Conservation: Public information - Water shortage met with J-32 | | J-32B | 1 | 1 | 1 | 1 | 1 | 1 | $0 | 1 | NA | NA | NA | NA | NA |
| | | Guadalupe | ** Vegetative management - UGRA | J-12 | J-33 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | 1 | NA | NA | 1 | 1 | 1 |
| | | | UGRA Acquisition of Surface Water Rights [2](EKCRWSP) | J-10 | J-34 | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | 1029 | $1,087,367 | 1 | NA | NA | 2 | 5 | 2 |
| | | | KCCC Acquisition of Surface Water Rights [2](EKCRWSP) | | J-35 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | $6,342,000 | 1 | NA | NA | 2 | 5 | 2 |
| | | | Construction of an Off-Channel Surface Water Storage [2](EKCRWSP) | J-11 | J-36 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,534,303 | 1 | 2 | 2 | 2 | 2 | 1 |
| | | | Construction of surface water treatment facilities and transmission lines [2](EKCRWSP) | J-10 | J-37 | 149 | 149 | 149 | 149 | 149 | 149 | $25,581,000 | 1 | 2 | 2 | 2 | 2 | 2 |
| | | | Construction of ASR facility [2](EKCRWSP) | J-10 | J-38 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $1,258,000 | 1 | 2 | 2 | 2 | 2 | 2 |
| | | | Construction of Well field for dense, rural areas [2](EKCRWSP) | | J-39 | 860 | 860 | 860 | 860 | 860 | 860 | $4,357,000 | 1 | 1 | 1 | 4 | 2 | 2 |
| | | | Construction of Desalination plant [2](EKCRWSP) | | J-40 | 860 | 860 | 860 | 860 | 860 | 860 | $14,539,000 | 1 | 2 | 1 | NA | NA | NA |
| | | | Construction of an Ellenburger Aquifer water supply well [2](EKCRWSP) | | J-41 | 108 | 108 | 108 | 108 | 108 | 108 | $567,000 | 1 | Unk. | Unk. | Unk. | 2 | 2 |
| | *Kerr County Irrigation | San Antonio | Additional groundwater well | | J-42 | 20 | 20 | 20 | 20 | 20 | 20 | $78,000 | NA | 3 | 1 | 2 | 1 | 2 |
| | *Kerr County Livestock | Colorado | Additional groundwater wells | | J-43 | 108 | 108 | 108 | 108 | 108 | 108 | $667,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| | *Kerr County Livestock | Guadalupe | Additional groundwater wells | | J-44 | 20 | 20 | 20 | 20 | 20 | 20 | $190,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| | *Kerr County Livestock | San Antonio | Additional groundwater well | | J-45 | 20 | 20 | 20 | 20 | 20 | 20 | $65,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| | *Kerr County Mining | Guadalupe | Additional groundwater well | | J-46 | 30 | 30 | 30 | 30 | 30 | 30 | $132,000 | 1 | 3 | 1 | 2 | 2 | 2 |

**Table 5-2. (Continued) Summary of Recommended and Alternate Water Management Strategy Evaluation**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2011 Strategy ID | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) | Quantity [a] | Quality [b] | Reliability [c] | Strategy Impacts [d] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | Water Resources | Agricultural Resources | Natural Resources |
| | | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | | (1-3) | (1-3) | (1-3) | (1-5) | (1-5) | (1-5) |
| Kinney | City of Brackettville | Rio Grande | Water loss audit and main-line repair | J-14 | J-47 | 58 | 58 | 58 | 58 | 58 | 58 | $1,116 | NA | NA | NA | NA | NA | NA |
| | | | Increase supply to Spoford with new water line | | J-48 | 3 | 3 | 3 | 3 | 3 | 3 | $751,000 | NA | 1 | 1 | 2 | 2 | 2 |
| | | | Increase storage facility | | J-49 | 3 | 3 | 3 | 3 | 3 | 3 | $288,000 | NA | NA | NA | NA | 2 | 2 |
| | Fort Clark Springs MUD | | Increase storage facility | | J-50 | 620 | 620 | 620 | 620 | 620 | 620 | $1,033,000 | NA | NA | NA | NA | 2 | 2 |
| | Kinney County-Other | | ** Vegetative Management | | J-51 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | NA | NA | NA | 1 | 1 | 1 |
| | *Kinney County Livestock | | Additional groundwater wells | | J-52 | 22 | 22 | 22 | 22 | 22 | 22 | $55,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| Real | *City of Camp Wood | Nueces | Conservation: Public information | J-18 | J-53 | 1 | 1 | 1 | 1 | 1 | 1 | $0 | 3 | NA | NA | NA | NA | NA |
| | | | Additional groundwater wells | J-17 | J-54 | 172 | 172 | 172 | 172 | 172 | 172 | $1,887,000 | 1 | 1 or 2 | 1 or 2 | 3 | 2 | 2 |
| | City of Leakey (Real County-Other) | | Water loss audit and main-line repair | J-16 | J-55 | 1 | 1 | 1 | 1 | 1 | 1 | $52,000 | NA | NA | NA | NA | NA | NA |
| | | | Additional groundwater well | J-15 | J-56 | 91 | 91 | 91 | 91 | 91 | 91 | $156,000 | NA | 1 or 2 | 1 or 2 | 3 | 2 | 2 |
| | | | Develop interconnections between wells within the City | | J-57 | 81 | 81 | 81 | 81 | 81 | 81 | $200,000 | NA | NA | NA | NA | 2 | 2 |
| | Real County-Other | | Water loss audit and main-line repair for Real WSC | | J-58 | 2 | 2 | 2 | 2 | 2 | 2 | $199,000 | NA | NA | NA | NA | NA | NA |
| | | | ** Vegetative Management | | J-59 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | NA | NA | NA | 1 | 1 | 1 |
| | | | Additional well for Oakmont Saddle WSC | | J-60 | 54 | 54 | 54 | 54 | 54 | 54 | $420,000 | NA | 1 | 1 | 2 | 2 | 2 |
| | *Real County Livestock | | Additional groundwater wells | | J-61 | 40 | 40 | 40 | 40 | 40 | 40 | $74,000 | 1 | 3 | 1 | 2 | 1 | 2 |
| Val Verde | City of Del Rio | Rio Grande | Water loss audit and main-line repair | | J-62 | 119 | 119 | 119 | 119 | 119 | 119 | $8,673,000 | NA | NA | NA | NA | NA | NA |
| | | | Drill & equip new well, connect to distribution system | | J-63 | 850 | 850 | 850 | 850 | 850 | 850 | $2,937,000 | NA | 1 | 1 | 3 | 2 | 2 |
| | | | Water treatment plant expansion | | J-64 | | 943 | 943 | 943 | 943 | 943 | $1,841,000 | NA | 2 | 1 | 3 | 2 | 2 |
| | | | Develop a wastewater reuse program | | J-65 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $1,700,000 | NA | 3 | 1 | 1 | 2 | 2 |
| | Val Verde County-Other | | ** Vegetative Management | | J-66 | 0 | 0 | 0 | 0 | 0 | 0 | $0 | NA | NA | NA | 1 | 1 | 1 |
| | *Val Verde County Mining | | Additional groundwater well | | J-67 | 80 | 80 | 80 | 80 | 80 | 80 | $235,000 | 1 | 3 | 1 | 2 | 2 | 2 |
| | | | | | Totals | 27,414 | 28,412 | 28,441 | 28,452 | 28,460 | 28,465 | 146,202,577 | | | | | | |

**Table 5-2. (Continued) Summary of Recommended and Alternate Water Management Strategy Evaluation**

***2016 ALTERNATE WATER MANAGEMENT STRATEGY***

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2011 Strategy ID | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) | Quantity [a] | Quality [b] | Reliability [c] | Strategy Impacts[d] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | | | | | Water Resources (1-5) | Agricultural Resources (1-5) | Natural Resources (1-5) |
| Bandera | City of Bandera | San Antonio | Surface water acquisition, treatment and ASR | J-1 | J-3 | 500 | 500 | 1,000 | 1,000 | 1,500 | 1,500 | $29,450,000 | NA | 2 | 2 | 3 | 2 | 2 |

*See Appendix 5B for quantification description of impact ranges.*

[z] Eastern Kerr County Regional Water Supply Project

* WUGs with a projected future supply deficit. *(See Table 4-1 for list of shortages)*

** Potential Supplies for Vegetative Management under Average Rainfall (see table below)

| 2016 Strategy ID | Water Management Strategy | Strategy Supply in all Decades (ac-ft/yr) |
|---|---|---|
| J-9 | Vegetative Management | 2,287 |
| J-19 | Vegetative Management | 145 |
| J-33 | Vegetative Management | 218 |
| J-51 | Vegetative Management | 145 |
| J-59 | Vegetative Management | 145 |
| J-66 | Vegetative Management | 145 |

a Quantity range: 1 = Meets 100% of shortage; 2 = Meets 50 to 90% of shortage; 3 = Meets <50% of shortage. *(See Table 4-1 for list of shortages)*

[b] Quality range: 1 = Meets safe drinking-water standards; 2 = Must be treated or mixed to meet safe drinking-water standards; 3 = Usable for intended use.

[c] Reliability range: 1 = Sustainable; 2 = Interruptible during droughts; 3 = Non-sustainable.

[d] Strategy impact range: 1 = Positive; 2 = No new; 3 = Minimal negative; 4 = Moderate negative; 5 = Significant negative.

**Table 5-3. Summary of Recommended and Alternate Water Management Strategy Cost**

| County | Water User Group | Strategy | Strategy ID | *Total Capital Cost | Annual Cost/Year | | | | | | Cost per Acre-Foot/Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Bandera | City of Bandera | Reuse treated wastewater effluent for irrigation use | J-1 | $450,000 | $42,711 | $44,328 | $46,053 | $10,584 | $13,760 | $17,888 | $138 | $143 | $148 | $34 | $44 | $58 |
| | | Promote, design & install rainwater harvesting systems | J-2 | $56,000 | $5,000 | $5,000 | $0 | $0 | $0 | $0 | $23,692 | $23,692 | $0 | $0 | $0 | $0 |
| | | Drill additional Lower Trinity well & lay pipeline to City | J-4 | $2,284,000 | $297,000 | $297,000 | $106,000 | $106,000 | $106,000 | $106,000 | $919 | $919 | $327 | $327 | $327 | $327 |
| | | Drill additional Middle Trinity wells within City | J-5 | $779,000 | $74,000 | $74,000 | $9,000 | $9,000 | $9,000 | $9,000 | $460 | $460 | $55 | $55 | $55 | $55 |
| | Bandera County-Other | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | $163,000 | $15,000 | $15,000 | $1,000 | $1,000 | $1,000 | $1,000 | $10,870 | $10,870 | $746 | $746 | $746 | $746 |
| | | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | $463,000 | $42,000 | $42,000 | $3,000 | $3,000 | $3,000 | $3,000 | $83,268 | $83,268 | $5,724 | $5,724 | $5,724 | $5,724 |
| | | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | $447,000 | $40,000 | $40,000 | $3,000 | $3,000 | $3,000 | $3,000 | $29,730 | $29,730 | $2,041 | $2,041 | $2,041 | $2,041 |
| | | ** Vegetative Management | J-9 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | Drought Management – San Antonio Basin | J-68 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | Additional well for Pebble Beach Subdivision | J-10 | $3,717,000 | $613,000 | $613,000 | $302,000 | $302,000 | $302,000 | $302,000 | $3,807 | $3,807 | $1,875 | $1,875 | $1,875 | $1,875 |
| | | Additional wells to provide emergency supply to VFD | J-11 | $2,824,000 | $283,000 | $283,000 | $47,000 | $47,000 | $47,000 | $47,000 | $1,497 | $1,497 | $250 | $250 | $250 | $250 |
| | | Additional wells to help Medina Lake area | J-12 | $1,377,000 | $166,000 | $166,000 | $51,000 | $51,000 | $51,000 | $51,000 | $6,167 | $6,167 | $1,900 | $1,900 | $1,900 | $1,900 |
| | | Drought Management – Nueces Basin | J-69 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | Bandera County Irrigation | Additional groundwater wells | J-13 | $244,000 | $31,000 | $31,000 | $11,000 | $11,000 | $11,000 | $11,000 | $238 | $238 | $85 | $85 | $85 | $85 |
| | Bandera County Livestock | Additional groundwater well | J-14 | $103,000 | $11,000 | $11,000 | $2,000 | $2,000 | $2,000 | $2,000 | $550 | $550 | $84 | $84 | $84 | $84 |
| Edwards | City of Rocksprings | Water loss audit and main-line repair | J-15 | $129,000 | $12,000 | $12,000 | $1,000 | $1,000 | $1,000 | $1,000 | $65,573 | $65,573 | $4,488 | $4,488 | $4,488 | $4,488 |
| | | Additional groundwater well | J-16 | $650,000 | $72,000 | $72,000 | $18,000 | $18,000 | $18,000 | $18,000 | $595 | $595 | $33 | $33 | $33 | $33 |
| | Edwards County-Other (Barksdale WSC) | Water loss audit and main-line repair | J-17 | $203,000 | $18,000 | $18,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $63,576 | $63,576 | $4,370 | $4,370 | $4,370 |
| | | Drill additional well in the Nueces River Alluvium Aquifer | J-18 | $114,000 | $21,000 | $21,000 | $11,000 | $11,000 | $11,000 | $11,000 | $373 | $373 | $197 | $197 | $197 | $197 |
| | Edwards County-Other | ** Vegetative Management | J-19 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | Edwards County Livestock | Additional groundwater wells | J-20 | $105,000 | $11,000 | $11,000 | $2,000 | $2,000 | $2,000 | $2,000 | $550 | $550 | $111 | $111 | $111 | $111 |
| | Edwards County Mining | Additional groundwater wells | J-21 | $109,000 | $12,000 | $12,000 | $3,000 | $3,000 | $3,000 | $3,000 | $400 | $400 | $93 | $93 | $93 | $93 |
| Kerr | City of Kerrville | Increase wastewater reuse | J-22 | $23,000,000 | $2,212,000 | $2,212,000 | $285,000 | $285,000 | $285,000 | $285,000 | $439 | $439 | $24 | $24 | $24 | $24 |
| | | Water loss audit and main-line repair | J-23 | $9,339,000 | $840,000 | $840,000 | $58,000 | $58,000 | $58,000 | $58,000 | $5,701 | $5,701 | $392 | $392 | $392 | $392 |
| | | Purchase water from UGRA | J-24 | $0 | $0 | $4,103,791 | $4,103,791 | $4,103,791 | $5,824,390 | $5,824,390 | $1,069 | $1,069 | $1,069 | $1,069 | $1,069 | $1,069 |
| | | Increased water treatment and ASR capacity | J-25 | $11,543,000 | $1,783,000 | $1,783,000 | $817,000 | $817,000 | $817,000 | $817,000 | $530 | $530 | $243 | $243 | $243 | $243 |
| | Loma Vista WSC | Conservation: Public information | J-26 | $0 | $2,206 | $2,206 | $2,206 | $2,206 | $2,206 | $2,206 | $529 | $520 | $519 | $512 | $504 | $497 |
| | | Additional groundwater well | J-27 | $728,000 | $82,000 | $82,000 | $21,000 | $21,000 | $21,000 | $21,000 | $1,468 | $1,468 | $378 | $378 | $378 | $378 |

**Table 5-3. (Continued) Summary of Recommended and Alternate Water Management Strategy Cost**

| County | Water User Group | Strategy | Strategy ID | *Total Capital Cost | Annual Cost/Year | | | | | | Cost per Acre-Foot/Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Kerr | Kerr County-Other | Water loss audit and main-line repair for Center Point WWW | J-28 | $33,000 | $3,000 | $3,000 | $165 | $165 | $165 | $165 | $9,762 | $9,762 | $165 | $165 | $165 | $165 |
| | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | $138,000 | $13,000 | $13,000 | $1,000 | $1,000 | $1,000 | $1,000 | $12,116 | $12,116 | $831 | $831 | $831 | $831 |
| | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | $99,000 | $9,000 | $9,000 | $1,000 | $1,000 | $1,000 | $1,000 | $9,000 | $9,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | $102,000 | $10,000 | $10,000 | $1,000 | $1,000 | $1,000 | $1,000 | $10,840 | $10,840 | $742 | $742 | $742 | $742 |
| | | Conservation: Public information | J-32 | $0 | $6,030 | $6,324 | $6,450 | $6,740 | $6,861 | $6,861 | $402 | $423 | $430 | $421 | $429 | $429 |
| | | Conservation: Public information - Water shortage met with J-32 | J-32A | $0 | $6,030 | $6,324 | $6,450 | $6,740 | $6,861 | $6,861 | $402 | $423 | $430 | $421 | $429 | $429 |
| | | Conservation: Public information - Water shortage met with J-32 | J-32B | $0 | $6,030 | $6,324 | $6,450 | $6,740 | $6,861 | $6,861 | $402 | $423 | $430 | $421 | $429 | $429 |
| | | ** Vegetative management - UGRA | J-33 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | UGRA Acquisition of Surface Water Rights [2](EKCRWSP) | J-34 | $1,087,367 | $1,087,367 | $0 | $0 | $0 | $0 | $0 | $1,057 | $0 | $0 | $0 | $0 | $0 |
| | | KCCC Acquisition of Surface Water Rights [2](EKCRWSP) | J-35 | $6,342,000 | $6,342,000 | $0 | $0 | $0 | $0 | $0 | $1,057 | $0 | $0 | $0 | $0 | $0 |
| | | Construction of an Off-Channel Surface Water Storage [2](EKCRWSP) | J-36 | $7,534,303 | $695,721 | $695,721 | $695,721 | $695,721 | $695,721 | $695,721 | $621 | $621 | $621 | $621 | $621 | $621 |
| | | Construction of surface water treatment plant facilities and distribution lines [2](EKCRWSP) | J-37 | $25,581,000 | $2,492,000 | $2,492,000 | $351,000 | $351,000 | $351,000 | $351,000 | $16,722 | $16,722 | $2,356 | $2,356 | $2,356 | $2,356 |
| | | Construction of ASR facilities [2](EKCRWSP) | J-38 | $1,258,000 | $114,000 | $114,000 | $105,000 | $105,000 | $105,000 | $105,000 | $102 | $102 | $8 | $8 | $8 | $8 |
| | | Construction of a well field for dense, rural areas [2](EKCRWSP) | J-39 | $4,357,000 | $525,000 | $525,000 | $160,000 | $160,000 | $160,000 | $160,000 | $611 | $611 | $187 | $187 | $187 | $187 |
| | | Construction of a desalination plant contingent on new well field [2](EKCRWSP) | J-40 | $14,539,000 | $2,844,000 | $2,844,000 | $1,627,000 | $1,627,000 | $1,627,000 | $1,627,000 | $3,307 | $3,307 | $1,892 | $1,892 | $1,892 | $1,892 |
| | | Construction of an Ellenburger Aquifer water supply well ([2](EKCRWSP) | J-41 | $567,000 | $70,000 | $70,000 | $23,000 | $23,000 | $23,000 | $230,000 | $647 | $647 | $209 | $209 | $209 | $209 |
| | Kerr County Irrigation | Additional groundwater well | J-42 | $78,000 | $9,000 | $9,000 | $2,000 | $2,000 | $2,000 | $2,000 | $450 | $450 | $79 | $79 | $79 | $79 |
| | Kerr County Livestock | Additional groundwater wells | J-43 | $667,000 | $66,000 | $66,000 | $10,000 | $10,000 | $10,000 | $10,000 | $660 | $660 | $95 | $95 | $95 | $95 |
| | Kerr County Livestock | Additional groundwater wells | J-44 | $190,000 | $18,000 | $18,000 | $2,000 | $2,000 | $2,000 | $2,000 | $900 | $900 | $111 | $111 | $111 | $111 |
| | Kerr County Livestock | Additional groundwater well | J-45 | $65,000 | $6,000 | $6,000 | $1,000 | $1,000 | $1,000 | $1,000 | $300 | $300 | $74 | $74 | $74 | $74 |
| | Kerr County Mining | Additional groundwater well | J-46 | $132,000 | $15,000 | $15,000 | $4,000 | $4,000 | $4,000 | $4,000 | $500 | $500 | $136 | $136 | $136 | $136 |
| Kinney | City of Brackettville | Water loss audit and main-line repair | J-47 | $1,116 | $1,116 | $1,116 | $1,116 | $1,116 | $1,116 | $1,116 | $19 | $19 | $19 | $19 | $19 | $19 |
| | | Increase supply to Spoford with new water line | J-48 | $751,000 | $67,000 | $67,000 | $4,000 | $4,000 | $4,000 | $4,000 | $24,013 | $24,013 | $1,596 | $1,596 | $1,596 | $1,596 |
| | | Increase storage facility | J-49 | $288,000 | $26,000 | $26,000 | $2,000 | $2,000 | $2,000 | $2,000 | $9,366 | $9,366 | $737 | $737 | $737 | $737 |
| | Fort Clark Springs MUD | Increase storage facility | J-50 | $1,033,000 | $93,000 | $93,000 | $7,000 | $7,000 | $7,000 | $7,000 | $150 | $150 | $12 | $12 | $12 | $12 |
| | Kinney County-Other | ** Vegetative Management | J-51 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | Kinney County Livestock | Additional groundwater wells | J-52 | $55,000 | $5,000 | $5,000 | $0 | $0 | $0 | $0 | $237 | $237 | $29 | $29 | $29 | $29 |

**Table 5-3. (Continued) Summary of Recommended and Alternate Water Management Strategy Cost**

| County | Water User Group | Strategy | Strategy ID | *Total Capital Cost | Annual Cost/Year | | | | | | Cost per Acre-Foot/Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Real | City of Camp Wood | Conservation: Public information | J-53 | $0 | $910 | $910 | $910 | $910 | $910 | $910 | $679 | $695 | $711 | $717 | $722 | $722 |
| | | Additional groundwater wells | J-54 | $1,887,000 | $270,000 | $270,000 | $112,000 | $112,000 | $112,000 | $112,000 | $1,570 | $1,570 | $86 | $86 | $86 | $86 |
| | City of Leakey (Real County-Other) | Water loss audit and main-line repair | J-55 | $52,000 | $4,000 | $4,000 | $220 | $220 | $220 | $220 | $13,774 | $13,774 | $220 | $220 | $220 | $220 |
| | | Additional groundwater well | J-56 | $156,000 | $25,000 | $25,000 | $12,000 | $12,000 | $12,000 | $12,000 | $275 | $275 | $133 | $133 | $133 | $133 |
| | | Develop interconnections between wells within the City | J-57 | $200,000 | $18,000 | $18,000 | $1,000 | $1,000 | $1,000 | $1,000 | $222 | $222 | $12 | $12 | $12 | $12 |
| | Real County-Other | Water loss audit and main-line repair for Real WSC | J-58 | $199,000 | $18,000 | $18,000 | $1,000 | $1,000 | $1,000 | $1,000 | $7,838 | $7,838 | $538 | $538 | $538 | $538 |
| | | ** Vegetative Management | J-59 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | Additional well for Oakmont Saddle WSC | J-60 | $420,000 | $38,000 | $38,000 | $3,000 | $3,000 | $3,000 | $3,000 | $706 | $706 | $56 | $56 | $56 | $56 |
| | Real County Livestock | Additional groundwater wells | J-61 | $74,000 | $8,000 | $8,000 | $2,000 | $2,000 | $2,000 | $2,000 | $400 | $400 | $62 | $62 | $62 | $62 |
| Val Verde | City of Del Rio | Water loss audit and main-line repair | J-62 | $8,673,000 | $780,000 | $780,000 | $54,000 | $54,000 | $54,000 | $54,000 | $6,568 | $6,568 | $452 | $452 | $452 | $452 |
| | | Drill & equip new well, connect to distribution system | J-63 | $2,937,000 | $331,000 | $331,000 | $85,000 | $85,000 | $85,000 | $85,000 | $389 | $389 | $21 | $21 | $21 | $21 |
| | | Water treatment plant expansion | J-64 | $1,841,000 | $417,000 | $417,000 | $263,000 | $263,000 | $263,000 | $263,000 | $442 | $442 | $24 | $24 | $24 | $24 |
| | | Develop a wastewater reuse program | J-65 | $1,700,000 | $152,000 | $152,000 | $10,000 | $10,000 | $10,000 | $10,000 | $49 | $49 | $3 | $3 | $3 | $3 |
| | Val Verde County-Other | ** Vegetative Management | J-66 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | Val Verde County Mining | Additional groundwater well | J-67 | $235,000 | $25,000 | $25,000 | $5,000 | $5,000 | $5,000 | $5,000 | $313 | $313 | $56 | $56 | $56 | $56 |

***2016 ALTERNATE WATER MANAGEMENT STRATEGY***

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bandera | City of Bandera | Surface water acquisition, treatment and ASR | J-3 | $29,450,000 | $2,474,000 | $2,474,000 | $10,000 | $10,000 | $10,000 | $10,000 | 4,948 | 4,948 | $10 | $10 | $7 | $7 |

* *Total capital costs are estimated based on September 2013 U.S. dollars.*

² Eastern Kerr County Regional Water Supply Project

** Potential Cost of Supplies for Vegetative Management under Average Rainfall (see table below)

| 2016 Strategy ID | Water Management Strategy | Strategy Supply in all Decades (ac-ft/yr) | *Total Capital Cost | Annual Cost/Year | | | | | | Cost per Acre Foot/Year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| J-9 | Vegetative Management | 2,287 | $0 | $8,798,720 | $4,399,360 | $2,199,680 | $0 | $0 | $0 | $3,802 | $1,901 | $951 | $0 | $0 | $0 |
| J-19 | Vegetative Management | 145 | $0 | $1,195,000 | $597,500 | $298,750 | $0 | $0 | $0 | $8,222 | $4,111 | $2,056 | $0 | $0 | $0 |
| J-33 | Vegetative Management | 218 | $0 | $420,000 | $210,000 | $105,000 | $0 | $0 | $0 | $1,926 | $963 | $482 | $0 | $0 | $0 |
| J-51 | Vegetative Management | 145 | $0 | $1,195,000 | $597,500 | $298,750 | $0 | $0 | $0 | $8,222 | $4,111 | $2,056 | $0 | $0 | $0 |
| J-59 | Vegetative Management | 145 | $0 | $1,195,000 | $597,500 | $298,750 | $0 | $0 | $0 | $8,222 | $4,111 | $2,056 | $0 | $0 | $0 |
| J-66 | Vegetative Management | 145 | $0 | $1,195,000 | $597,500 | $298,750 | $0 | $0 | $0 | $8,222 | $4,111 | $2,056 | $0 | $0 | $0 |

**Table 5-4. Summary of Recommended and Alternate Water Management Strategy Environmental Assessment**

| County | Water User Group | Water Management Strategy | 2016 Strategy ID | * Total Number of Rare, Threatened & Endangered Species in County | Environmental Impact Factor ** Envir. Water Needs (1-5) | Habitat (1-5) | Cultural Resources (1-5) | Envir. Water Quality (1-5) | Bays & Estuaries *** | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| Bandera | City of Bandera | Reuse treated wastewater effluent for irrigation use | J-1 | 22 | 2 | 2 | 2 | 2 | Not Applicable | Reduces dependence on new groundwater. |
| | | Promote, design & install rainwater harvesting systems | J-2 | | 1 | 1 | 2 | 1 | | Provides sustainable supplemental fresh water. |
| | | Additional Lower Trinity well and lay necessary pipeline | J-4 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | | Additional Middle Trinity wells within City water infrastructure area | J-5 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | Bandera County-Other | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Vegetative Management | J-9 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | | Drought Management – San Antonio Basin | J-68 | | 2 | 2 | 2 | 2 | | Reduces dependence on existing supply sources. |
| | | Additional well for Pebble Beach Subdivision | J-10 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | | Additional wells to provide emergency supply to VFD | J-11 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | | Additional wells to help Medina Lake area | J-12 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | | Drought Management – Nueces Basin | J-69 | | 2 | 2 | 2 | 2 | | Reduces dependence on existing supply sources. |
| | Bandera County Irrigation | Additional groundwater wells | J-13 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| | Bandera County Livestock | Additional groundwater well | J-14 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow BCRAGD regulations. |
| Edwards | City of Rocksprings | Water loss audit and main-line repair | J-15 | 21 | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Additional groundwater well | J-16 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |
| | Edwards County-Other (Barksdale WSC) | Water loss audit and main-line repair | J-17 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Drill additional well in the Nueces River Alluvium Aquifer | J-18 | | 2 | 2 | 2 | 2 | | Caution is necessary to not overexploit the aquifer. |
| | Edwards County-Other | Vegetative Management | J-19 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | Edwards County Livestock | Additional groundwater wells | J-20 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |
| | Edwards County Mining | Additional groundwater wells | J-21 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |
| Kerr | City of Kerrville | Increase wastewater reuse | J-22 | 22 | 2 | 2 | 2 | 2 | | Reduces dependence on existing supply sources. |
| | | Water loss audit and main-line repair | J-23 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Purchase water from UGRA | J-24 | | 2 | 2 | 2 | 2 | | Will observe current low-flow restrictions. |
| | | Increased water treatment and ASR capacity | J-25 | | 2 | 2 | 2 | 2 | | Reduces dependence on new groundwater. |
| | Loma Vista WSC | Conservation: Public information | J-26 | | 2 | 2 | 2 | 2 | | Intended to reduce water use. |
| | | Additional groundwater well | J-27 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |

**Table 5-4. (Continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessment**

| County | Water User Group | Water Management Strategy | 2016 Strategy ID | * Total Number of Rare, Threatened & Endangered Species in County | Environmental Impact Factor ** Envir. Water Needs (1-5) | Habitat (1-5) | Cultural Resources (1-5) | Envir. Water Quality (1-5) | Bays & Estuaries *** | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| Kerr | Kerr County-Other | Water loss audit and main-line repair for Center Point WWW | J-28 | 22 | 2 | 2 | 2 | 2 | Not Applicable | Intended to reduce water loss. |
| | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Conservation: Public information | J-32 | | 2 | 2 | 2 | 2 | | Intended to reduce water use. |
| | | Vegetative management - UGRA | J-33 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | | UGRA Acquisition of Surface Water Rights [2](EKCRWSP) | J-34 | | 2 | 2 | 2 | 2 | | Changes supply use, not flow. |
| | | KCCC Acquisition of Surface Water Rights [2](EKCRWSP) | J-35 | | 2 | 2 | 2 | 2 | | Changes supply use, not flow. |
| | | Construction of an Off-Channel Surface Water Storage [2](EKCRWSP) | J-36 | | 2 | 1 | 2 | 2 | | Provides temporary birding habitat. |
| | | Construction of surface water treatment plant facilities and distribution lines [2](EKCRWSP) | J-37 | | 2 | 3 | 2 | 2 | | Construction of facilities will displace a small segment of natural habitat. |
| | | Construction of ASR facilities [2](EKCRWSP) | J-38 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | | Construction of a well field for dense, rural areas [2](EKCRWSP) | J-39 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | | Construction of a desalination plant contingent on new well field [2](EKCRWSP) | J-40 | | 2 | 3 | 2 | 2 | | Construction of facilities will displace a small segment of natural habitat. |
| | | Construction of an Ellenburger Aquifer water supply well [2](EKCRWSP) | J-41 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | Kerr County Irrigation | Additional groundwater well | J-42 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | Kerr County Livestock | Additional groundwater wells | J-43 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | Kerr County Livestock | Additional groundwater wells | J-44 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | Kerr County Livestock | Additional groundwater well | J-45 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| | Kerr County Mining | Additional groundwater well | J-46 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow HGCD regulations. |
| Kinney | City of Brackettville | Water loss audit and main-line repair | J-47 | 22 | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Increase supply to Spoford with new water line | J-48 | | 2 | 2 | 2 | 2 | | Temporary land disturbance during excavation for new pipeline. |
| | | Increase storage facility | J-49 | | 2 | 3 | 2 | 2 | | Temporary land disturbance during facility construction. |
| | Fort Clark Springs MUD | Increase storage facility | J-50 | | 2 | 3 | 2 | 2 | | Temporary land disturbance during facility construction. |
| | Kinney County-Other | Vegetative Management | J-51 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | Kinney County Livestock | Additional groundwater wells | J-52 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow KCGCD regulations. |
| Real | City of Camp Wood | Conservation: Public information | J-53 | 21 | 2 | 2 | 2 | 2 | | Intended to reduce water use. |
| | | Additional groundwater wells | J-54 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |
| | City of Leakey (Real County-Other) | Water loss audit and main-line repair | J-55 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Additional groundwater well | J-56 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |
| | | Develop interconnections between wells within the City | J-57 | | 2 | 2 | 2 | 2 | | Temporary land disturbance during excavation for new pipeline. |
| | Real County-Other | Water loss audit and main-line repair for Real WSC | J-58 | | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Vegetative Management | J-59 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | | Additional well for Oakmont Saddle WSC | J-60 | | 2 | 2 | 2 | 2 | | Well construction and operation to follow RECRD regulations. |

**Table 5-4. (Continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessment**

| County | Water User Group | Water Management Strategy | 2016 Strategy ID | * Total Number of Rare, Threatened & Endangered Species in County | Environmental Impact Factor ** | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Envir. Water Needs (1-5) | Habitat (1-5) | Cultural Resources (1-5) | Envir. Water Quality (1-5) | Bays & Estuaries *** | |
| Real | Real County Livestock | Additional groundwater wells | J-61 | 21 | 2 | 2 | 2 | 2 | Not Applicable | Well construction and operation to follow RECRD regulations. |
| Val Verde | City of Del Rio | Water loss audit and main-line repair | J-62 | 21 | 2 | 2 | 2 | 2 | | Intended to reduce water loss. |
| | | Drill & equip new well, connect to distribution system | J-63 | | 2 | 2 | 2 | 2 | | Temporary land disturbance during drilling, completion, and pipeline connection. |
| | | Water treatment plant expansion | J-64 | | 2 | 3 | 2 | 2 | | Temporary land disturbance during facility construction. |
| | | Develop a waste water reuse program | J-65 | | 1 | 2 | 2 | 2 | | Temporary land disturbance during placement of new reuse distribution pipelines. |
| | Val Verde County-Other | Vegetative Management | J-66 | | 1 | 1 | 1 | 1 | | Restores historical natural habitat. |
| | Val Verde County Mining | Additional groundwater well | J-67 | | 2 | 2 | 2 | 2 | | Temporary land disturbance during drilling and completion of well. |
| ***2016 ALTERNATE WATER MANAGEMENT STRATEGY*** | | | | | | | | | | |
| Bandera | City of Bandera | Surface water acquisition, treatment and ASR | J-3 | 22 | 4 | 2 | 2 | 2 | NA | Construction of facilities will displace a small segment of natural habitat. Flow in Medina River would be reduced during periods of diversion. |

* Texas Parks & Wildlife Department's Natural Diversity Database of Rare, Threatened and Endangered Species. Individual species impact is not determined.

*See Appendix 5B for quantification description of impact ranges.*

** Environmental impact range: 1 = Positive; 2 = No New; 3 = Minimal Negative; 4 = Moderate Negative; 5 = Significant Negative

*** All strategies occur beyond the distance of potential impact to flows into the coastal bay and estuary systems.

[2] Eastern Kerr County Regional Water Supply Project

# 5.3 WATER CONSERVATION

## 5.3.1 State Water Conservation Overview

### 5.3.1.1 Water Conservation Planning

Water conservation is one of the most important components of water supply management. Recognizing its impact, setting realistic goals, and aggressively enforcing implementation may significantly extend the time when new supplies and associated infrastructure are needed. This chapter explores conservation opportunities and best management practices, and provides a road map for integrating conservation planning into long-range water supply management goals.

The Texas Water Development Board defines 'conservation' as those practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling or reuse of water so that a water supply is made available for future or alternative uses. Water conservation management strategies recommended in Chapter 5 include water loss audits to reduce distribution losses, public education to bring awareness of wasteful practices, and brush management.

Effective conservation programs implement best management practices to try to meet the targets and goals identified within the *Plan* and are important to water conservation planning for all entities such as: municipal, agricultural, industrial, and commercial. Water conservation management planning currently implemented by municipalities, agricultural and commercial interests, and other water users supersede recommendations in this *Plan* and are considered consistent with this *Plan.*

The Texas Water Development Board and the Texas State Soil and Water Conservation Board jointly conducted a study of ways to improve or expand water conservation efforts in Texas. The results of that study are available in a joint 2006 report titled "An Assessment of Water Conservation in Texas, Prepared for the 80th Texas Legislature" (http://www.twdb.texas.gov/publications/reports/special_legislative_reports/doc/TWDBTSSWCB_80th.pdf) and contains the following:

- An assessment of both agricultural and municipal water conservation issues;
- Information on existing conservation efforts by the TWDB and the TSSWCB;
- Information on existing conservation efforts by municipalities receiving funding from the TWDB, as specified in water conservation plans submitted by the municipalities as part of their applications for assistance;
- A discussion of future conservation needs;
- An analysis of programmatic approaches and funding for additional conservation efforts;
- An assessment of existing statutory authority and whether changes are needed to more effectively promote and fund conservation projects; and
- An assessment of the TWDB's agricultural water conservation program.

The implementation of water conservation programs that are cost effective, meet state mandates, and result in permanent real reductions in water use will be a challenge for the citizens of the Plateau Region.

Smaller communities that lack financial and technical resources will be particularly challenged and will look to the State for assistance.

Since portions of the Region are particularly susceptible to water-supply shortages during periods of drought conditions, these areas are especially encouraged to develop conservation oriented management plans. Likewise, water-user entities within these areas should become actively involved in the regional water planning activities associated with this *Plan.*

The PWPG considers all groundwater sources recognized in this P*lan* as being critical to the future health and economic welfare of the Plateau Region. Due to the Regions reliance on groundwater to meet current and future water needs, the PWPG recommends that local groundwater conservation districts be formed throughout the entire Region to administer sound, reasonable, and scientifically-based management objectives; and that these districts play a major role in the regional water planning process.

It is generally recognized that brush infestations are the symptom of deeper ecological disturbances such as fire control, drought, grazing mismanagement, wildlife overpopulations and other causes. Selective Brush Management, as a tool to improve watershed yields and water quality, is a conservation management strategy of great interest in the Plateau Region, as well as in surrounding planning regions. A program is in place and administered through the Texas State Soil and Water Conservation Board to provide a cost-share funding program to landowners in the targeted watersheds for the Selective Brush Management. Funding for this program should be targeted on selected areas identified through modeling.

The PWPG joins with the Rio Grande Region (M) and the Far West Texas Region (E) in encouraging funding for projects aimed at the eradication and long-term suppression of salt cedar and other nuisance phreatophytes in the Rio Grande watershed.

#### 5.3.1.2 Model Water Conservation Plans

Water Conservation Plan forms are available from TCEQ in WordPerfect and PDF formats. The forms for the following entity types listed below are available at: http://www.tceq.state.tx.us/permitting/water_supply/water_rights/conserve.html. You can receive a print copy of a form by calling 512/239-4691 or by email to wras@tceq.state.tx.us.

**Municipal Use** – Utility Profile and Water Conservation Plan Requirements for Municipal Water Use by Public water Suppliers (TCEQ-10218) Word

**Wholesale Public Water Suppliers** – Profile and Water Conservation Plan Requirements for Wholesale Public Water Suppliers (TCEQ-20162) Word

**Industrial/Mining Use** – Industrial/Mining Water Conservation Plan (TCEQ-10213) Word

**Agricultural Uses** – Agriculture Water Conservation Plan-Non-Irrigation (TCEQ-10541) Word

System Inventory and Water Conservation Plan for Individually-Operated Irrigation System (TCEQ-10238) Word

System Inventory and Water Conservation Plan for Agricultural Water Suppliers Providing Water to More Than One User (TCEQ-10244) Word

### 5.3.1.3 State Water Conservation Programs and Guides

The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at: http://www.twdb.state.tx.us/conservation/index.asp. Likewise, water conservation tips were developed by the TCEQ's Clean Texas 2000 and can be accessed at the following website: http://www.tceq.texas.gov/response/drought/drought_tips.html.

#### Water-Saving Plumbing Fixture Program

The Texas Legislature created the Water-Savings Plumbing Fixture Program on Jan. 1, 1992 to promote water conservation. Manufacturers of plumbing fixtures sold in Texas must comply with the Environmental Performance Standards for Plumbing Fixtures, which requires all plumbing fixtures such as showerheads, toilets and faucets sold in Texas to conform to specific water use efficiency standards.

Since more water is used in the bathroom than any other place in the home, water-efficient plumbing fixtures play an integral role in reducing water consumption, wastewater production, and consumers' water bills. It is estimated that switching to water-efficient fixtures can save the average household between $50 and $100 per year on water and sewer bills. Many hotels and office buildings find that water-efficient fixtures can save 20 percent on water and wastewater costs.

#### Water Conservation Best Management Practices

The 78th Texas Legislature under Senate Bill 1094 created the Texas Water Conservation Implementation Task Force and charged the group with reviewing, evaluating, and recommending optimum levels of water use efficiency and conservation for the state. TWDB Report 362, Water Conservation Best Management Practices Guide was prepared in partial fulfillment of this charge. The Guide is organized into three sections, for municipal, industrial, and agricultural water user groups with a total of 55 Best Management Practices (BMPs). Each BMP has several elements that describe the efficiency measures, implementation techniques, schedule of implementation, scope, water savings estimating procedures, cost effectiveness considerations, and references to assist end-users in implementation. This document can be accessed at the following TWDB website:
http://www.twdb.state.tx.us/publications/reports/numbered_reports/doc/R362_BMPGuide.pdf.

#### Public Water Conservation Education

Public education may be one of the most productive actions that can result in the greatest amount of water savings. Most citizens are willing to actively do their part to conserve water once the need is communicated and the means by which to accomplish the most benefit is explained. Numerous state, county, and academic agencies provide educational material and demonstrations. Groundwater conservation districts also provide water conservation activities. The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at: http://www.twdb.state.tx.us/conservation/index.asp. Likewise, water conservation tips were developed by the TCEQ's Clean Texas 2000 and can be accessed at the following website: http://www.tceq.texas.gov/response/drought/drought_tips.html. TPWD also offers programs geared toward the appreciation and conservation of the state's outdoor natural resources (http://www.tpwd.state.tx.us/landwater/water/conservation/) which include:

- Freshwater Inflows and Estuaries
- Coastal Studies
- National Coastal Assessment
- River Studies
- Texas Gulf Ecological Management Sites

Education of our youth may be one of the best ways to spread the word about conservation of water. The TWDB provides excellent educational programs for all grade levels K-12th. Information pertaining to this program can be accessed at: https://www.twdb.texas.gov/conservation/education/kids/index.asp. The groundwater conservation districts in the Plateau Region have water conservation management goals that include:

- Publishing conservation articles in local newspapers;
- Providing conservation presentations and demonstrations at county shows;
- Conducting school programs relating to conservation issues; and
- Working with river authorities to promote the clean rivers program.

## Watershed Best Management Practices

Watershed best management practices are activities taken to manage, protect, and restore the quality of water resources. Best management practices are designed to consider a variety of water uses and maximize conservation. The Environmental Protection Agency has put together a list of fourteen recommended BMPs (http://www.epa.gov/oaintrnt/water/best_practices.htm) that have proven to be helpful in water conservation efforts. Several of these practices are discussed further for being cost effective, practical and efficient for the Plateau Region.

## Brush Management

A potential means of increasing water supply is to reduce the amount of water consumed by shrubs and trees on rangelands. The density and coverage of shrubs has increased dramatically during the past century as former grasslands have now converted to shrub-lands or closed-canopy woodlands. A total loss of herbaceous vegetation cover will increase water yields in the form of surface runoff. However, this process will accelerate erosion, degrade water quality, and damage aquatic ecosystems. A more desirable way of increasing water yield is to manage vegetation to decrease evapotranspiration, which will generally increase the amount of water that percolates below the root zone into groundwater and eventually back into streams. Researchers* believe it is appropriate to broaden the issue from solely focusing on

*"brush control for increasing water yield" to "best management practices for watershed health and sustainability".*

* *Wilcox, B.P., Dugas, W.A., Owens, M.K., Ueckert, D.N., and Hart, C.R., 2005, Shrub Control and Water Yield on Texas Rangelands, Current State of Knowledge: Texas Agricultural Experiment Station Research Report 05-1.*

## Rainwater Harvesting

The following discussion on Rainwater Harvesting is taken from the Texas Water Development Board's 'The Texas Manual on Rainwater Harvesting', 3rd Edition. This manual can be accessed from TWDB's website:
http://www.twdb.texas.gov/innovativewater/rainwater/doc/RainwaterHarvestingManual_3rdedition.pdf.

Rainwater is valued for its purity and softness. It has a nearly neutral pH, and is free from disinfection by-products, salts, minerals, and other natural man-made contaminants. Plants thrive under irrigation with stored rainwater. Appliances last longer when free from the corrosive or scale effects of hard water. Users with potable systems prefer the superior taste and cleansing properties of rainwater. Rainwater harvesting, in its essence, is the collection, conveyance, and storage of rainwater.

Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus. Advantages and benefits of rainwater harvesting are numerous (Krishna, 2003):

- The water is free; the only cost is for collection and use.
- The end use of harvested water is located close to the source, eliminating the need for complex and costly distribution systems.
- Rainwater provides a water source when groundwater is unacceptable or unavailable, or it can augment limited groundwater supplies.
- The zero hardness of rainwater helps prevent scale on appliances, extending their use; rainwater eliminates the need for a water softener and the salts added during the softening process.
- Rainwater is sodium free, important for persons on low sodium diets.
- Rainwater is superior for landscape irrigation.
- Rainwater harvesting reduces flow to storm water drains and also reduces non-point source pollution.
- Rainwater harvesting helps utilities reduce the summer demand peak and delay expansion of existing water treatment plants.
- Rainwater harvesting reduces consumers' utility bills.

### Landscape Maintenance

A significant amount of water is used each year in the maintenance of residential and non-residential landscapes. Landscape irrigation conservation practices are an effective method of accounting for and reducing outdoor water usage while maintaining healthy landscapes and avoiding runoff. Water wise landscape programs should follow the seven principals of xeriscape:

- Planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf area
- Efficient irrigation
- Use of mulch
- Appropriate maintenance

Additional detail on this subject is available in TWDB Report 362 'Water Conservation Best Management Practices Guide': http://www.twdb.state.tx.us/publications/reports/numbered_reports/doc/R362_BMPGuide.pdf.

## 5.3.1.4 Water Loss Audit

Reported municipal use generally includes a variable amount of water that does not reach the intended consumer due to water leaks in the distribution lines, unauthorized consumption, storage tank overflows, and other wasteful factors. For some communities, attending to these issues can be a proactive conservation strategy that may result in significant water savings.

To address the lack of information on water loss, the 78th Texas Legislature passed House Bill 3338, which required retail public utilities that provide potable water to perform and file with the TWDB a water audit computing the utility's most recent annual system water loss every five years. In response to the mandate of House Bill 3338, TWDB developed a water audit methodology for utilities to quantify water losses, standardize water loss reporting and help measure water efficiency. This TWDB report 376 titled 'Water Loss Audit Manual for Texas Utilities' can be accessed at: http://www.twdb.state.tx.us/publications/brochures/conservation/doc/WaterLossManual_2008.pdf.

A summary of the first audit, An Analysis of Water Loss as Reported by Public Water Suppliers – 2007 was provided to the Plateau Water Planning Group (PWPG) for consideration in developing water supply management strategies. The report lists utilities in Region J (Plateau), along with Region I, as having the highest non-revenue water percentage and the highest reported average unbilled authorized water use of the 16 regions in the state. This document can be accessed from the TWDB website in its entirety at:

- Volume I - https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/0600010612_WaterLossinTexas.pdf

- Volume II - https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/0600010612_waterlossintexas_appendix.pdf

Water Loss Audit Resources

The TWDB provides a significant amount of information and services pertaining to water loss audit that can be accessed at: https://www.twdb.texas.gov/conservation/resources/waterloss-resources.asp. Additional resources and appropriate forms provided by TWDB include:

- Water Audit Worksheet Instructions
- Water Loss Guidance
- Guidelines for Setting a Target Infrastructure Leakage Index (ILL)
- Water Loss Manual for Texas Utilities (Updated March 2008)
- Main Line Water Loss Calculator
- Monthly Water Loss Report
- Leak Detection Loan Form
- Ultrasonic Flow Meter Equipment Loan Form

### 5.3.2 Regional Conservation Water Management Strategies

Many of the recommended water management strategies listed in Table 5-2 are classified as "Conservation". These strategies are first to be considered in meeting future water supply needs. Conservation strategies include:

- Reuse of treated wastewater
- Water loss audit and main-line repair
- Vegetative management
- Rainwater harvesting
- Public education

Specific water management strategies that fall within these categories are listed in Table 5-5.

## Table 5-5. Conservation Water Management Strategies

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Bandera | City of Bandera | San Antonio | Reuse treated wastewater effluent for irrigation use | J-1 | 310 | 310 | 310 | 310 | 310 | 310 | $450,000 |
| | | | Promote, design & install rainwater harvesting systems | J-2 | 1 | 1 | 1 | 1 | 1 | 1 | $56,000 |
| | Bandera County-Other | San Antonio | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | 1 | 1 | 1 | 1 | 1 | 1 | $163,000 |
| | | | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | 1 | 1 | 1 | 1 | 1 | 1 | $463,000 |
| | | | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | 1 | 1 | 1 | 1 | 1 | 1 | $447,000 |
| | | | Vegetative Management | J-9 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | Drought Management (BCRAGD) | J-68 | 467 | 519 | 546 | 556 | 563 | 568 | $0 |
| | | Nueces | Drought Management (BCRAGD) | J-69 | 29 | 32 | 34 | 34 | 35 | 35 | $0 |
| Edwards | City of Rocksprings | Colorado | System water loss audit and main-line repair | J-15 | 1 | 1 | 1 | 1 | 1 | 1 | $129,000 |
| | Edwards County-Other (Barksdale WSC) | Nueces | System water loss audit and main-line repair | J-17 | 1 | 1 | 1 | 1 | 1 | 1 | $203,000 |
| | Edwards County Other | | Vegetative Management | J-19 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| Kerr | City of Kerrville | Guadalupe | Increase wastewater reuse | J-22 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $23,000,000 |
| | | | System water loss audit and main-line repair | J-23 | 147 | 147 | 147 | 147 | 147 | 147 | $9,339,000 |
| | Loma Vista WSC | Guadalupe | Conservation: Public information | J-26 | 4 | 4 | 4 | 4 | 4 | 4 | $0 |
| | Kerr County-Other | Guadalupe | Water loss audit and main-line repair for Center Point WWW | J-28 | 1 | 1 | 1 | 1 | 1 | 1 | $33,000 |
| | | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | 1 | 1 | 1 | 1 | 1 | 1 | $138,000 |
| | | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | 1 | 1 | 1 | 1 | 1 | 1 | $99,000 |
| | | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | 1 | 1 | 1 | 1 | 1 | 1 | $102,000 |
| | | | Conservation: Public information | J-32 | 15 | 15 | 15 | 16 | 16 | 16 | $0 |
| | | | Vegetative management - UGRA | J-33 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |

**Table 5-5. (Continued) Conservation Water Management Strategies**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Kinney | City of Brackettville | Rio Grande | System water loss audit and main-line repair | J-47 | 58 | 58 | 58 | 58 | 58 | 58 | $1,116 |
| | Kinney County-Other | | Vegetative Management | J-51 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| Real | City of Camp Wood | Nueces | Conservation: Public information | J-53 | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | City of Leakey (Real County-Other) | | System water loss audit and main-line repair | J-55 | 1 | 1 | 1 | 1 | 1 | 1 | $52,000 |
| | Real County-Other | | System water loss audit and main-line repair for Real WSC | J-58 | 2 | 2 | 2 | 2 | 2 | 2 | $199,000 |
| | | | Vegetative Management | J-59 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| Val Verde | City of Del Rio | Rio Grande | System water loss audit and main-line repair | J-62 | 119 | 119 | 119 | 119 | 119 | 119 | $8,673,000 |
| | | | Develop a waste water reuse program | J-65 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $1,700,000 |
| | Val Verde County-Other | | Vegetative Management | J-66 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |

### 5.3.3 Municipal Conservation Programs

Texas Water Code §11.1271 requires water conservation plans for all municipal and industrial water users with surface water rights of 1,000 acre-feet per year or more and irrigation water users with surface water rights of 10,000 acre-feet per year or more. Water conservation plan summaries for the cities of Kerrville and Del Rio, which meet these criteria, are provided in the following sections. The Upper Guadalupe River Authority, which also has water rights that meet the criteria, is not currently providing water and therefore has not developed a conservation plan under the above TWC requirement. However, UGRA does have a Water Conservation/Drought Management Plan, which was adopted in 1993. Water conservation plans are also required for all other water users applying for a State water right, and may also be required for entities seeking State funding for water supply projects.

City of Del Rio Water Conservation Plan

The City of Del Rio adopted a new Water Conservation Plan and Drought Contingency and Water Emergency Plan on May 12, 2009. The Plan provides for the following measures.

- Establishes a conservation goal of 176 gpd/per person, a 20% reduction from the 2007 rate;
- Requires the testing and installation of meters on all connections;
- Develops a more detailed management plan to more accurately account for otherwise unaccounted for water;
- Coordinates Plan with the Plateau Water Planning Group; expands educational programs;
- Considers potential to modify current rate structure to actively discourage increased water use;
- Ensures that any new wholesale contracts or contract extensions will require wholesale customers to develop and implement water conservation plans consistent with the Plan.

The City's Water Conservation and Drought Contingency Plan is intended to establish criteria to identify when water supplies may be threatened and the actions that should be taken to ensure these potential threats are minimized. The approved 2014 Water Conservation Plan can be accessed at: http://www.cityofdelrio.com/DocumentCenter/View/1484.

### 5.3.4 Groundwater Conservation District Management Plans

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts. The districts are charged with managing groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states, in part, "Groundwater Conservation Districts created as provided by this chapter are the state's preferred method of groundwater management." Four districts are currently in operation within the planning region.

- Bandera County River Authority and Groundwater District
- Headwaters Groundwater Conservation District (Kerr County)
- Kinney County Groundwater Conservation District

- Real-Edwards Conservation and Reclamation District

In recent sessions, the Texas Legislature has redefined the manner in which groundwater is to be managed by establishing a process referred to as Groundwater Management Areas http://www.twdb.texas.gov/groundwater/management_areas/index.asp. This new process is summarized in Chapter 1, Section 1.1.2. The Real-Edwards and a portion of Kinney districts are in GMA 7; while the Bandera and Kerr (Headwaters) districts are in GMA 9. A portion of the Kinney district is in GMA 10.

As part of the joint planning process, groundwater conservation districts are responsible for determining the *desired future conditions* of principal aquifers within a management area. *Desired future conditions* are defined in Title 31, Part 10, §35601. (6) of the Texas Administrative Code as "the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts." *Desired future conditions* are implemented to help meet the planning goal for the conservation of water that is to be used for future uses. The following link provides information on desired future conditions: http://www.twdb.state.tx.us/groundwater/management_areas/DFC.asp.

Based on adopted *desired future conditions*, the TWDB estimates the amount of withdrawals that can occur over a specified time (*modeled available groundwater*) that does not deplete the aquifer beyond the stated *desired future condition*. As of July 2010, desired future conditions have been adopted and modeled available groundwater has been determined for the following aquifers in the Plateau Region: Trinity, Edwards Group of the Edwards Trinity (Plateau), Edwards BFZ, and Edwards-Trinity (Plateau).

### 5.3.4.1 Bandera County River Authority and Groundwater District

The Bandera County River Authority and Groundwater District (http://www.bcragd.org/) was originally the Bandera County River Authority, created by the Texas legislature in 1971, and the Springhills Water Management District, created by the legislature in 1989. The authority of the Bandera County River Authority was incorporated into the Springhills Water Management District, and in 2003 the TCEQ authorized changing the District's name to Bandera County River Authority and Groundwater District. The District includes all of Bandera County within its jurisdiction. The mission of the District is to manage, protect and conserve the County's water and natural resources, while protecting private property rights. The most current District management plan was adopted in April of 2010 and amended in April 2013. The plan can be accessed at: http://www.twdb.state.tx.us/groundwater/docs/GCD/bcragwd/bcragwd_mgmt_plan2013.pdf.

**Adopted Future Conditions for Bandera County**

| **Aquifer** | Edwards Group of the Edwards-Trinity (Plateau) | Trinity |
|---|---|---|
| **DFC** | No net increase in average drawdown through 2060 | Average drawdown of 30 feet through 2060 |

### 5.3.4.2 Headwaters Groundwater Conservation District

The Headwaters Groundwater Conservation District (http://www.hgcd.org/) is part of the Hill Country Priority Groundwater Management Area (9) and was created by the Texas legislature in 1991 (HB 1463). The District's revised 2013 Management Plan can be accessed at: http://www.hgcd.org/pdf/Management%20Plan%20Official%20Version%202013.pdf. The District includes all of Kerr County within its jurisdiction.

The purpose of the District is to provide for the conservation, preservation, protection, recharging and prevention of waste of groundwater reservoirs or their subdivisions within the defined boundaries of the District. The District is responsible for registering and permitting wells drilled in the county, along with conducting aquifer analysis to help determine appropriate plans for future development.

Adopted DFCs for the aquifers in Kerr County are shown below. With regards to the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, the District declares it 'non-relevant'. Districts in a groundwater management area may, as part of the process for adopting and submitting desired future conditions, propose classification of a portion or portions of a relevant aquifer as non-relevant (31 Texas Administrative Code 356.31 (b)). This classification of an aquifer is made if the districts determine that aquifer characteristics, groundwater demands, and current groundwater uses do not warrant adoption of a desired future condition. Further details explaining 'non-relevant' aquifers can be at TWDB website: http://www.twdb.texas.gov/groundwater/docs/Explanatory_Report_DFC_Submittal_July_2013.pdf.

**Adopted Desired Future Conditions for Kerr County**

| **Aquifer** | Edwards Group of the Edwards-Trinity (Plateau) | Trinity |
|---|---|---|
| **DFC** | No net increase in average drawdown through 2060 | Average drawdown of 30 feet through 2060 |

### 5.3.4.3 Kinney County Groundwater Conservation District

The Kinney County Groundwater Conservation District (http://www.kinneycogcd-state-tx.us/) was created by the legislature in 2001 (HB 3243), and was confirmed by the voters of Kinney County in 2002. The District includes all of Kinney County within its jurisdiction. The District was created to develop, promote, and implement water conservation and management strategies to conserve, preserve, protect groundwater supplies within the District, protect and enhance recharge, prevent waste and pollution, and to promote the efficient use of groundwater within the District. The 2013 approved Management Plan includes goals such as: provide the most efficient and sustainable use of groundwater; address conjunctive surface water management issues; address drought conditions and participate in the development of desired future conditions of aquifers. The Districts Management Plan can be accessed at: http://www.twdb.state.tx.us/groundwater/docs/GCD/kincgcd/kincgcd_mgmt_plan2013.pdf.

**Adopted Desired Future Conditions for Kinney County**

| **Aquifer** | Edwards BFZ | Edwards-Trinity (Plateau) |
|---|---|---|
| **DFC** | Water level in well 70-38-902 shall not fall below 1,184 feet MSL | Drawdown which is consistent with maintaining, at Los Maras Springs, an annual flow of 23.9 cfs and median flow of 24.4 cfs on GAM |

#### 5.3.4.4 Real-Edwards Conservation and Reclamation District

The Real-Edwards Conservation and Reclamation District (http://www.recrd.org/) was formed by the Texas legislature in 1959 (HB 447) and includes all of Real and Edwards Counties within its jurisdiction. The District was created to provide for the conservation preservation, protection, recharge and prevention of waste of the underground water reservoirs located under the District. The District strives to bring about conservation, preservation and the efficient, beneficial and wise use of water for the benefit of the citizens and the economy of the District through monitoring and protecting the quantity and quality of the groundwater. The District also aims to maintain groundwater ownership and rights of the landowners.

District activities include regulating groundwater withdrawals by means of spacing and production limits, using the Texas Water Development Board's observation network to monitor changing storage conditions of groundwater supplies within the District, undertaking, as necessary, and cooperating with investigations of the groundwater resources within the District and making the results of investigations available to the public upon adoption by the Board, and potentially requiring reduction of groundwater withdrawals to amounts which will not cause harm to the aquifer.

**Adopted Desired Future Conditions for the Counties of Real and Edwards**

| | | |
|---|---|---|
| **County** | Edwards (GMA 7) and Real (GMA 7) | Real (GMA 7) |
| **Aquifer** | Edwards-Trinity (Plateau) | Trinity |
| **DFC** | Average drawdown of 7 feet | Average drawdown of 7 feet |

### 5.3.5 Upper Guadalupe River Authority Conservation Program

The Upper Guadalupe River Authority (UGRA) provides a significant conservation outreach program serving citizens of Kerr County and elsewhere in the upper Guadalupe River Basin. The UGRA employs two full-time staff for education and public awareness with emphasis on water conservation, and promotes the following activities:

- Publishing conservation articles in local newspapers;
- Providing conservation presentations and demonstrations at county shows;
- Performing a weekly radio program;
- Conducting school conservation education programs; and
- Working with river authorities to promote the Clean Rivers Program.

UGRA has implemented a water enhancement cost share program targeting the removal of brush. Priority agricultural water enhancement activities to be applied will focus on brush clearing (primarily Ashe Juniper) and construction of water and sediment control basins. In UGRA's water enhancement cost share program, UGRA is matching a percentage of eligible landowners cost in removing brush. Eligible landowners include those who have an approved NRCS or Kerr County SWCD contract.

### 5.3.6 Vegetative Management and Land Stewardship

Vegetative management of Ashe Juniper, also commonly known as "cedar" has become a significant source of discussion and debate as to its impact on water resources on the Edwards Plateau. Ashe Juniper is native to central Texas and was initially controlled through both man-made and natural fires and through foraging. As these events were reduced, cedar returned and has been expanding in the Region. Eradication methods have included controlled burns, use of heavy equipment to pull the plant up by its roots, mechanical cutting and chemical methods. There has been a great deal of debate regarding the impact on water resources by cedar with various groups calculating how much water cedar takes away from both groundwater and surface water sources. In a 2003, report done by A.A. McCole of the University of Texas Geology Department, it was noted that "in late summer and winter the Ashe Juniper obtains approximately between 72% and 100% of its water from groundwater. In contrast, during the wet periods of the year, spring and fall, mass balance calculations indicate that between 45% and 100% of Ashe Juniper's water is derived from soil water. This seasonal shift indicates the presence of Ashe Juniper can appreciably reduce groundwater resources both by lateral roots intercepting potential recharge during the wet season and direct uptake of groundwater by deep roots during the dry season. Ashe Juniper will directly compete with grasses for soil water during the wet season, limiting herbaceous productivity."

In 2010, the USGS published a study, "Effects of Brush Management on the Hydrologic Budget and Water Quality In and Adjacent to Honey Creek State Park Natural Area, Comal County, Texas 2001-2010". The results of this study indicated that brush eradication did not increase runoff to streams but did suggest that clearing brush can result in more infiltration. The study found that before clearing potential groundwater recharge was 17% of the total water budget, but increased to 24% after clearing. The study showed that prior to clearing a rainfall event produced a potential recharge of 5.91 inches of the rain that fell and after clearing, it increased to 7.09 inches; for a difference of 1.18 inches. In terms of actual water, the extra 1.18 inches amounts to approximately 32,042 gallons per acre. Thus, in order to obtain one acre foot of water, 10 acres will need to be cleared to gain an additional acre foot of water as infiltration. From these and other studies, it would appear that brush eradication can have a positive impact on groundwater recharge and a limited impact on surface water runoff. However, with increased groundwater recharge it is reasonable to assume that a portion of this groundwater would percolate down to aquifers as well as provide base flow to surface water via springs.

Brush management is a difficult issue to deal with on a planning level since much of the work that needs to be done is on private property with landowners having varied interests. From literature on the subject many authors note that brush management includes both removing the brush, but also providing land management through replacement with other native species that will prevent erosion and hold moisture. However, as a strategy brush management does show potential for enhancing ground water supplies and subsequent base flow to surface water bodies.

# APPENDIX 5A
# RECOMMENDED AND ALTERNATE WATER MANAGEMENT STRATEGIES

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# INTRODUCTION

Water Management Strategies described in this appendix are proposed recommended projects to meet projected water supply shortages in future decades, and projects of specific interest by water-user entities participating in this planning process. The strategy evaluation procedure is designed to provide a side-by-side comparison such that all strategies can be assessed based on the same quantifiable factors as shown in Chapter 5 Tables 5-2, 5-3 and 5-4. Specific factors considered in each Table were:

Table 5-2

- Quantity adequacy
- Quality adequacy
- Reliability
- Impacts to water, agricultural, and natural resources

Table 5-3

- Financial cost (total capital cost, annual cost, and cost per acre-foot)

Table 5-4

- Environmental impacts
  - Environmental water needs
  - Wildlife habitat
  - Cultural resources
  - Environmental water quality
  - Inflows to bays and estuaries

Qualitative and quantifiable impacts resulting from the implementation of projects are an important aspect of the overall analysis of the viability of water management strategies. The Tables above provide a coded ranking of impacts to designated required analysis categories. An explanation of the qualitative and quantifiable rankings listed in the Tables is provided in Appendix 5B. It is recognized that all strategies that require constructed infrastructure, including pipelines, will have either a temporary or permanent land disturbance on the footprint of the project.

Cost evaluations for all strategies include capital cost, debt service, and annual operating and maintenance (O&M) expenses. Capital costs are estimated based on September 2013 US dollars. The length of debt service is 20 years unless otherwise stated. An annual unit cost is also calculated based on the O&M cost per acre-foot of water supplied.

# 5A.1 WATER MANAGEMENT STRATEGIES FOR THE CITY OF BANDERA

The City of Bandera and many other residents of Bandera County rely on the Lower Trinity Aquifer for municipal, domestic, livestock, and irrigation water supply needs, and the demand from the Lower Trinity is projected to increase as the population increases. Because the water level in the Lower Trinity has declined about 350 feet in City of Bandera wells since pumping started in the 1950s, there is concern that continued withdrawals from the Aquifer may negatively impact the Aquifer's ability to meet the long-term water supply needs of the area.

Although the supply-demand analysis does not project a future water supply deficit for the City of Bandera, the following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-1) Reuse treated wastewater effluent for irrigation of public spaces and for Flying L Resort
- (J-2) Promote, design, and install rainwater harvesting systems on public buildings
- (J-3) Acquire surface water supply, build required treatment facilities, connect to distribution network, and inject unused supply into underlying Lower Trinity Aquifer (ASR)
- (J-4) Additional Lower Trinity Aquifer well outside the current cone-of-depression and lay necessary pipeline
- (J-5) Additional Middle Trinity Aquifer wells within City water infrastructure area Alternate Water Management Strategy

The City of Bandera has been active in promoting water conservation during the current drought and has committed to using water conservation as a long-term water management strategy. Conservation practices that the City has adopted include tiered water rates; providing the public with water conservation information; meter change out program and water line replacement program to reduce unaccounted for water loss. The City has also been working with residential and commercial water customers to identify BMPs that can be used to reduce water consumption as well as evaluating the potential for installing rainwater harvesting systems on public buildings. The City of Bandera has adopted the Bandera County River Authority and Groundwater District Drought Contingency Plan. The City has been in drought stage for the past three years and has implemented various stages of the plan. The various stages of drought management have reduced water use and heightened public awareness of the need to conserve water.

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Perform water loss audit to determine the need for replacing leaking distribution lines and faulty meters
- Promote Best Management Practices (BMPs) for residential and commercial water customers

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve items such as: replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed at the following link: https://www.twdb.texas.gov/financial/index.asp.

In 2007, the Flying L PUD in Bandera County applied for TWDB funding (WDF) for the following completed water project:

- Water system improvements to Flying L PUD

## J-1 Reuse Treated Wastewater Effluent for Irrigation of Public Spaces and for Flying L Resort

The City of Bandera has requested funding through the Texas Water Development Board to study the potential of using treated wastewater effluent for irrigation of public parks, athletic fields and for the Flying L Resort. The importance of this effort is that the treated wastewater effluent is a known constant and can provide a new source of water for these uses. Currently, the Flying L Resort uses water from wells in the Lower and Middle Trinity Aquifers and from reuse water from the Flying L PUD for irrigation of their properties, including a golf course. All current public supplies come predominantly from the Lower Trinity Aquifer, and as a consequence a significant aquifer cone-of-depression has resulted underlying the City of Bandera and surrounding area. If demands can be reduced it will potentially have a positive impact on water levels within the Aquifer.

**Quantity, Reliability, and Cost** – The quantity and reliability of this source is known through current wastewater discharges allowed under the City's wastewater discharge permit. Average daily flow from the wastewater plant is approximately 277,000 gallons/day (310 acre-feet/year). Based on the positive recommendation from the feasibility study, construction of this project will include amending the current discharge permit, potentially upgrading the wastewater treatment plant, a pump station, storage tanks and piping to deliver water. Total estimated capital cost for this project is approximately $450,000 with an annual operations and maintenance cost of approximately $5,000.

## J-2 Promote, Design, and Install Rainwater Harvesting Systems on Public Buildings

Rainwater harvesting is a practical and valuable method for supplying water for multiple uses including household, landscape, livestock and agricultural. A renewed interest in this approach is emerging due to escalating environmental and economic costs associated with the traditional centralized water systems or the drilling of wells. The State has devoted a considerable amount of attention to rainwater harvesting and has enacted many laws regulating this practice. Three specific pieces of legislation support the collection of rainwater: Texas Tax Code 151.355 which allows for a state sales tax exemption on rainwater harvesting equipment, Texas Property Code 202.007 prevents homeowners associations from banning rainwater harvesting installations, and Texas House Bill 3391 which requires designs of new state buildings to include rainwater harvesting system technology.

The City of Bandera and the Bandera County River Authority and Groundwater District (BCRAGD) is actively involved in the conservation of water through rainwater harvesting. In 2013, Bandera High School was the recipient of the Texas Water Development Board's Texas Rain Catcher Award. This program is established to promote technology, educate the public, and to recognize excellence in the application of rainwater harvesting systems in Texas.

The City of Bandera, with the recommendation from the BCRAGD, has plans to develop a rainwater collection system utilizing rooftops located in the downtown area. This strategy assumes that the system will be gravity fed and used for local irrigation purposes. This project is designed to collect rainwater from two commercial sized roofs and store the water in fiberglass tanks at the respective locations. The strategy includes a fiberglass tank as opposed to a steel tank, since the steel tank would cost considerably more.

**Quantity, Reliability, and Cost** – This strategy will provide an additional one acre-foot per year. The total estimated capital cost for this project is approximately $56,000 with an annual operation and maintenance cost of approximately $2,500. The reliability of this supply is dependent on seasonal rainfall, but even in drought conditions some rainfall occurs.

## J-3 Acquire Surface Water Supply, Build Required Treatment Facilities, Connect to Distribution Network, and Inject Unused Supply into Underlying Lower Trinity Aquifer (ASR)

The City of Bandera has considered the feasibility of constructing a water treatment facility to treat surface water from the Medina River. As much of the treated water as is needed will go directly into customer distribution, with the excess being injected into existing public supply wells for future retrieval (ASR). A May 2009 study report titled *'ASR Feasibility in Bandera County'* was prepared for the Plateau Region Water Planning Group and can be accessed at the following link for more strategy detail: http://www.ugra.org/pdfs/BanderaReportMay09.pdf.

Bandera County currently has a Water Supply Agreement with Bandera-Medina-Atascosa WCID #1 (BMA WCID#1) for the option of up to 5,000 acre-feet per year. The BMA WCID#1 owns Certificate of Adjudication CA-19-2130, which authorizes the District to divert up to 65,830 acre-feet per year for irrigation, municipal and industrial uses; up to 750 acre-feet per year specifically for domestic and livestock purposes; and up to 170 acre-feet per year specifically for municipal use.

Under CA-19-2130, BMA WCID#1 is authorized to divert water from Medina Lake and Diversion Dam. However, it is anticipated that the surface water purchased by Bandera County for local use and the potential ASR project will be diverted in the vicinity of the City of Bandera, upstream of Medina Lake. As a result, an amendment of the existing water right owned by BMA WCID#1 is required and the upstream diversion point will likely be subject to additional bypass requirements. A minimum bypass equal to the 7Q2 was assumed to evaluate the reliability of this diversion. The 7Q2 is defined as the minimum average 7-day flow that has a return period of 2 years. The published 7Q2 for the Medina River at Bandera is 20 cfs (Chapter 307 – Texas Surface Water Quality Standards, TCEQ).

The reliability of the River diversion was calculated with a Run 3 version of the Water Availability Model (WAM) of the Guadalupe-San Antonio Basin dated March 2008, provided by the TCEQ. Assumptions of the Run 3 version include adherence to strict prior appropriation; maximum use and storage; no return flows; and a hydrologic simulation period of 1934-1989. The version as received from the TCEQ includes updates for Lake Medina/Diversion Lake and the addition of channel loss factors to all main stem water rights in the Guadalupe and San Antonio River Basins. Based on this assessments, the average diversion over the historical period (1934-1989) is 3,680 acre-feet per year.

For the purpose of this *Plan*, this strategy is included as an alternate strategy designed to be recommended upon the existence of a sufficient supply in the Medina River.

**Quantity, Reliability, and Cost** – An initial facility will provide 500 acre-feet per year of treated water. As much as is needed will go directly into customer distribution, with the excess being injected into existing public supply wells. In 2040 the facility will increase capacity to 1,000 acre-feet per year, and in 2060 the capacity increases to 1,500 acre-feet per year. To be conservative, a diversion of 85 percent of the average WAM 3 supply or 3,100 acre-feet per year is assumed to be reliably available for planning purposes.

The estimated capital costs for a 6.7 MGD capacity source water treatment facility is approximately $20,063,000. The cost to construct and equip two Lower Trinity wells capable of both injection and withdrawals is approximately $1,014,000. The total capital cost is approximately $29,450,000 with a unit cost of approximately $798 per acre-foot.

## J-4 Additional Lower Trinity Aquifer Well Outside the Current Cone-of-Depression and Lay Necessary Pipeline

The City of Bandera obtains its water from the Trinity Aquifer and serves a growing population. The projected population growth is expected to increase from 1,045 in 2020; to 1,361 by 2070. In order to keep pace with the growing water demands, the City of Bandera, with the recommendation from the (BCRAGD) has plans to develop additional groundwater from the Lower Trinity Aquifer.

The development of additional supplies from the Lower Trinity Aquifer includes one new well located approximately four miles north of town. It is assumed that the City will purchase the necessary property, costing approximately $10,000 per acre, along with the associated water rights and develop the infrastructure needed to pipe the water back to the City. This well will produce water from approximately 900 feet below the surface.

**Quantity, Reliability, and Cost** – The strategy supply is estimated at 323 acre-feet per year. The Lower Trinity Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional demands. Care will need to be taken to find a suitable site for the new well to prevent any overlapping of existing aquifer cones-of-depression. The cost to develop a water well in the Lower Trinity Aquifer is significant, along with the necessary infrastructure to store and pump the water back to the City of Bandera. The total estimated capital cost for this project is approximately $2,284,000 with an annual operations and maintenance cost of approximately $106,000.

## J-5 Additional Middle Trinity Aquifer Wells within City Water Infrastructure Area

The City of Bandera with the recommendation from BCRAGD has identified the Middle Trinity Aquifer as a potential source of supply for meeting future water demands. Currently, this source is not being used for municipal purposes. Development of this Aquifer may provide a source of water that could potentially reduce peak demands on existing wells in the Lower Trinity Aquifer.

The proposed three wells will be located near the Medina River where more recharge might be anticipated and will produce water from approximately 550 feet below the surface. This strategy assumes that the supply from the Middle Trinity Aquifer would require minimal treatment such as chlorine disinfection. In addition, this strategy assumes 1,500 feet of connection piping.

**Quantity, Reliability, and Cost** – The quantity of water available in the Middle Trinity Aquifer is less than that of the Lower Trinity Aquifer. However, the wells can be pumped at a sustainable rate that does not exceed the MAG allowable. The reliability of water from this source is expected to be approximately 50 gpm. However, the Middle Trinity Aquifer has not been developed for municipal water supply in Bandera. The three wells are expected to yield approximately 161 acre-feet per year. The cost to develop a municipal water well in the Middle Trinity Aquifer is anticipated to be less since the City will not have to drill as deep. Furthermore, this strategy assumes that the new wells will be located within the City limits, minimizing project costs associated with the amount of connection piping required to meet the existing distribution system. The total estimated capital cost for this project is approximately $779,000 with an annual cost of approximately $74,000.

## 5A.2 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY-OTHER

Bandera County-Other has less than 23,947 in population, including individuals living outside of a named water user group. This compilation of users known as county-other is self-supplied and relies predominately on the Trinity Aquifer for their water supply needs, either on private wells or privately owned water supply systems. In a few locations, the Edwards-Trinity (Plateau) is a modest source of supply.

Although the supply-demand analysis does not project a future water supply deficit for Bandera County-Other, the following water management strategies are recommended to enhance the reliability of the future water supply availability for Bandera County Other:

- (J-6) Water loss audit and main-line repair for Bandera County FWSD #1
- (J-7) Water loss audit and main-line repair for Bandera River Ranch #1
- (J-8) Water loss audit and main-line repair for Medina Water Supply Corporation
- (J-9) Vegetative Management
- (J-10) Additional well and necessary infrastructure for Pebble Beach subdivision
- (J-11) Additional wells to provide emergency supply near the volunteer fire department
- (J-12) Additional wells and distribution lines to help mitigate problems in Medina Lake area
- (J-68) Drought Management – San Antonio Basin
- (J-69) Drought Management – Nueces Basin

Strategies J-6, J-7 and J-8 involve performance of a water loss audit and, based on the results of the audit, repair to impacted main water distribution lines. System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the District.

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve items such as: replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed at the following link: https://www.twdb.texas.gov/financial/index.asp.

Water management strategies considered, but do not meet SWIFT qualifications:

- Build wastewater collection and treatment system to help mitigate problems in Medina Lake area

Bandera River Ranch WSC is currently in the application process for TWDB funding (RWAF) regarding the following water project:

- Drill additional well, storage tank and associated equipment

## J-6 Water Loss Audit and Main-line Repair for Bandera County FWSD #1

According to the 2010 TWDB Public Water System Water Loss Survey, Bandera County FWSD #1 had a total water loss of approximately 3,587,999 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (439,889 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.8 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately $163,000.

## J-7 Water Loss Audit and Main-line Repair for Bandera River Ranch #1

According to the 2010 TWDB Public Water System Water Loss Survey, Bandera River Ranch #1 had a total water loss of approximately 1,348,411 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (164,506 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 2.4 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately $463,000.

## J-8 Water Loss Audit and Main-line Repair for Medina Water Supply Corporation

According to the 2010 TWDB Public Water System Water Loss Survey, Medina Water Supply Corporation had a total water loss of approximately 2,620,721 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (439,757 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 2.3 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately $447,000.

## J-9 Vegetative Management

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (*Arundo donax*) and Elephant Ears (*Colocasia esculenta*) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite.

Giant River Cane (*Arundo donax*) has become a significant problem throughout the Plateau Region. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plants high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp, and has received permits to use this wasp in the eradication efforts. Due to the *Arundo donax* being highly invasive, the Texas Legislature passed legislation making it illegal to sell or distribute *Arundo donax* without a permit from the Texas Department of Agriculture.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Bandera County / Edwards Aquifer / Medina River study, the estimated average annual volume of water supplied is 0.5166 acre-feet per acre.

**Quantity, Reliability, and Cost** – This strategy assumes a chemical control method that will be implemented on 4,480 acres. The calculated average annual runoff benefit from the treated 4,480 acres is 2,314 acre-feet per year. However, the benefit during drought-of-record conditions is zero acre-feet per year. The total estimated capital cost for chemical control for this project is approximately $1,964 per acre, with a total annual cost of $8,798,720. The annual operations and maintenance cost will have to be determined on a case by case basis if the *Arundo donax* reappears.

## J-10 Additional Wells and Necessary Infrastructure for Pebble Beach Subdivision

Bandera County FWSD #1 with the support from the BCRAGD has plans to design and construct a membrane filtration system to remove sulfates from one of their existing water wells. However, on August 15, 2013 the District was designated by TCEQ as having a water supply emergency since one of their main water wells stopped producing in March of 2013. Shortly thereafter, Bandera County FWSD #1 was granted funding for the emergency project which includes the acquisition of a new water well site at a separate location from their five existing wells. Of those five wells, only one is currently producing water and requires advanced treatment for municipal purposes. The other four wells are not considered a reliable supply and have been pulled off-line for water quality issues.

This strategy assumes that one new water well be drilled in the Trinity Aquifer, approximately 1,200 feet in depth. It is anticipated that the well will be cased with either 8- or 10-inch PVC or steel pipe. A 150 gpm electric submersible pump will be installed. In addition, a chlorinator for disinfection purposes will be installed and housed in a small building located on-site. The proposed well site will include a new 30,000 gallon groundwater storage tank and a dual pump station. An 8-inch water line will be installed to convey water from the well head to the storage tank, and ultimately to the nearby potable water distribution system. In addition, necessary upgrades will be made to the filtration system at the existing WTP site in order to increase capacity. The TWDB has granted Bandera County FWSD #1 $785,000 in assistance funding from the Drinking Water State Revolving Fund (DWSRF) program and $350,000 in emergency grant assistance from the Texas Department of Agriculture.

**Quantity, Reliability, and Cost** – The quantity of water from the Trinity Aquifer is deemed to be sufficient to meet future demands if a site outside of the existing cone-of-depression can be found. The Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. It is anticipated that this strategy will provide an additional 161 acre-feet per year. The total estimated capital cost for this project is approximately $3,717,000 with an annual operations and maintenance cost of approximately $291,000.

## J-11 Additional Wells to Provide Emergency Supply near Volunteer Fire Department

Bandera County River Authority & Groundwater District (BCRAGD) has plans to develop a Regional Project designed to offer relief to both the local residents impacted by severe drought conditions, and to provide a source of water to be potentially used by Fire Departments for emergency firefighting. This strategy assumes that public supply wells will be drilled in strategic locations and outfitted with a 30,000 gallon storage tank per site, which will be connected to the wells by 500 feet of connection piping. In addition, this strategy will be monitored by the BCRAGD to document aquifer conditions, conduct scientific studies such as determining aquifer recharge from rainfall, DFC compliance and regional planning. It is estimated that two new wells will be drilled in the Lower Trinity Aquifer. One well will be drilled in Eastern Bandera County approximately 800 feet in depth, with a capacity of 75 gpm. The second well will be located in Western Bandera County approximately 1,100 feet in depth, with a capacity of 100 gpm. The developed water will require minimal treatment such as chlorine disinfection for municipal purposes.

**Quantity, Reliability, and Cost** – It is anticipated that these two wells will yield a total of 189 acre-feet per year from the Lower Trinity Aquifer. The aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. The cost to develop water in the Lower Trinity Aquifer is significant. The total estimated capital cost for this project is approximately $2,824,000 with an annual cost of approximately $283,000.

## J-12 Additional Wells and Develop Distribution Lines to Help Mitigate Problems in Medina Lake Area

Bandera County River Authority & Groundwater District (BCRAGD) has declared weekly drought conditions registering as severe and sometimes exceptional throughout 2014. The Lake Hills area of Bandera County is located in the eastern portion of the County. Close to and around Medina Lake, Lake Hills is relative to other sections of Bandera County, the most heavily populated area of the District.

Historically, populations around the edge of the lake were directly dependent on surface water extraction, while populations that are not directly lake-front have been dependent on shallow Glen Rose Aquifer (Upper and Middle Trinity) wells. Studies have shown that Medina Lake and the Glen Rose portion of the Trinity Aquifer adjacent to the Lake are interconnected, thus the Aquifer is influenced by the Lake. Due to the recent drought, Medina Lake water levels have drastically declined (4% total capacity), resulting in a lowering of the groundwater table. These events have inevitably caused the surrounding wells to run dry, leaving a statistically significant population in a state of an emergency shortage of water. With current residents of Lake Hills predominately commuting to San Antonio for employment, and water security significantly decreasing, Bandera County faces a significant threat of losing that population and tax base.

This strategy assumes that drilling deeper Lower Trinity wells is not economically feasible for most individual property owners and therefore recommends the creation of a Public Water Supply (PWS) in order to provide a sustainable water supply to the Avalon subdivision. BCRAGD plans to establish a PWS with all necessary distribution lines to serve a population of 5,500 in the Lake Hills area.

This strategy estimates the purchase of two acres at approximately $10,000 per acre, and includes the development of two new wells drilled near the Avalon subdivision in Lake Hills. One well will be developed at a depth of 850 feet drilled into the Middle Trinity portion of the Aquifer. The second well will be drilled 1,100 feet below the surface into the Lower Trinity Aquifer. This strategy will include a 10,000 gallon storage tank, along with approximately five miles of six-inch diameter transmission line that connects wells to storage and distribution facility. It is assumed that this strategy will require advanced treatment such as chlorine disinfection for municipal purposes.

**Quantity, Reliability, and Cost** – Combined, the two new wells will provide approximately 27 acre-feet per year. The quantity and reliability of this strategy is expected to be a total of 75 gpm. Historical municipal, industrial and agricultural use indicates that the Middle and Lower Trinity Aquifer is deemed to be sufficient to meet future water demands. The aquifer has shown that it can be considered reliable as a water supply if properly developed. The total estimated capital cost for this project is approximately $1,377,000 with an annual operations and maintenance cost of approximately $71,000.

## J-68 Drought Management (San Antonio Basin)

The Bandera County River Authority and Groundwater District (BCRAGD) has implemented a drought management plan (see Chapter 7 Section 7.3.6.1) to aid in groundwater conservation during declared drought conditions. Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. Drought stages are mandated pumping restrictions for permitted wells and recommended restrictions for exempt wells. Strategy J-68 recommends that the BCRAGD declare a minimum of Stage 2 (20-percent reduction) on specified wells in the Bandera County San Antonio River Basin to reduce aquifer supply demand by 20 percent. The resulting pumpage reduction will decrease water supply demand in the San Antonio Basin (Chapter 2 Table 2-2) by: 467 acre-feet/year in 2020; 519 acre-feet/year in 2030; 546 acre-feet/year in 2040; 556 acre-feet/year in 2050; 563 acre-feet/year in 2060; and 568 acre-feet/year in 2070.

## J-69 Drought Management (Nueces Basin)

The Bandera County River Authority and Groundwater District (BCRAGD) has implemented a drought management plan (see Chapter 7 Section 7.3.6.1) to aid in groundwater conservation during declared drought conditions. Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. Drought stages are mandated pumping restrictions for permitted wells and recommended restrictions for exempt wells. Strategy J-69 recommends that the BCRAGD declare a minimum of Stage 2 (20-percent reduction) on specified wells in the Bandera County Nueces River Basin to reduce aquifer supply demand by 20 percent. The resulting pumpage reduction will decrease water supply demand in the Nueces Basin (Chapter 2 Table 2-2) by: 29 acre-feet/year in 2020; 32 acre-feet/year in 2030; 34 acre-feet/year in 2040; 34 acre-feet/year in 2050; 35 acre-feet/year in 2060; and 35 acre-feet/year in 2070.

# 5A.3 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY IRRIGATION

Bandera County has approximately 129 acre-feet of an irrigation shortage over the planning horizon. Irrigation within the Plateau Region is generally limited in most of the counties due to arid conditions and lack of well-developed soils. Low well yields common throughout much of the Region also limit the development of large-scale irrigation. Bandera County irrigates approximately 173 acres of land with groundwater. The Trinity Aquifer is the sole source of groundwater used for irrigation purposes within the County. In addition to groundwater, most of the diversions by water rights on both the Nueces River and the San Antonio River are used for irrigation purposes. The following water management strategy is recommended to enhance the reliability of the future water supply availability for the irrigation needs within Bandera County:

## J-13 Additional Wells in the Trinity Aquifer (Nueces River Basin)

The Trinity Aquifer has been identified as a potential source of water to meet the irrigation shortages within the County. Water from this source is generally good. TDS levels increase as the depth to the Aquifer increases. The Trinity Aquifer is one of the most extensive and highly used groundwater sources in Texas. This strategy assumes that three new wells will be drilled to provide approximately 130 acre-feet per year. These wells will produce water from approximately 330 feet below the surface.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 40 gpm. Historical municipal, industrial and agricultural use indicates that the Trinity outcrops may be a viable source. For this *Plan*, the three new wells are assumed to supply an additional 130 acre-feet per year. The reliability of this supply is considered to be medium, based on competing demands.

The total capital cost of this project is approximately $244,000. This equates to $238 per acre-foot (0.73 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost decreases to $85 per acre-foot ($0.26 per 1,000 gallons) of treated water.

# 5A.4 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY LIVESTOCK

Bandera County has approximately 13 acre-feet of livestock shortages over the planning horizon. Livestock within the County obtain supplies from both surface and groundwater sources. Surface water, such as local supply, is commonly used, but limited due to the recent drought. Groundwater from the Edwards-Trinity (Plateau) Aquifer and Trinity Aquifer are more reliable sources. The following water management strategy is recommended to enhance the reliability of the future water supply availability for livestock needs within Bandera County:

## J-14 Additional Well in the Edwards-Trinity (Plateau) Aquifer (San Antonio River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock shortages within the County and is a recommended strategy. Water from this source ranges from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. This strategy assumes that one new well will be drilled to provide approximately 20 acre-feet per year. This well would produce water from approximately 70 feet below the surface.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 70 gpm. Historical agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the one new well is assumed to supply an additional 20 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands.

The total cost of this project will be approximately $103,000. This equates to $550 per acre-foot ($1.69 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost drops to $84 per acre-foot ($0.26 per 1,000 gallons) of treated water.

# 5A.5 WATER MANAGEMENT STRATEGIES FOR THE CITY OF ROCKSPRINGS

The City of Rocksprings is the county seat for Edwards County, named from the natural springs that occur within the porous limestone rocks in the area. The City and many other residents of Edwards County rely on the Edwards-Trinity (Plateau) Aquifer for municipal, domestic, livestock and irrigation water supply needs. Some local surface water is used by livestock. However, much of the supply from these sources is nearly fully developed for current use.

The City of Rocksprings has a projected water supply deficit of 98 acre-feet per year in 2020; decreasing to 94 acre-feet per year by 2070. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-15) Water loss audit and main-line repair for City of Rocksprings
- (J-16) Additional well in the Edwards-Trinity (Plateau) Aquifer

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Conduct updates to the SCADA / monitoring system
- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-15 Water Loss Audit and Main-line Repair for City of Rocksprings

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the City ordinance.

According to the 2010 TWDB Public Water System Water Loss Survey, the City of Rocksprings had a total water loss of approximately 1,278,360 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the City can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (57,398 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.07 miles of 6" diameter main-line would be replaced, with a total project capital cost of approximately $129,000.

## J-16 Additional Well in the Edwards-Trinity (Plateau) Aquifer

The City of Rocksprings has recently completed the construction of one new well in the Edwards-Trinity (Plateau) Aquifer. The location of this well is approximately six blocks west from the existing overhead storage facility. The City will need to install approximately 200 feet of connection pipe to connect to the well. This strategy assumes that the new well will produce water approximately 480 feet below the surface, providing an estimated 121 acre-feet per year. Minimal advance treatment such as chlorine disinfection is required for municipal use. The total capital cost of this strategy is approximately $650,000.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 75 gpm. Historical municipal, agricultural and industrial use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the one new well is assumed to supply an additional 121 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands. The total capital cost of this project is approximately $650,000.

## 5A.6 WATER MANAGEMENT STRATEGIES FOR BARKSDALE WATER SUPPLY CORPORATION

The Barksdale Water Supply Corporation is a Not for Profit 501 C Corporation that serves the small Community of Barksdale. Currently, the system has two small (40 gpm each) alluvial wells that pump water into the systems pressure tank, and is then distributed to 83 active connections in the system. Due to the small number of connections and relatively low water rates, the income of the system is not adequate to set aside funding for capital improvements. Therefore, over the years the infrastructure of the water supply corporation has deteriorated and the system is in need of repair and upgrades. The system is currently at peak output, and the projected increase demands from new subdivisions in the area will require extensive upgrades, which will include two additional wells and a new larger capacity pressure tank. In full build-out, the subdivision will add an additional 28 connections or a 34 percent increase in system capacity.

Although the supply-demand analysis does not project a future water supply deficit for Barksdale Water Supply Corporation, the following water management strategies are recommended to enhance the reliability of the Community's future water supply availability:

- (J-17) Water loss audit and main-line repair for Barksdale WSC
- (J-18) Additional well in the Nueces River Alluvium

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve replacing and/or repairing old infrastructure do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed here: https://www.twdb.texas.gov/financial/index.asp.

Water management strategies considered but do not meet SWIFT qualifications:

- Replace pressure tank

### J-17 Water Loss Audit and Main-line Repair for Barksdale WSC

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the Corporation ordinance.

According to the 2010 TWDB Public Water System Water Loss Survey, the Community of Barksdale's had a total water loss of approximately 349,451 gallons per year (26.64 percent) due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the Community can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (93,094 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 1.1 miles of 6" diameter main-line would be replaced, with a total project capital cost of $203,000.

## J-18 Additional Well in the Nueces River Alluvium Aquifer

Barksdale WSC with the recommendation from Real-Edwards Groundwater Conservation and Reclamation District has plans to drill one additional well in the Nueces River Alluvium Aquifer to help supplement the existing water system. This strategy assumes that the necessary groundwater pumping authorization and well property will be obtained for the development of one new well, located a sufficient distance from the other municipal wells in the system to prevent overlapping cones-of-depression. This well is expected to maintain minimum production of 50 gpm. The new well will be drilled at a depth of 50 feet. In addition, this strategy includes 500 feet of six-inch connection pipeline.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to provide up to 54 acre-feet per year. Sufficient groundwater is available from the Nueces River Alluvium Aquifer without causing excessive water-level declines; however, in a severe drought, alluvial aquifers are the first to go dry. The total capital cost for this project is estimated at $114,000.

# 5A.7 WATER MANAGEMENT STRATEGIES FOR EDWARDS COUNTY-OTHER

Edwards County-Other has less than 870 in population including individuals living outside of a named water user group. This compilation of users known as county-other is self-supplied and relies predominately on the Edwards-Trinity (Plateau) Aquifer for their water supply needs either on private wells or privately owned water supply systems. In a few locations, the Nueces River Alluvium Aquifer is a modest source of supply.

Although the supply-demand analysis does not project a future water supply deficit for Edwards County-Other, the following water conservation management strategy is recommended to enhance the reliability of water supply availability within Edwards County:

## J-19 Vegetative Management

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (Arundo donax) and Elephant Ears (Colocasia esculenta) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite.

Giant River Cane (*Arundo donax*) has become a significant problem in the western portions of the Plateau Region especially in Val Verde and Kinney Counties. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plants high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp, and has received permits to use this wasp in the eradication efforts.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Edwards County / Edwards Aquifer /

Upper Nueces River study, the estimated average annual volume of water supplied is 0.145 acre-feet per acre.

**Quantity, Reliability, and Cost** – This strategy assumes a chemical control method that will be implemented on approximately 1,000 acres. The calculated average annual runoff benefit from the treated 1,000 acres is 145 acre-feet per year. However, the benefit during drought-of-record conditions is zero acre-feet per year. The total estimated capital cost for chemical control for this project is approximately $1,195 per acre, with a total annual cost of $1,195,000. The annual operations and maintenance cost will have to be determined on a case by case basis if the *Arundo donax* reappears.

# 5A.8 WATER MANAGEMENT STRATEGIES FOR EDWARDS COUNTY LIVESTOCK

Edwards County has approximately 16 acre-feet of livestock shortages over the planning horizon. Livestock within the county obtains supplies from both surface and groundwater sources. Surface water such as local supply is commonly used, but limited due to the recent drought. Groundwater from the Edwards-Trinity (Plateau) Aquifer is a more reliable source.

The following water management strategy is recommended to enhance the reliability of the future water supply availability for livestock needs within Edwards County:

## J-20 Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Nueces River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards Group, which are underlying sediments of the Trinity Group that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that two new wells will be drilled to produce water from approximately 300 feet below the surface.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 10 gpm. Historical municipal, industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the two new wells are assumed to supply an additional 20 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands.

The total capital cost of this project is approximately $105,000. This equates to $550 per acre-foot ($1.69 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost

# 5A.9 WATER MANAGEMENT STRATEGIES FOR EDWARDS COUNTY MINING

Edwards County has approximately 22 acre-feet of mining water supply shortage over the planning horizon. Local surface water in conjunction with groundwater from the Edwards-Trinity (Plateau) Aquifer, provide the water needed for industrial use within the County. The following water management strategy is recommended to enhance the reliability of the future water supply availability for the mining water-supply shortages within Edwards County:

## J-21 Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Rio Grande River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that two new wells will be drilled to produce water from approximately 335 feet below the surface.

**Quantity, Reliability, and Cost** –The quantity and reliability of water from this source is expected to be approximately 10 gpm. Historical municipal, industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the two new wells are assumed to supply an additional 30 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands.

The total capital cost of this project is approximately $109,000. This equates to $400 per acre-foot (1.23 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost decreases to $93 per acre-foot ($0.29 per 1,000 gallons) of treated water.

# 5A.10 WATER MANAGEMENT STRATEGIES FOR THE CITY OF KERRVILLE

The City of Kerrville has developed a conjunctive-use policy for both surface water and groundwater, and passed a comprehensive Water Management Plan in early 2004 (updated 2010). The policy specifies that: (1) surface water will be used to the maximum extent that it is available, (2) groundwater will be a supplemental source of supply, and (3) water consumption will be reduced through conservation.

The TCEQ Guadalupe River WAM 3 drought-of-record analysis yields 150 acre-feet per year of surface water as reliable for the City of Kerrville. For planning purposes, the City proposes to use this estimate of available surface water, even though the estimate is significantly less than the permitted amount based on availability during a drought-of-record. Kerrville will develop additional surface and groundwater supplies, storage options or modifications to the existing permits, and expansion of the aquifer storage and recovery (ASR) system if it can be shown that there are periods when the City will not be able to use the permitted water from the Guadalupe River.

The City of Kerrville has been operating an ASR system for the past several years. In this system, a portion of treated Guadalupe River surface water is injected into the Lower Trinity Aquifer during months of water surplus and recovered from the Aquifer for subsequent use during dry summer months. Currently, the ASR has two wells that serve for both injection and recovery. The capacity of the storage in the ASR is virtually unlimited, but the rates of injection and recovery are limited to 1 MGD in each of the two wells. A third and fourth well are in planning stages. As of December 2015, the total storage in the ASR was 600 million gallons (1,841 acre-feet).

Assuming that a drought-of-record starts immediately, the maximum reliable supply for the City of Kerrville is 150 acre-feet per year using the volume stored in the Aquifer as of June 2010. Permit 1996 would provide an additional 150 acre-feet per year for municipal use, for a total of 300 acre-feet per year. However, the ASR storage does not recover quickly, and if there are multiple drought years, the ASR may not have enough storage for a reliable supply to cover the entire drought period. Therefore, a reliable surface water supply of 150 acre-feet per year for the City of Kerrville is recommended.

Based on current groundwater availability estimates, the firm yield of the Lower Trinity Aquifer is estimated at 4,250 acre-feet per year in the Kerrville area. The City of Kerrville uses approximately 3 MGD, or 3,360 acre-feet per year as an available groundwater supply during a drought year. The City continues to rely on the Lower Trinity Aquifer as a dependable source of water. Through the City's conjunctive use policy, groundwater is reserved for meeting peak demand in a normal year and base demand in a drought year. For planning purposes, the estimates of available groundwater are 5 MGD (5,600 acre-feet per year) for peak demand and 3 MGD (3,360 acre-feet per year) for average demand.

The City has identified the possibility of modifying its own existing water permits. Currently the City's ability to divert under its existing permits is dependent on whether more senior water right holders exercise their rights, and is also affected by the City's Special Conditions written into its permits. If the City had more reliability from the Guadalupe River and more latitude in its ability to divert during certain months of the year, the City could more fully utilize its ASR facility.

The City of Kerrville's water treatment capacity also limits its utilization of its ASR facility. The City needs excess treatment capacity to treat and store 4 MGD during periods of higher streamflow; the current

ASR system is limited to 2 MGD. The City has included the necessary project to increase the ASR system to 4 MGD in the ten-year capital improvement program.

The availability of water will become a factor limiting the growth of both Kerrville and Kerr County. Currently, the supply-demand analysis for the City of Kerrville projects a water-supply deficit of 3,194 acre-feet per year in 2020; increasing to 3,450 acre-feet per year by 2070. Water management strategies that the City can consider as possible future sources of supply include:

- (J-22) Increase wastewater reuse
- (J-23) Water loss audit and main-line repair for City of Kerrville
- (J-24) Contracting with UGRA for additional water supply to be delivered to Kerr County
- (J-25) Increasing water treatment capacity in conjunction with increasing ASR capacity

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-22 Increase Wastewater Reuse

The City of Kerrville is proposing to construct a 105 million gallon detention pond at the City's existing WWTP to store treated effluent for reuse purposes. In addition, this project includes the construction of one new pump station, along with 2,700 feet of 24-inch diameter gravity line that will run from the WWTP to the pond, and 2,500 feet of 8-inch diameter transmission line. The design of this project is to also include a second detention pond later in the process when water demands warrant its construction. This strategy assumes the cost of the second pond as part of the total project capital cost. The estimated total project cost is $23,000,000.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 5,041 acre-feet per year. The reliability of this source is considered to be high. The total capital cost is approximately $23,000,000.

## J-23 Water Loss Audit and Main-line Repair for City of Kerrville

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the City ordinance.

According to the 2013 TWDB Public Water System Water Loss Survey, the City of Kerrville had a water loss of approximately 231,302,672 gallons per year (17.51 percent) due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the City can reduce the unaccounted for water and get a more accurate look at water consumption.

Currently the City of Kerrville is replacing old inaccurate water meters with new remote read meters. With this increase in accuracy, the City is hopes to reduce unaccounted for water, allowing for a more accurate look at water consumption.

This strategy assumes a potential savings of 147 acre-feet per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 49 miles of 6" diameter main-line would be replaced, with a total project capital cost of $9,339,000.

## J-24 Contracting with UGRA for Additional Water Supply to be Delivered to Kerr County

The City of Kerrville could purchase or acquire under contract a portion of UGRA's surface water right. The City would use the additional water to supplement its existing water permits on the Guadalupe River and/or wholesale finished water to UGRA. Presumably the purchase or acquirement of water from UGRA will involve a contractual agreement between the two entities allowing the City to divert more water from the Guadalupe River than it is authorized under its current permits. This strategy could also provide water to areas served by UGRA or stored in their network.

The City's objective in obtaining more water from the Guadalupe River is to have more reliability from the River flows and more latitude in its ability to divert during certain months of the year. This would allow the City to more fully utilize its ASR facility. Up to 3,840 acre-feet per year is needed by the year 2030, and an additional 1,610 acre-feet per year (5,450 acre-feet per year) in 2060 for a total of 116, 810 acre-feet over the 30-year period. An estimated purchase price of $1,069 per acre-foot is assumed for this planning process; however the City will negotiate an actual price when and if this strategy is implemented in the future.

The reliability is dependent on the amount of water physically present within the Guadalupe River. UGRA and the City both take from the same source (Guadalupe River). The term "regulated stream flow" is generally synonymous with water that is physically present within a water body. It is noted that the upper Guadalupe River's minimum regulated stream flow (flow during drought-of-record), as determined by TCEQ's WAM Run 3, is 6,867 acre-feet per year. However, the sum of authorized water rights is 12,128 acre-feet per year. This means that during a drought-of-record, the water present in the Upper Guadalupe River is only half the amount of water authorized for diversion. Thus, this strategy could be of some assistance if needed in the early stages of a drought-of-record, but could not be used to meet needs in an extended drought period.

The existing water permits of both UGRA and the City contain Special Conditions that allow diversions only when flows of the Guadalupe are above a minimum level. These restrictions help protect instream flows and the aquatic environment, in addition to serving as key water supply indicators. Any water purchase contract will likely have to contain the same or similar stream flow restrictions because TCEQ and TPWD are interested in maintaining minimum flows regardless of where the water is purchased.

The source of the water for this strategy is the Guadalupe River water through a purchase contract with UGRA, or a subordination and purchase contract with GBRA. All water purchase contracts must be approved by TCEQ, just as new or amended water rights must be approved by TCEQ. This means that although TCEQ staff will not conduct a full hydrologic study for a contract, the Agency will likely investigate any implications of the proposed contract on the Special Conditions outlined within the City's existing water permit. Bookkeeping within the TCEQ master water rights database would simply show the City's new diversions as a contract keyed to the water right of whichever entity provides the water.

**Quantity, Reliability, and Cost** – The average annual volume of water considered for this strategy is 3,840 acre-feet per year starting in 2030 and increasing to 5450 acre-feet per year by 2060. However, this strategy relies on a source that is dependent on river inflows. During a drought-of-record, the Guadalupe River will not have sufficient volumes to meet UGRA's water diversion rights, therefore the supply volume during drought-of-record is zero. Due to this variability of supply, the reliability is determined to be low to moderate. The total capital cost is approximately $4,103,791 in 2030 increasing to 5,824,390 by 2060.

## J-25 Increasing Water Treatment Capacity in Conjunction with Increasing ASR Capacity

The City of Kerrville is planning on expanding its existing water treatment plant from its current capacity of 5 MGD to 7 MGD, and the ASR pumping and storage capacity of 2 MGD to 4 MGD. The capacity of the storage in the ASR is virtually unlimited, but the rates of injection and recovery are limited to 1 MGD in each of the two wells. A third and fourth well are in planning stages. As of December 2015, the total storage in the ASR was 600 million gallons (1,841 acre-feet).

The City is also evaluating the possibility of treating wastewater to drinking water standards and storing it in the ASR system. Wastewater is one of the most reliable sources of water during a drought and thus must be considered as a possible water supply. If it were decided to proceed with this project the City would need an additional 2-3 MGD of ASR capacity.

The City's current water treatment capacity limits its utilization of its ASR facility. The City has identified the need for an additional 2 MGD of treatment capacity to take care of peak use; take advantage of periods when higher stream flows occur in the Guadalupe River; and thus fully utilize its ASR. The increased storage capacity provided by the expanded ASR operation will make available water supplies more reliable. However, during drought-of-record conditions, water available from the upper Guadalupe River may be limited or nonexistent. Treated Guadalupe River water is injected into the aquifer during non-drought conditions when surface water is plentiful and is retrieved at a later time as a supply source during drought-of-record conditions when surface water is scarce.

**Quantity, Reliability, and Cost** – The treated supply made available through this strategy is estimated to be 3,360 acre-feet per year. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate. The total capital cost is estimated at $11,543,000.

# 5A.11 WATER MANAGEMENT STRATEGIES FOR LOMA VISTA WATER SUPPLY COMPANY

Loma Vista Water Supply Company serves 3,309 residents. These residents obtain their municipal water supply from groundwater wells completed in the Trinity Aquifer. Groundwater from the Trinity Aquifer is primarily used for municipalities and domestic supply in the local area, and for irrigation, livestock and rural domestic purposes elsewhere in the county. The demand from this supply is projected to increase over the planning horizon as the population of the Loma Vista service area increases. As a result, there are identified shortages of 30 acre-feet per year in 2020; increasing to 57 acre-feet per year by 2070. To address these shortages, the following water management strategies are recommended to supplement their existing Trinity Aquifer supply.

- (J-26) Provide public with conservation information
- (J-27) Additional groundwater well in the Trinity Aquifer

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-26 Provide Public with Conservation Information

Loma Vista WSC is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 4 acre-feet per year. The annual cost of this project is estimated to be $2,206.

Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable, yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implanting effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner. A more detailed description of conservation best management practices that might be encouraged is available in TWDB Report 362, Water Conservation Best Management Practices Guide.

## J-27 Additional Groundwater Well in the Trinity Aquifer

Additional groundwater supplies can be made available to Loma Vista Water Supply Company by constructing additional well infrastructure to withdraw and deliver groundwater from the Lower Trinity Aquifer. This source has been heavily used in the local area by neighboring communities of Ingram and Kerrville. However, sufficient supplies appear to be available from the Trinity to meet the increased Loma Vista demand. To be eligible to pump this additional supply, will require negotiating a new pumping permit from the Headwaters Groundwater Conservation District. It should be recognized that the chemical quality of groundwater produced from some layers of the Trinity Aquifer may be less then desirable and may require advanced treatment for municipal use. This strategy assumes that one new well would need to be drilled to produce water from approximately 600 feet below the surface. Minimal treatment, such as chlorine disinfection will be necessary for municipal purposes. This strategy assumes that 1.75 miles of six-inch diameter transmission line will be installed to connect the well to current infrastructure.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 170 gpm. Historical industrial, agricultural and municipal use indicates that the Trinity Aquifer may be a viable source, but high TDS may require advanced treatment. The Trinity Aquifer is one of the most extensive and highly used groundwater resources in the central-Texas Hill Country. For this *Plan*, the new well is assumed to supply an additional 57 acre-feet per year. The reliability of the supply is considered to be adequate; however, overuse of the Aquifer may result in short- and long-term local water-level declines.

The total capital cost of this project will be approximately $728,000. This equates to $1,469 per acre-foot ($4.51 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost decreases to $378 per acre-foot of treated water. The cost of this strategy may have an adverse impact on the community's financial resources. However, with the limitations of surface water supplies, new groundwater wells might potentially be a more reliable water supply.

# 5A.12 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY-OTHER

Kerr County-Other has a projected population of 24,040 in 2020; increasing to 28,900 by 2070. This includes individuals living outside of a named water user group. This compilation of users known as county-other is self-supplied and relies predominately on groundwater for their water supply needs. Private wells or privately owned water supply systems, utilizing either the Trinity Aquifer or the Edwards-Trinity (Plateau) Aquifer provide for the residents that reside outside of the City's distribution system.

Kerr County Commissioners' Court in partnership with the Upper Guadalupe River Authority (UGRA) has plans to develop several Eastern Kerr County Regional Water Supply projects (J-34 through J-40) in order to better serve expanding rural areas. These projects will offer reliable and sustainable sources of water for the growing water demands.

The mission of UGRA is to conserve and reclaim surface water through the preservation and distribution of the water resources for future growth in order to maintain and enhance the quality of life for all Kerr County citizens. UGRA's commitment to water conservation is reflected in its Fiscal Year 2015 budget which contains $450,000 for watershed programs, $1,000 for water research, $80,000 for water development and over $100,000 for various water quantity and water quality monitoring programs.

Kerr County Other has a projected water supply deficit of 8 acre-feet per year for the planning horizon. The following water management strategies are recommended to enhance the reliability of the future water supply availability for Kerr County-Other:

- (J-28) Water loss audit and main-line repair for Center Point Wiedenfeld Water Works
- (J-29) Water loss audit and main-line repair for Hills and Dales Wiedenfeld Water Works
- (J-30) Water loss audit and main-line repair for Rustic Hills Water
- (J-31) Water loss audit and main-line repair for Verde Park Estates Wiedenfeld Water Works
- (J-32) Municipal and County-Other Conservation for Upper Guadalupe River Authority
- (J-33) Vegetative Management

Strategies J-28 through J-31 involve performance of a water loss audit and, based on the results of the audit, repair to impacted water distribution main lines. System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice (BMP), a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste ordinance.

## J-28 Water Loss Audit and Main-line Repair for Center Point WWW

According to the 2010 TWDB Public Water System Water Loss Survey, Center Point Wiedenfeld Water Works had a total water loss of approximately 584,087 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (17.3%) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (101,175 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.2 miles of 6" diameter main-line would be replaced, with a total project capital cost of $33,000.

## J-29 Water Loss Audit and Main-line Repair for Hills and Dales WWW

According to the 2010 TWDB Public Water System Water Loss Survey, Hills and Dales Wiedenfeld Water Works had a total water loss of approximately 1,379,306 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (24.2%) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 1.0 acre-feet per year (333,792 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.7 miles of 6" diameter main-line would be replaced, with a total project capital cost of $138,000.

## J-30 Water Loss Audit and Main-line Repair for Rustic Hills Water

According to the 2010 TWDB Public Water System Water Loss Survey, Rustic Hills Water had a total water loss of 150,208 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (10.4%) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (15,622 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.5 miles of 6" diameter main-line would be replaced, with a total project capital cost of $99,000.

## J-31 Water Loss Audit and Main-line Repair for Verde Park Estates WWW

According to the 2010 TWDB Public Water System Water Loss Survey, Verde Park Estates Wiedenfeld Water Works had a total water loss of approximately 1,030,391 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (26.8%) is the sum of reported break and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (276,351 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.5 miles of 6" diameter main-line would be replaced, with a total project capital cost of $102,000.

## J-32 Municipal and County-Other Conservation for UGRA

Once a month, the Upper Guadalupe River Authority (UGRA) publishes a column in the local newspapers, "Currents," in which various issues are discussed and explained such as water quality issues and best management practices for protecting water quantity and quality. UGRA is currently developing an educational video on water enhancement strategies for the Upper Guadalupe River Watershed to be used to help agricultural producers better understand water enhancement and range management strategies.

UGRA is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 15 acre-feet per year in 2020; increasing to 16 acre-feet per year in 2070. The total project cost for implementing a public information program is estimated to be $6,030 in 2020; increasing to $6,861 in 2070.

Public information programs such as these, even though they may not be directly related to any equipment or operational change, can result in both short-and long-term water savings. Behavioral changes by customers will only occur if a reasonable yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implementing effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner. A more detailed description of conservation best management practices is available in TWDB Report 362, Water Conservation Best Management Practices Guide.

## J-33 Vegetative Management (UGRA)

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (Arundo donax) and Elephant Ears (Colocasia esculenta) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite.

UGRA has implemented a water enhancement cost share program targeting the removal of brush. Priority agricultural water enhancement activities to be applied will focus on brush clearing (primarily Ashe Juniper) and construction of water and sediment control basins. In UGRA's water enhancement cost share program, UGRA is matching a percentage of eligible landowners cost in removing brush. Eligible landowners include those who have an approved NRCS or Kerr County SWCD contract.

Vegetative management of Ashe Juniper, also commonly known as "cedar" has become a significant source of discussion and debate as to its impact on water resources on the Edwards Plateau. Ashe Juniper is native to central Texas and was initially controlled through both man-made and natural fires and through foraging. As these events were reduced, cedar returned and has been expanding in the Region. Eradication methods have included controlled burns, use of heavy equipment to pull the plant up by its roots, mechanical cutting and chemical methods. There has been a great deal of debate regarding the impact on water resources by cedar with various groups calculating how much water cedar takes away from both groundwater and surface water sources. In a 2003 report by A.A. McCole of the University of Texas Geology Department, it was noted that "in late summer and winter the Ashe Juniper obtains approximately between 72% and 100% of its water from groundwater. In contrast, during the wet periods of the year, spring and fall, mass balance calculations indicate that between 45% and 100% of Ashe Juniper's water is derived from soil water. This seasonal shift indicates the presence of Ashe Juniper can appreciably reduce groundwater resources both by lateral roots intercepting potential recharge during the wet season and direct uptake of groundwater by deep roots during the dry season. Ashe Juniper will directly compete with grasses for soil water during the wet season."

In 2010, the USGS published a study, "Effects of Brush Management on the Hydrologic Budget and Water Quality In and Adjacent to Honey Creek State Park Natural Area, Comal County, Texas 2001-2010". The results of this study indicated that brush eradication did not increase runoff to streams but did suggest that clearing brush can result in more infiltration. The study found that before clearing potential groundwater recharge was 17% of the total water budget, but increased to 24% after clearing. The study showed that prior to clearing a rainfall event produced a potential recharge of 5.91 inches of the rain that fell and after clearing, it increased to 7.09 inches; for a difference of 1.18 inches. In terms of actual water, the extra 1.18 inches amounts to approximately 32,042 gallons per acre. Thus, in order to obtain one acre foot of water, 10 acres will need to be cleared to gain an additional acre foot of water as infiltration. From these and other studies, it would appear that brush eradication can have a positive impact on groundwater recharge and a limited impact on surface water runoff. However, with increased groundwater recharge it is reasonable to assume that a portion of this groundwater would percolate down to aquifers as well as provide base flow to surface water via springs.

From literature on the subject many authors note that brush management includes both removing the brush, but also providing land management through replacement with other native species that will prevent erosion and hold moisture. As a strategy brush management does show potential for enhancing groundwater supplies and subsequent base flow to surface water bodies.

This strategy assumes that the location of the project will be within the drainage basins of the three forks of the upper Guadalupe River in Kerr County including: Johnson Creek; North Fork Guadalupe; and South Fork Guadalupe. The cost estimate to clear 1,500 acres of Ashe Juniper each year is assumed to be approximately $280 per acre. Strategy J-33 supports the current water enhancement cost share program and this grant request to be partially funded by UGRA.

**Quantity, Reliability, and Cost** – Based on a 2004 article, "Management of Ashe Juniper on Rangeland in Bosque County" the estimate to clear Ashe Juniper is $294.94 per acre for shear cut and $106.60 for grubbing. This strategy assumes that Ashe Juniper will be eradicated by shear cutting 1,500 acres, which is estimated to provide an additional 218 acre-feet per year of water during average rainfall years. However, the benefit during drought-of-record conditions is zero acre-feet per year. The estimated annual project cost is approximately $420,000.

# 5A.13 WATER MANAGEMENT STRATEGIES FOR THE EASTERN KERR COUNTY REGIONAL PROJECTS

Population growth in eastern Kerr County continues to increase, creating genuine concerns pertaining to the water availability needed to meet these growing demands. Kerr County Commissioners' Court (KCCC) in partnership with the Upper Guadalupe River Authority (UGRA) has plans to develop several Eastern Kerr County Regional Water Supply Projects (EKCRWSP) to provide for conjunctive use of surface water and groundwater in high density growth areas of eastern Kerr County outside of the area serviced by the City of Kerrville. A facility plan was completed in 2010 utilizing an EDAP grant from the TWDB for a wholesale surface water supply.

Although the *2016 Plateau Region Water Plan* does not project a water supply shortage for the rural Guadalupe River Basin portion of Kerr County at large, it is recognized that a greater percentage of the rural population is concentrated in the eastern portion of the county (see Chapter 2 Figure 2-3). To prepare for this concentrated water supply need the following water management strategies are recommended to enhance the reliability of the future water supply availability for the Kerr County Other category:

- (J-34) UGRA acquisition of surface water rights
- (J-35) KCCC acquisition of surface water rights
- (J-36) Construction of an off-channel surface water storage
- (J-37) Construction of surface water treatment facilities and transmission line
- (J-38) Construction of ASR facilities
- (J-39) Construction of a well field to provide groundwater to densely populated rural areas
- (J-40) Construction of a desalination plant contingent on new well field
- (J-41) Construction of an Ellenburger Aquifer water supply well

## J-34 UGRA Acquisition of Surface Water Rights

UGRA is exploring the potential of acquiring additional water rights to surface flows in the Guadalupe River. The potential of acquiring water rights for 1,029 acre-feet per year was first evaluated by LBG-Guyton Associates and Freese and Nichols, Inc. during the previous planning period (*Water Rights Analysis and ASR Feasibility in Kerr County, 2010* – see Chapter 1 of this *Plan*). A more recent analysis by ARCADIS (2015) was performed to model the most feasible withdrawal rate. The potential new supply along with UGRA's existing rights to 2,000 acre-feet per year is anticipated to be treated at a new regional facility (see Strategy J-37) and distributed within the eastern region of Kerr County. Excess supplies not distributed may be stored in the ASR project described in Strategy J-38.

**Quantity, Reliability, and Cost** – It is understood that the acquisition of additional water rights does not guarantee that the full volume of the right is available during drought-of-record conditions. Total estimated cost for this supply acquisition of 1,029 acre-feet per year is $1,087,367. This strategy will only change the use of the water and thus does not generate any additional impacts beyond those that already are in existence with the original owner of the right.

## J-35 Kerr County Commissioners' Court Acquisition of Surface Water Rights

The KCCC is exploring the potential of acquiring permits to divert surface water in the Guadalupe River in Kerr County. Based on a 1999 MOU between the KCCC and the Guadalupe Blanco River Authority (GBRA), the KCCC would negotiate the diversion rights to 6,000 acre-feet per year of GBRA water rights after January 1, 2021. The potential new supply is anticipated to be treated at a new regional facility (see Strategy J-37) and distributed within the eastern region of Kerr County.

**Quantity, Reliability, and Cost** – It is understood that the acquisition of additional water rights does not guarantee that the full volume of the right is available during drought-of-record conditions. Total estimated cost for this supply acquisition of 6,000 acre-feet per year is $6,342,000. This strategy will only change the use of the water and thus does not generate any additional impacts beyond those that already are in existence with the original owner of the right.

## J-36 Construction of an Off-Channel Surface Water Storage

This Regional Project provides for the securing of one or more off-channel ground storage facilities. The strategy assumes that the facility will be lined with impervious material to prevent subsurface seepage loss. Guadalupe River water will be captured during excessive flow episodes. Following a period of time to allow for settling of sediment, the captured water will be diverted for treatment to drinking water quality to a facility site near the Community of Center Point (see Strategy J-37). Water supply generated from this strategy will be combined with water supplies generated in Strategies J-35 and J-36 for public distribution.

**Quantity, Reliability, and Cost** – The volume of water this strategy will produce is estimated to average 1,121 acre-feet per year, which will generally only occur during high river flow episodes. During drought-of-record periods, the supply is likely unavailable. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate by itself; however, in combination with other more reliable supplies (Strategies J-34 and J-35) the project becomes more meaningful. Total estimated capital cost for this project is $7,534,303 with an annual cost of $695,721.

## J-37 Construction of Surface Water Treatment Facilities and Transmission Line

The construction of a surface water treatment facility to serve the unincorporated community of Center Point and other rural areas in eastern Kerr County includes a 200,000 gpd surface water treatment plant, an intake structure and pumping station, a 500,000 gallon elevated storage tank, and an assumed five miles of 10-inch diameter transmission line. Water supply sources for this facility are generated through strategies J-34, J-35, J-36 and possibly J-39, J-40 and J-41.

**Quantity, Reliability, and Cost** – In total, this strategy will provide 149 acre-feet per year of treated water. The new supply of water will go directly into customer distribution. The estimated capital cost for a 0.2 MGD capacity source water treatment facility is $25,581,000. Treated supplies in excess of those that are of immediate use can be made available for storage in an ASR project (see Strategy J-38).

## J-38 Construction of ASR Facility

The feasibility of constructing an ASR facility to provide additional water supplies to the eastern portion of Kerr County was evaluated by LBG-Guyton Associates and Freese and Nichols, Inc. during the previous planning period (*Water Rights Analysis and ASR Feasibility in Kerr County, 2010* – see Chapter 1 of this *Plan*). This strategy evaluation assumed a facility site near the Community of Center Point. This strategy assumes that 1,124 acre-feet per year of excess treated water from the Strategy J-37 water treatment facility would be injected into the Lower Trinity Aquifer and recovered during times of supply shortage.

**Quantity, Reliability, and Cost** – The cost to construct and equip ASR wells capable of both injection and withdrawal is approximately $1,258,000. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate.

## J-39 Construction of a Well Field to Provide Groundwater to Densely Populated Rural Areas

Part of the Regional Project is to develop a well field to provide a water supply to the densely populated rural areas of Eastern Kerr County. This strategy assumes four wells will be drilled in the Trinity Aquifer to provide an additional 860 acre-feet per year. These wells would produce water from 530 feet below the surface. This strategy assumes a five-mile, 10-inch diameter transmission line will transport the water from the wells to the distribution center (Strategy J-37). Minimal treatment, such as chlorine disinfection, will be required for municipal purposes. In addition, advanced treatment will be necessary for municipal purposes due to anticipated water quality issues (Strategy J-37 or J-40). The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

**Quantity, Reliability, and Cost** – The quantity and reliability of water from this source is expected to be approximately 200 gpm. For this *Plan*, the four new wells are assumed to supply an additional 860 acre-feet per year. The Trinity Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. The total estimated capital cost for this project is approximately $4,357,000 with an annual operations and maintenance cost of approximately $160,000.

## J-40 Construction of a Desalination Plant Contingent on New Well Field

This strategy is contingent on Strategies J-39 and J-41. Due to anticipated water quality issues (radon and sulfides) from the groundwater obtained in a newly developed well field or from an Ellenburger Aquifer supply well, advanced treatment will be necessary for municipal purposes. The brine concentrate from the wells will be disposed of using an evaporation pond.

**Quantity, Reliability, and Cost** –For this *Plan*, it is assumed that a 1.2 MGD brackish desalination treatment unit (for treatment of elevated TDS levels) as well as a simple filtration unit (for treatment of elevated radon and sulfides) would be necessary to treat the water for municipal use. It is anticipated that this strategy would provide an additional 860 acre-feet per year of water. The reliability of water from this source is expected to be medium to high based on competing demands. The total estimated capital cost for this project is $14,539,000 with an annual operations and maintenance cost of $1,627,000.

## J-41 Construction of an Ellenburger Aquifer Water Supply Well

This strategy considers a new water supply well providing water to the Eastern Kerr County Regional Project. The single well will be drilled to a depth of approximately 1,000 feet and will tap the Ellenburger Aquifer. Although there are no Ellenburger supply wells in Kerr County, the aquifer is a significant groundwater source for the City of Fredericksburg immediately to the north in Gillespie County. Subsurface geology suggests that there is a strong potential that usable groundwater will be encountered in the Ellenburger in northern Kerr County. An initial pilot hole will be drilled to total depth to verify the existence of a groundwater supply prior to completing the well to its full capacity. The Headwaters Groundwater Conservation District will provide geotechnical guidance on the drilling of the well. Groundwater supplies produced from this well will be routed to the EKCRWSP distribution network or, if water quality treatment is necessary, to the desalination facility discussed in Strategy J-40.

**Quantity, Reliability, and Cost** – The Ellenburger Aquifer has been identified as a viable source, but the quantity and reliability of water from this source is unknown. For this *Plan*, one new well will be drilled at a depth of 1,000 feet below the surface to provide an additional 108 acre-feet per year of water. This strategy includes two miles of six-inch diameter transmission line. Minimal treatment, such as chlorine disinfection, will be required for municipal purposes. The total estimated capital cost for this project is $567,000 with an annual operations and maintenance cost of $23,000.

# 5A.14 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY IRRIGATION

Kerr County is projected to have approximately 14 acre-feet of irrigation water supply shortage over the planning horizon. Irrigation within the Plateau Region is generally limited in most of the counties due to arid conditions and lack of well-developed soils. Low well yields common throughout much of the Region also limit the development of large-scale irrigation. Kerr County farmers irrigate approximately 57 acres of land with groundwater. The Trinity Aquifer and the Edwards-Trinity (Plateau) Aquifer are the primary sources of groundwater used for irrigation purposes within the County. In addition to groundwater, 6,904 acre-feet per year from the Guadalupe River is used for irrigation purposes. The following water management strategy is recommended to enhance the reliability of the future water supply availability for irrigation needs within Kerr County:

## J-42 Additional Well in the Trinity Aquifer (San Antonio River Basin)

The Trinity Aquifer has been identified as a potential source of water to meet the irrigation shortages within Kerr County. The Aquifer is comprised of five different water-bearing units which are often in hydraulic communication and collectively should be considered a leaky-aquifer system. Water from this source is generally of acceptable quality for irrigation use. Recharge to the Lower Trinity in Kerr County likely occurs primarily by lateral underflow from the north and west. This strategy assumes that one new well will be drilled to approximately 400 feet below the surface.

**Quantity, Reliability, and Cost** –Historical municipal, industrial and agricultural use indicates that the Trinity outcrops may be a viable source. Well yields from the Lower Trinity are generally unpredictable and vary greatly. The greater depth makes completing this well more difficult. In some areas however, the Lower Trinity has higher yields and better water quality than shallower aquifers. For this *Plan*, the one new 30 gpm well is assumed to supply an additional 20 acre-feet per year. The reliability of this supply is considered to be moderate, based on competing demands.

The total cost of this project will be approximately $78,000. This equates to $450 per acre-foot ($1.38 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost will decrease to $79 per acre-foot ($0.24 per 1,000 gallons) of treated water.

# 5A.15 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY LIVESTOCK

Kerr County is projected to have approximately 130 acre-feet of livestock water supply shortage over the planning horizon. Livestock within the County obtains supplies from both surface and groundwater sources. Surface water such as local supply is commonly used, but limited due to the recent drought. Groundwater from the Edwards-Trinity (Plateau) Aquifer and the Trinity Aquifer are more reliable sources.

The following water management strategies are recommended to enhance the reliability of the future water supply availability for livestock needs within Kerr County:

- (J-43) Additional wells in the Edwards-Trinity (Plateau) Aquifer – Colorado River Basin
- (J-44) Additional wells in the Edwards-Trinity (Plateau) Aquifer – Guadalupe River Basin
- (J-45) Additional well in the Trinity Aquifer – San Antonio River Basin

## J-43 Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Colorado River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that 13 new wells will be drilled to approximately 360 feet below the surface.

**Quantity, Reliability, and Cost** –Historical industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the 13 new 5 gpm wells are assumed to supply an additional 108 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands and water quality issues. Total cost of this project is approximately $667,000.

## J-44 Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Guadalupe River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that 4 new wells would need to be drilled to approximately 310 feet below the surface.

**Quantity, Reliability, and Cost** –Historical industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the 4 new 4 gpm wells are assumed to supply an additional 20 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands and water quality issues. Total cost of this project will be approximately $190.000.

### J-45 Additional Well in the Trinity Aquifer (San Antonio River Basin)

The Trinity Aquifer has been identified as a potential source of water to meet the livestock shortages within Kerr County. The Aquifer is comprised of five different water-bearing units which are often in hydraulic communication and collectively should be considered a leaky-aquifer system. Water from this source is generally is generally of sufficient quality to meet Livestock consumption needs. Recharge to the Lower Trinity in Kerr County likely occurs primarily by lateral underflow from the north and west. This strategy assumes that one new well will be drilled to approximately 395 feet below the surface.

**Quantity, Reliability, and Cost** –Historical municipal, industrial and agricultural use indicates that the Trinity outcrops may be a viable source. Well yields from the Lower Trinity are generally unpredictable and vary greatly. For this *Plan*, the one new 17 gpm well is assumed to supply an additional 20 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands. Total cost of this project will be approximately $65,000.

# 5A.16 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY MINING

Kerr County is projected to have approximately 21 acre-feet of mining water supply shortage over the planning horizon. Water rights diverted from the Guadalupe River in conjunction with groundwater from the Edwards-Trinity (Plateau) and Trinity Aquifers provide the water needed for mining use within the County. The following water management strategy is recommended to enhance the reliability of the future water supply availability for the mining water supply shortages within Kerr County:

## J-46 Additional Well in the Trinity Aquifer (Guadalupe River Basin)

The Trinity Aquifer has been identified as a potential source of water to meet the mining shortages within Kerr County. The Aquifer is comprised of five different water-bearing units which are often in hydraulic communication and collectively should be considered a leaky-aquifer system. Water from this source is generally of sufficient quality to meet mining needs. This strategy assumes that one new well will be drilled to approximately 440 feet below the surface.

**Quantity, Reliability, and Cost** –Historical municipal, industrial and agricultural use indicates that the Trinity outcrops may be a viable source. For this *Plan*, the one new 80 gpm well is assumed to supply an additional 30 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands.

The total cost of this project will be approximately $132,000. This equates to $500 per acre-foot ($1.53 per 1,000 gallons) of treated water during debt service. After the infrastructure is fully paid for, the cost decreases to $136 per acre-foot ($0.42 per 1,000 gallons) of treated water.

# 5A.17 WATER MANAGEMENT STRATEGIES FOR THE CITY OF BRACKETTVILLE

The City of Brackettville is the county seat of Kinney County, with a population projected at 1,734 in 2020; increasing to 1,746 by 2070. The City and many other residents of Kinney County rely primarily on groundwater from three different aquifers: Edwards-Trinity (Plateau), Edwards Balcones Fault Zone (BFZ), and the Austin Chalk. Combined, these sources support water use for municipal, domestic, livestock and irrigation purposes. Although the water demand for the City of Brackettville is not projected to increase over the planning horizon, the following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-47) Water loss audit and main-line repair for the City of Brackettville
- (J-48) Increase supply to Spoford with new water line infrastructure
- (J-49) Increase storage facility

In addition to the above recommended water management strategy, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-47 Water Loss Audit and Main-line Repair for the City of Brackettville

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the City ordinance.

This strategy assumes a potential savings of 58 acre-feet per year, with a total annual cost of approximately $1,116. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. The strategy 6" diameter main-line would be replaced, with an annual operations and maintenance cost of $1,116.

## J-48 Increase Supply to Spoford with New Water Line Infrastructure

The Kinney County Commissioners Court has plans to provide water through a 10.5 mile pipeline from the City of Brackettville to the Kinney County Union Pacific Facility. This strategy includes an additional 250,000 gallon storage tank located at the end of the pipeline. The storage tank will provide an additional water supply for municipal and industrial purposes.

**Quantity, Reliability, and Cost** – This strategy will supply approximately 3 acre-feet of additional water available through transmission to the Kinney County Union Pacific Facility. The reliability of this strategy is considered to be high. The total capital cost of this strategy includes the construction of 10.5 miles of six-inch diameter transmission line and a 250,000 gallon storage tank. The total capital cost for this project is estimated at $751,000 with an annual operations and maintenance cost of approximately $4,000.

## J-49 Increase Storage Facility

The City of Brackettville has plans to develop a 125,000 gallon ground storage facility. This storage facility will ensure that adequate water is available to be piped to the Kinney County Union Pacific Facility in Spoford for municipal and industrial purposes.

**Quantity, Reliability, and Cost** – It is assumed that this strategy will provide an additional 3 acre-feet per year of water. The total estimated capital cost for this project is approximately $288,000 with an annual operations and maintenance cost of approximately $2,000.

# 5A.18 WATER MANAGEMENT STRATEGIES FOR FORT CLARK SPRINGS MUD

Fort Clark Springs MUD is located next to the City of Brackettville and shares the Edwards-Trinity (Plateau) Aquifer for their municipal water supply needs. Although the Fort Clark Springs MUD water demand is not projected to increase over the planning horizon, the following water management strategy is recommended to enhance the reliability of the Community's future water supply availability:

- (J-50) Increase storage facility

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve replacing and/or repairing old infrastructure do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed here: https://www.twdb.texas.gov/financial/index.asp.

The following Fort Clark Springs MUD water management strategy is needed but does not meet SWIFT qualification requirements:

- Repair or upgrade pumps in wells and distribution network

In addition to the above recommended water management strategy, the following water conservation management measures are suggested:

- Perform water loss audit to determine the need for replacing leaking distribution lines and faulty meters
- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-50 Increase Storage Facility

The Fort Clark Springs MUD (District) currently has 929 connections, an average daily usage of 0.5 MGD with 660,000 gallons of total storage and a well production capacity of 2 MGD. Additional supply is needed to ensure availability during drought-of-record conditions and to meet peek demands. While the District has the minimum amount of storage available, additional storage will provide the needed water supply. In order to achieve this goal, a 500,000 gallon ground storage tank will provide access to the new supply.

**Quantity, Reliability, and Cost** – This strategy is assumed to provide an additional 620 acre-feet per year of water. The total estimated capital cost for this project is approximately $1,033,000 with an annual cost of approximately $93,000.

# 5A.19 WATER MANAGEMENT STRATEGIES FOR KINNEY COUNTY-OTHER

Kinney County has a rural population of approximately 704 including individuals living outside of Brackettville and Fort Clark Springs. This compilation of domestic water users known as "County Other" is primarily self-supplied from groundwater sources of the Edwards-Trinity (Plateau), Edwards (BFZ), and Austin Chalk Aquifers. Much of the rural economy is based on ranching operations, which relies on local surface streams to provide water for their livestock. Sycamore, Pinto, West Nueces, and Los Moras Rivers and Creeks all play a key role in maintaining the ranching heritage. Natural flow in these streams is negatively influenced by the presence of non-native plant species. Although the supply-demand analysis does not project a future water supply deficit for Kinney County-Other, the following water conservation management strategy is recommended to enhance the reliability of the future water supply.

## J-51 Vegetative Management

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (Arundo donax) and Elephant Ears (Colocasia esculenta) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite.

Giant River Cane (*Arundo donax*) has become a significant problem in the western portions of the Plateau Region especially in Val Verde and Kinney Counties. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plants high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp, and has received permits to use this wasp in the eradication efforts.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Kinney County / Edwards Aquifer /

Upper Nueces River study, the estimated average annual volume of water supplied is 0.145 acre-feet per acre.

**Quantity, Reliability, and Cost** – This strategy assumes a chemical control method that will be implemented on 1,000 acres. The calculated average annual runoff benefit from the treated 1,000 acres is 145 acre-feet per year. However, the benefit during drought-of-record conditions is zero acre-feet per year. The total estimated capital cost for chemical control for this project is approximately $1,195 per acre, with a total annual cost of approximately $1,195,000. The annual operations and maintenance cost will have to be determined on a case by case basis if the *Arundo donax* reappears.

# 5A.20 WATER MANAGEMENT STRATEGIES FOR KINNEY COUNTY LIVESTOCK

Kinney County is projected to have approximately 22 acre-feet of livestock water supply shortage over the planning horizon. Livestock within the County obtains supplies from both surface and groundwater sources. Surface water such as local supply is commonly used, but limited due to the recent drought. However, Strategy J-51 discussed an option for improving surface water supply availability. Groundwater from the Austin Chalk, Edwards (BFZ), and Edwards-Trinity (Plateau) Aquifers is a more reliable source. The following water management strategy is recommended to enhance the reliability of the future water supply for livestock needs within Kinney County.

## J-52 Additional Wells in the Austin Chalk Aquifer (Rio Grande River Basin)

While groundwater from any of the local aquifers is an option, the Austin Chalk Aquifer has been identified for this strategy as a potential source of water to meet the livestock shortages within Kinney County. The Aquifer is located in the southern half of Kinney County. Wells located south of Highway 90 obtain part or all of their water from the Austin Chalk Aquifer. A wide range of production rates exists for wells completed in this Aquifer. The best production from the Austin Chalk occurs in areas that have been fractured or contain a number of solution openings. Most of the more productive wells completed in the Aquifer are located along Las Moras Creek. This strategy assumes that two new wells will be drilled to produce water from approximately 100 feet below the surface.

**Quantity, Reliability, and Cost** – The Austin Chalk Aquifer has been identified as a reliable water supply. Production from the Austin Chalk Aquifer is primarily for domestic and livestock use indicating that this aquifer is a viable source for the purpose of this strategy. For this *Plan*, the two new 10 gpm wells are assumed to supply an additional 22 acre-feet per year. The reliability of this supply is considered to be medium, based on locating a productive well site. Total cost of this project will be approximately $55,000.

# 5A.21 WATER MANAGEMENT STRATEGIES FOR THE CITY OF CAMP WOOD

The City of Camp Wood derives all of its municipal water from Old Faithful Spring (also known as Krueger Spring or Camp Wood Spring) that issues from alluvial gravel overlying the Glen Rose Limestone of the Edwards-Trinity (Plateau) Aquifer. The TCEQ Nueces River WAM (Run 3) results indicate that there is no reliable water available from the Spring during a repeat of the drought-of-record. However, Old Faithful did not cease to flow during the drought of the 1950s. Due to the recent drought the discharge from the spring has been insufficient in meeting all the current needs. For this reason, the City of Camp Wood is considering developing an alternate source of supply.

The City of Camp Wood in August of 2014 appeared on the TCEQ's Public Water Supply Limiting Water Use list seeking assistance for emergency funds earmarked for emergency groundwater supply wells. Currently the City remains on this list, which is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at the following link: https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html.

The City of Camp Wood is projected to have a shortage in 2020 of 134 acre-feet per year; decreasing to 126 acre-feet per year by 2070. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-53) Provide public with conservation information
- (J-54) Additional well in the Edwards-Trinity (Plateau) Aquifer

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers
- Perform water loss audit to determine the need for replacing leaking distribution lines and faulty meters

## J-53 Provide Public with Conservation Information

The City of Camp Wood is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which would result in a water savings of 1 acre-foot per year.

Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implanting effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner. A more detailed description of conservation best management practices that might be encouraged is available in TWDB Report 362, Water Conservation Best Management Practices Guide.

## J-54 Additional Well in the Edwards-Trinity (Plateau) Aquifer

As Old Faithful Spring can no longer be relied upon to provide a sufficient supply of public drinking water, the City of Camp Wood will need to develop a new water supply source from wells completed into the Edwards-Trinity (Plateau) Aquifer. The potential of constructing wells capable of producing at this desired rate is good, although exploratory drilling and testing will likely be needed before this strategy can be relied upon as a dependable source. Due to high levels of iron and manganese, advanced treatment will likely be required for municipal use. This strategy includes the construction of four new wells to be completed at 1,000 feet below the surface, each operating at a capacity of 40 gpm. The location of the additional wells is assumed to be near the City's current treatment plant. This project will require approximately 500 feet of six-inch diameter connection piping.

**Quantity, Reliability, and Cost** –Historical municipal, agricultural and industrial use indicates that the Edwards-Trinity (Plateau) Aquifer has sufficient availability to meet the City of Camp Wood's water supply needs. For this *Plan*, the four new well are assumed to supply an additional 172 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands. Total estimated capital cost for this project is $1,887,000 with an annual operations and maintenance cost of approximately $270,000.

# 5A.22 WATER MANAGEMENT STRATEGIES FOR THE CITY OF LEAKEY

The City of Leakey relies primarily on the Edwards-Trinity (Plateau) Aquifer and the Frio River Alluvium Aquifer for municipal water supply purpose. Small volumes of surface water are used to supplement the irrigation water supply needs of the City. Due to the recent drought, the City of Leakey in August of 2014 appeared on the TCEQ's Public Water Supply Limiting Water Use list, seeking assistance for emergency funds earmarked for emergency groundwater supply wells. Currently, the City remains on this list which is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at the following link: https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html.

Although the supply-demand analysis does not project a future water supply deficit for the City of Leakey, drought like conditions continues to impact the City's water supplies. The following water management strategy is recommended to enhance the reliability of the City's future water supply availability:

- (J-55) Water loss audit and main-line repair for the City of Leakey
- (J-56) Drill additional well in the Frio River Alluvium Aquifer
- (J-57) Develop interconnection between wells within the City of Leakey

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Promote Best Management Practices (BMPs) for residential and commercial water customers

## J-55 Water Loss Audit and Main-line Repair for the City of Leakey

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the City ordinance.

This strategy assumes a potential savings of approximately 1 acre-foot per year (111,805 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.3 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately $52,000.

## J-56 Drill Additional Well in the Frio River Alluvium Aquifer

The City of Leakey currently has a total of six Frio River Alluvium Aquifer wells, with the sixth well recently being completed in 2014. The City has plans to connect all the wells within their system in order for the public water supply system to become a more reliable future source of supply (see Strategy J-57). During the recent drought, it appeared that the water level would drop to the point where one or more of these wells would no longer be viable. In consideration of this limited groundwater availability, the Real Edwards Conservation and Reclamation District passed an emergency rule that allowed for the immediate permitting of an additional well or other potential water source for the City of Leakey. In addition, the City is looking at a solid waste disposal system and it is anticipated that such a system will require additional water.

Sufficient groundwater is available from the Frio River Alluvium Aquifer without causing excessive water-level declines; however, in a severe drought alluvial aquifers are the first to go dry. It is recommended that the new well be a sufficient distance away from the other municipal wells in the system to prevent overlapping cones-of-depression.

This strategy assumes that the construction of one new well will be drilled to a depth of 40 feet in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 85gpm. In addition, this strategy includes 500 feet of six-inch diameter connection piping. Minimal treatment, such as chlorine disinfection, will be required for municipal purposes.

**Quantity, Reliability, and Cost** –The Frio River Alluvium Aquifer has been identified as a potential and viable source to meet water supply needs for the City of Leakey. For this *Plan*, the one new 85 gpm well is assumed to supply an additional 91 acre-feet per year. The reliability of the supply is considered to be low to medium based on water quantity issues. Total estimated capital cost for this project is approximately $156,000 with an annual cost of approximately $25,000.

## J-57 Develop Interconnections between Wells within the City of Leakey

The City of Leakey has developed their current water supply system based on individual wells providing water to sections of the City. The current drought had a significant impact on the City's alluvial wells with some of the wells dropping to levels where they could not be pumped. This experience has demonstrated the need to integrate the system as both a conservation and water supply strategy. By interconnecting the independent systems, an additional 81 acre-feet per year of water can be pumped to other areas, thus reducing the demands on each individual well. This would potentially prevent the over drafting of wells during drought periods. The key well that would be incorporated into the system is Well #5. This strategy assumes approximately 3,500 feet of 6-inch line will need to be installed to connect all wells and the installation of a SCADA system is recommended.

**Quantity, Reliability, and Cost** – This strategy is assumed to supply an additional 81 acre-feet per year of water. The total estimated capital cost for this project is approximately $200,000 with an annual operations and maintenance cost of approximately $1,000.

# 5A.23 WATER MANAGEMENT STRATEGIES FOR REAL COUNTY-OTHER

The rural area of Real County Other has less than 2,632 in population including individuals living outside of Leakey and Camp Wood. This compilation of water users known as "County Other" is self-supplied and relies primarily on groundwater from the Nueces River Alluvium and Edwards-Trinity (Plateau) Aquifers for their water supply needs as produced from private domestic wells or by small public systems such as the Real Water Supply Corporation. A modest source of supply is also provided by the Edwards-Trinity (Plateau) Aquifer. Due to the recent drought, there is no availability for planning purposes in the Nueces River.

Much of the rural economy is based on ranching operations, which relies on local surface streams to provide water for their livestock. Natural flow in these streams is negatively influenced by the presence of non-native plant species.

Although the supply-demand analysis does not project a future water-supply deficit for Real County-Other, rural communities within the area have certainly suffered from extreme drought conditions. The following water management strategies are recommended to enhance the reliability of the future water supply for residents within rural Real County:

- (J-58) Water loss audit and main-line repair for Real Water Supply Corporation
- (J-59) Vegetative management
- (J-60) Additional well for Oakmont Saddle Mountain Water Supply Corporation

## J-58 Water Loss Audit and Main-line Repair for Real Water Supply Corporation

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information, progressive water rate increases and by implementing a water waste prohibition in the adopted rate tariff of the Corporation ordinance.

According to the 2010 TWDB Public Water System Water Loss Survey, Real Water Supply Corporation (WSC) had a total water loss of approximately 2,839,603 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (26%) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 2.3 acre-feet per year (742,272 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 1 mile of 6" diameter main-line will be replaced, with a total project capital cost of approximately $199,000.

## J-59 Vegetative Management

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (Arundo donax) and Elephant Ears (Colocasia esculenta) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite.

Giant River Cane (*Arundo donax*) has become a significant problem in the western portions of the Plateau Region especially in Val Verde and Kinney Counties. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plants high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp, and has received permits to use this wasp in the eradication efforts.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Real County / Edwards Aquifer / Upper Nueces River study, the estimated average annual volume of water supplied is 0.145 acre-feet per acre.

**Quantity, Reliability, and Cost** – This strategy assumes a chemical control method that will be implemented on 1,000 acres. The calculated average annual runoff benefit from the treated 1,000 acres is 145 acre-feet per year. However, the benefit during drought-of-record conditions is zero acre-feet per year. The total estimated capital cost for chemical control for this project is approximately $1,195 per acre, with a total annual cost of $1,195,000. The annual operations and maintenance cost will have to be determined on a case by case basis if the *Arundo donax* reappears.

## J-60 Additional Well for Oakmont Saddle Mountain Water Supply Corporation

Due to the recent drought, Oakmont Saddle Mountain WSC has experienced the loss of production in supply well #1. Currently, the WSC is operating on water well #2, an unapproved temporary shallow well in the Frio River Alluvium Aquifer. Real County received a Disaster Relief Grant from the Texas Department of Agriculture on June 13, 2012 to benefit Oakmont Saddle Mountain WSC for a system improvement project that will replace well #1. Through a series of failed attempts to successfully reach a reliable water supply, the water supply corporation had to abandon efforts on the construction of two wells. Since then, the WSC has drilled an experimental fourth well five feet from one of the previous wells, which involved an excavation three feet in width, 40 feet in depth and 11 feet to bedrock. This was performed for the purpose of considering a filtration zone constructed through the removal of alluvial gravel and installation of an 8" PVC perforated pipe.

To bring this new supply on-line will require the construction of the well facility and its connection to the distribution system. This strategy assumes a spring water source with the construction of a water tight concrete basin, installation of pump and associated piping, electrical and all appurtenances. Authorization to construct this spring water source well was issued by TCEQ letter dated October 24, 2014. The Oakmont Saddle Mountain WSC has applied to the TWDB for SWIFT funding for this project.

**Quantity, Reliability, and Cost** – It is anticipated that this strategy will provide an additional 54 acre-feet per year of water. The total estimated project cost is $420,000. The reliability of this source is low to medium depending on the surface water availability. Shallow alluvium wells are typically the first water supply to become an unreliable source during drought like conditions. This water supply is dependent on groundwater influenced by surface water availability.

# 5A.24 WATER MANAGEMENT STRATEGIES FOR REAL COUNTY LIVESTOCK

Real County is projected to have approximately 33 acre-feet of livestock water supply shortage over the planning horizon. Livestock within the County obtains supplies from both surface and groundwater sources. Surface water such as local supply is commonly used, but limited due to the recent drought. The Edwards-Trinity (Plateau) Aquifer is the principal groundwater source used for livestock purposes. The following water management strategy is recommended to enhance the reliability of the future water supply availability for livestock needs within Real County:

## J-61 Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Nueces River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock shortages within Real County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that two new wells will be drilled to produce water from approximately 175 feet below the surface.

**Quantity, Reliability, and Cost** –Historical industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. For this *Plan*, the two new wells are assumed to supply an additional 40 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands and water quality issues. Total cost of this project will be approximately $74,000.

# 5A.25 WATER MANAGEMENT STRATEGIES FOR THE CITY OF DEL RIO

The City of Del Rio is the only wholesale water provider in the Plateau Region. In addition to its own use, the City provides water to Laughlin Air Force Base and subdivisions outside of the City. Del Rio also provides water and wastewater services to two colonias: Cienegas Terrace and Val Verde Park Estates.

The City of Del Rio relies primarily on San Felipe Springs, which issues from the Edwards-Trinity (Plateau) Aquifer, but has also been designated as being under the influence of surface water by TCEQ. The water is collected through pumps set in the springs, treated with microfiltration and chlorine and then connected to the distribution system. The City of Del Rio has a water right authorizing it to divert 11,416 acre-feet per year from San Felipe Springs for municipal use. Elsewhere in the County, all known water wells produce water from the Salmon Peak and McKnight Formations of the Edwards Group.

The average discharge of San Felipe Springs since Lake Amistad was filled is about 110 cubic feet per second (cfs), approximately 80,000 acre-feet per year. During recent droughts, the spring discharge has fallen below 50 cfs, approximately 36,000 acre-feet per year. Although the supply-demand analysis does not project a future water supply deficit for the City of Del Rio, the diminished supply availability from the Springs during drought periods requires Del Rio to consider other water supply options. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-62) Water loss audit and main-line repair for the City of Del Rio
- (J-63) Drill and equip new well and connect to distribution system
- (J-64) Water treatment plant expansion
- (J-65) Develop a wastewater reuse program

In addition to the above recommended water management strategies, the following water conservation management measures are suggested:

- Vegetative management
- Promote Best Management Practices (BMPs) for residential and commercial water customers

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve items such as: replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed here: https://www.twdb.texas.gov/financial/index.asp.

In addition to the recommended strategies listed above, the City of Del Rio has the following funded, water projects listed with the TWDB as of November 2014:

- Water main replacement
- Collection system reconstruction

## J-62 Water Loss Audit and Main-line Repair for the City of Del Rio

System water audits and water loss programs are effective methods of accounting for all water usage by a utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in setting goals and priorities for cost-effectively reducing water losses. By adopting this best management practice, a utility will be implementing a more frequent implementation of water auditing and loss reduction techniques than required by HB 3338. A more detailed description of this best management practice is available in TWDB Report 362, Water Conservation Best Management Practices Guide, and in the TWDB Water Loss Manual. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part. The community should also look towards conservation measures through public information and through progressive water rate increases.

The City of Del Rio in 2001 completed a distribution system improvement project funded by the TWDB to replace leaking distribution lines. A 1999 water audit found more than 37 percent of the City's water unaccounted. Since these improvements, Del Rio has reduced the volume of unaccounted water to 19 percent, approximately 338,563,633 gallons per year total loss. This amount of water loss is the sum of reported breaks and leaks and unreported loss. However, the American Water Works Association (AWWA) recommends entities with more than 10 percent water loss to take corrective action.

This strategy assumes that the City of Del Rio will continue to pursue conservation measures through public information, progressive water rate increases, and additional water audits to reduce the volume of unaccounted water.

This strategy assumes a potential savings of 119 acre-feet per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 46 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately $8,673,000.

## J-63 Drill and Equip a New Well and Connect to Distribution System

The City of Del Rio currently has a total of three wells located north of town; however, due to complications with the production of these wells, all three wells are presently inactive. In order to alleviate the water demand from San Felipe Springs, Del Rio plans to locate an alternate source of supply. The Edwards-Trinity (Plateau) Aquifer has been identified as groundwater source for future water supplies. This source may require minimal advanced treatment such as chlorine disinfection for municipal purposes. As the three existing inactive wells are not classified as being active water supply sources, the addition of a new well is considered a new supply source.

**Quantity, Reliability, and Cost** – This strategy assumes the development of one new well located near the existing wells, north of town. The well will be drilled at a depth of 650 feet and is anticipated to produce an additional 850 acre-feet per year. This strategy includes 0.5 miles of 14-inch diameter transmission line. The total capital cost is estimated to be approximately $2,937,000.

## J-64 Water Treatment Plant Expansion

The City of Del Rio uses a membrane treatment facility, which treats water pumped from San Felipe Springs. The treatment plant is approximately 15 years old and is in need of two additional pods to keep pace with the communities growing water demands. This strategy assumes costs associated with the 1 MGD treatment plant expansion which is anticipated to come on-line by 2030. This strategy is necessary to provide the water supply for the following J-65 strategy.

**Quantity, Reliability, and Cost** – It is expected that this project will supply an additional 943 acre-feet per year. The total capital cost for this project is approximately $1,841,000.

## J-65 Develop a Waste Water Reuse Program

A long term strategy for the City is to begin to use its wastewater effluent for irrigation of the municipal golf course, provide reuse water to Laughlin AFB, and eventually to irrigate public parks. Assuming that half of that discharge is used for reuse, this strategy will then provide a new water resource for the area. This strategy is reliant on the expansion of the City's wastewater treatment plant (Strategy J-64).

**Quantity, Reliability, and Cost** – The current wastewater discharge permit for the City of Del Rio is 2.7 MGD (3,092 acre-feet per year). The effluent provided for reuse will be a continual supply available on a daily basis for municipal uses. The estimated construction cost to install approximately 54,000 feet of pipe and associated pumping facilities is estimated to be $1.7 million.

# 5A.26 WATER MANAGEMENT STRATEGIES FOR VAL VERDE COUNTY-OTHER

The rural area of Val Verde County has a population projected at 14,855 in 2020; increasing to 30,080 by 2070. This population includes individuals living outside of the City of Del Rio and Laughlin AFB. This compilation of water users known as "County Other" is partially supplied by Del Rio, but is mostly self-supplied and relies solely on the Edwards-Trinity (Plateau) Aquifer for their water supply needs either from private domestic wells, or privately owned water supply systems. Much of the rural economy is based on ranching operations, which relies on local surface streams to provide water for their livestock. Natural flow in these streams is negatively influenced by the presence of non-native plant species.

Although the supply-demand analysis does not project a future water supply deficit for Val Verde County-Other, the following water management strategy is recommended to enhance the reliability of the future water supply for residents within Val Verde County Other:

- (J-66) Vegetative Management

The TWDB requires that water management strategies develop new water to be applicable for SWIFT funding. Projects that involve items such as: replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed at the following link: https://www.twdb.texas.gov/financial/index.asp.

In addition to the recommended strategies listed above, the Del Rio County has the following funded, water projects listed with the TWDB as of November 2014:

- Lakeview Estates Water & Wastewater – Prepare a plan to identify needed water to serve rural areas near Lake Amistad
- Colonia Water Service – Extend the City of Del Rio water system to service subdivisions east of Laughlin Air Force Base

## J-66 Vegetative Management

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (Arundo donax) and Elephant Ears (Colocasia esculenta) in the local watersheds.

Giant River Cane (*Arundo donax*) has become a significant problem in the western portions of the Plateau Region especially in Val Verde and Kinney Counties. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plants high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp, and has received permits to use this wasp in the eradication efforts.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Val Verde County / Edwards Aquifer / Upper Nueces River study, the estimated average annual volume of water supplied is 0.145 acre-feet per acre.

**Quantity, Reliability, and Cost** – This strategy assumes a chemical control method that will be implemented on 1,000 acres. The calculated average annual runoff benefit from the treated 1,000 acres is 145 acre-feet per year. However, the benefit during drought-of-record conditions is zero acre-feet per year. The total estimated capital cost for chemical control for this project is approximately $1,195 per acre, with a total cost of $1,195,000. The annual operations and maintenance cost will have to be determined on a case by case basis if the *Arundo donax* reappears.

# 5A.27 WATER MANAGEMENT STRATEGIES FOR VAL VERDE COUNTY MINING

The mining industry in Val Verde County is projected to have approximately 73 acre-feet of mining water supply shortage over the planning horizon. Both surface water and groundwater supplies provide water for mining purposes within the County. The Edwards-Trinity (Plateau) Aquifer is the sole groundwater source used for mining purposes. The following water management strategy is recommended to enhance the reliability of the future water supply availability for the mining water supply shortages within Val Verde County:

## J-67 Additional Well in the Edwards-Trinity (Plateau) Aquifer (Rio Grande River Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortage within Val Verde County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that one new well will be drilled to produce water from approximately 395 feet below the surface.

**Quantity, Reliability, and Cost** –Historical industrial and agricultural use indicates that the Edwards-Trinity (Plateau) Aquifer may be a viable source. For this *Plan*, the one new well is assumed to supply an additional 80 acre-feet per year. The reliability of this supply is considered to be medium to high, based on competing demands and water quality issues. Total cost of this project will be approximately $235,000 with an annual cost of $25,000.

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# APPENDIX 5B
# STRATEGY EVALUATION QUANTIFICATION MATRIX

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# STRATEGY EVALUATION QUANTIFICATION MATRIX

The practicality of an implemented water management strategy may be measured in terms of quantity, quality and reliability of water produced and the varying degree of impact (positive or negative) on pre-existing local conditions. The Plateau Region Water Planning Group has adopted a standard procedure for ranking potential water management strategies. Quantitative and qualitative measurements are tabulated in Chapter 5 Tables 5-2 and 5-4. This procedure classifies the strategies using the TWDB's following standard categories developed for regional water planning:

**Table 5-2:**

- Quantity
- Quality
- Reliability
- Impact of Water, Agricultural, and Natural Resources

**Table 5-4:**

- Environmental Impact
  - Threatened and endangered species
  - Environmental water needs
  - Wildlife habitat
  - Cultural resources
  - Environmental water quality
  - Bays and estuaries

## Quantity, Quality and Reliability

Quantity, quality and reliability are quantitatively assessed and assigned a ranking from 1 to 3 as listed in the Matrix Table below, which shows the correlation between the category and the ranking.

**Table 5B-1. Quantity, Quality and Reliability Category Ranking Matrix**

| Rank | Quantity | Quality | Reliability |
|---|---|---|---|
| 1 | Meets 100% of shortage | Meets safe drinking water standards | Sustainable |
| 2 | Meets 50-99% of shortage | Must be treated or mixed to meet safe drinking water standards | Interruptible |
| 3 | Meets < 50% of shortage | Usable for intended non-drinking use only | Un-sustainable |

**Quantity** adequacy is measured as a percent of the volume of water needed to meet the specified water user group's (WUG's) shortage as calculated in Table 4-1 of Chapter 4 that is produced by the water management strategy. Percent volumes are only analyzed for WUGs with projected supply shortages.

**Quality** adequacy is measured in terms of meeting TCEQ Safe Drinking Water Standards. However, not all strategies are intended for use requiring SDWSs.

**Reliability** is evaluated based on the expected or potential for the water to be available during drought. Strategies that use water from a source that would not exceed permits or MAGs even during droughts are rated as <u>sustainable</u>. Strategies that use water from a source that is available during normal meteorological conditions, but may not be 100% available during drought are rated as <u>interruptible</u>. Strategies in which 100% of the supply cannot be maintained even during normal meteorological conditions are rated as <u>un-sustainable</u>.

**<u>Impact on Water, Agricultural and Natural Resources</u>**

Impacts are quantitatively assessed and assigned a ranking from 1 to 5 as listed in the Matrix Table below, which shows the correlation between the category and the ranking.

**Table 5B-2. Strategy Impact Category Ranking Matrix**

| Rank | Water Resources | Agricultural Resources | Natural Resources |
|---|---|---|---|
| 1 | Positive | Positive | Positive |
| 2 | None | None | None |
| 3 | Low | Low | Low |
| 4 | Medium | Medium | Medium |
| 5 | High | High | High |

**Water Resources** impacts refer to the potential for the implemented strategy to compete for water sources shared with adjacent properties. The matrix ranking depicts the potential range of water-level drawdown induced across property boundaries during the life of the strategy project.

1 Positive - No aquifer drawdown; increased surface water flow

2 None – No new aquifer drawdown; no change to surface water flow

3 Low – <10 feet of aquifer drawdown; < 10% reduction in average surface flows

4 Medium – 10 to 50 feet of aquifer drawdown; 10 to 30% reduction in average surface flows

5 High - > 50 feet of aquifer drawdown; > 30% reduction in surface flows

**Agricultural Resources** impacts refer to the agricultural economic impact resulting from the loss or gain of water supplies currently in use by the agricultural user as the result of the implementation of a strategy. See Section 1.2.8 in Chapter 1 for a detailed discussion on the Agricultural Resources of the Plateau Region.

1 Positive – provides water to agricultural users

2 None – does not impact agricultural supplies

3 Low – reduces agricultural activity by less than 10%

4 Medium – reduces agricultural activity by more than 10%

5 High – water rights use changes from agricultural to some other use thus elimination agricultural activity

**Natural Resources** impacts are those that impact the terrestrial and aquatic habitat of native plant and animal wildlife, as well as the scenic beauty of the Region that is critical to the tourism industry. See Section 1.2.9 in Chapter 1 for a detailed discussion on the Natural Resources of the Plateau Region.

1 Positive – provides water to natural resources

2 None – does not impact natural resources

3 Low – reduces natural resources water supply by less than 10%

4 Medium – reduces natural resources water supply by more than 10%

5 High – reduces natural resources water supply by more than 50%

**Environmental Impacts**

Environmental impacts are quantitatively assessed and assigned a ranking from 1 to 5 as listed in the Matrix Table below, which shows the correlation between the category and the ranking. The Environmental Matrix takes into consideration the following categories;

- Threatened and Endangered Species
- Environmental Water Needs
- Wildlife Habitat
- Cultural Resources
- Environmental Water Quality
- Bays and Estuaries

**Table 5B-3. Environmental Impact Category Ranting Matrix**

| Threatened and Endangered Species | Rank | Environmental Water Needs | Wildlife Habitat | Cultural Resources | Environmental Water Quality | Bays and Estuaries |
|---|---|---|---|---|---|---|
| Number of species in county where strategy infrastructure occurs | 1 | Positive | Positive | Positive | Positive | Not applicable |
| | 2 | No new | No new | No new | No new | |
| | 3 | Minimal negative | Minimal negative | Minimal negative | Minimal negative | |
| | 4 | Moderate negative | Moderate negative | Moderate negative | Moderate negative | |
| | 5 | Significant negative | Significant negative | Significant negative | Significant negative | |

**Threatened and Endangered Species** refers to the number of designated rare, threatened, and endangered species located in each county as listed in the Texas Parks and Wildlife Department's Natural Diversity Database of Rare, Threatened, and Endangered Species as of 8-24-2015 located at http://tpwd.texas.gov/huntwild/wild/wildlife_diversity/txndd. Impacts to specific species will require additional assessment.

**Environmental Water Needs** impacts refer to how the strategy will impact the area's overall environmental water needs. Water is vital to the environmental health of a region, and so it is important to take into account how strategies will impact the amount of water that will be available to the environment.

1 Positive – additional water will be introduced for environmental use

2 No new – no additional water will be introduced for environmental use

3 Minimal negative – environmental water needs will be reduced by <10%

4 Moderate negative – environmental water needs will be reduced by 10 to 30%

5 Significant negative - environmental water needs will be reduced by >30%

**Wildlife Habitat** impacts refer to how the strategy will impact the wildlife habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted.

1 Positive – additional habitat area for wildlife use will be created

2 No new – no additional habitat area for wildlife use will be created or destroyed

3 Minimal negative – wildlife habit will be reduced by < 100 acres

4 Moderate negative – wildlife habit will be reduced by 100 to 1,000 acres

5 Significant negative - wildlife habit will be reduced by > 1,000 acres

**Cultural Resources** impacts refer to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people. Locations, buildings and features with scientific, cultural or historic value are considered to be cultural resources.

1 Positive – cultural resources will be identified and protected

2 No new – no impact will occur to local cultural resources

3 Minimal negative – disturbance to cultural resources will be < 10%

4 Moderate negative – disturbance to cultural resources will be 10 to 20%

5 Significant negative - disturbance to cultural resources will be > 20%

**Environmental Water Quality** impacts refer to the impact that the implementation of the strategy will have on the local area's natural water quality. Negative impacts could include the introduction of poorer quality water, the reduction of the natural flow of water of native quality source water, or the introduction of detrimental chemical elements into the natural water ways.

1 Positive – water quality of area streams will be enhanced for existing environmental use

2 No new – water quality characteristics of existing environmental habitat will not be changed

3 Minimal negative – water quality characteristics of existing environmental habitat will be negatively altered by < 10%

4 Moderate negative – water quality characteristics of existing environmental habitat will be negatively altered by < 10 to 30%

5 Significant negative - water quality characteristics of existing environmental habitat will be negatively altered by > 30%

**Bays and Estuaries** – The Plateau Region is located too far away from any bays and estuaries of the Texas coastline to have a quantifiable impact. Therefore this category was assumed to be non-applicable for every strategy.

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# APPENDIX 5C
# AUXIALIARY WATER MANAGEMENT STRATEGY TABLES

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# Auxiliary Water Management Strategy Tables

Table 5C-1. Recommended Water Management Strategy – Roll-Up Summary

Table 5C-2. Management Supply Factor

**Table 5C-1. Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Bandera | City of Bandera | San Antonio | Reuse treated wastewater effluent for irrigation use | J-1 | 310 | 310 | 310 | 310 | 310 | 310 | $450,000 |
| | | | Promote, design & install rainwater harvesting systems | J-2 | 1 | 1 | 1 | 1 | 1 | 1 | $56,000 |
| | | | Additional Lower Trinity well and lay necessary pipeline | J-4 | 323 | 323 | 323 | 323 | 323 | 323 | $2,284,000 |
| | | | Additional Middle Trinity wells within City water infrastructure | J-5 | 161 | 161 | 161 | 161 | 161 | 161 | $779,000 |
| | *Bandera County Other | | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | 1 | 1 | 1 | 1 | 1 | 1 | $163,000 |
| | | | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | 1 | 1 | 1 | 1 | 1 | 1 | $463,000 |
| | | | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | 1 | 1 | 1 | 1 | 1 | 1 | $447,000 |
| | | | **Vegetative Management | J-9 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | Drought Management (BCRAGD) | J-68 | 467 | 519 | 546 | 556 | 563 | 568 | $0 |
| | | | Additional well for Pebble Beach Subdivision | J-10 | 161 | 161 | 161 | 161 | 161 | 161 | $3,717,000 |
| | | | Additional wells to provide emergency supply to VFD | J-11 | 189 | 189 | 189 | 189 | 189 | 189 | $2,824,000 |
| | | | Additional wells to help Medina Lake area | J-12 | 27 | 27 | 27 | 27 | 27 | 27 | $1,377,000 |
| | | Nueces | Drought Management (BCRAGD) | J-69 | 29 | 32 | 34 | 34 | 35 | 35 | $0 |
| | * Bandera County Irrigation | Nueces | Additional groundwater wells | J-13 | 130 | 130 | 130 | 130 | 130 | 130 | $244,000 |
| | * Bandera County Livestock | San Antonio | Additional groundwater well | J-14 | 20 | 20 | 20 | 20 | 20 | 20 | $103,000 |
| Edwards | * City of Rocksprings | Colorado | Water loss audit and main-line repair | J-15 | 1 | 1 | 1 | 1 | 1 | 1 | $129,000 |
| | | Nueces | Additional groundwater well | J-16 | 121 | 121 | 121 | 121 | 121 | 121 | $650,000 |
| | Edwards County Other | Nueces | Water loss audit and main-line repair for Barksdale WSC | J-17 | 1 | 1 | 1 | 1 | 1 | 1 | $203,000 |
| | | | Additional well in the Nueces River Alluvium Aquifer | J-18 | 54 | 54 | 54 | 54 | 54 | 54 | $114,000 |
| | | | **Vegetative Management | J-19 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |

**Table 5C-1. (Continued) Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Edwards | * Edwards County Livestock | Nueces | Additional groundwater wells | J-20 | 20 | 20 | 20 | 20 | 20 | 20 | $105,000 |
| | * Edwards County Mining | Rio Grande | Additional groundwater wells | J-21 | 30 | 30 | 30 | 30 | 30 | 30 | $109,000 |
| Kerr | * City of Kerrville | Guadalupe | Increase wastewater reuse | J-22 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $23,000,000 |
| | | | Water loss audit and main-line repair | J-23 | 147 | 147 | 147 | 147 | 147 | 147 | $9,339,000 |
| | | | Purchase water from UGRA | J-24 | | 0 | 0 | 0 | 0 | 0 | $4,103,791 |
| | | | Increased water treatment and ASR capacity | J-25 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 3360 | $11,543,000 |
| | * Loma Vista WSC | | Conservation: Public information | J-26 | 4 | 4 | 4 | 4 | 4 | 4 | $0 |
| | | | Additional groundwater well | J-27 | 57 | 57 | 57 | 57 | 57 | 57 | $728,000 |
| | * Kerr County Other | Guadalupe | Water loss audit and main-line repair for Center Point WWW | J-28 | 1 | 1 | 1 | 1 | 1 | 1 | $33,000 |
| | | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | 1 | 1 | 1 | 1 | 1 | 1 | $138,000 |
| | | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | 1 | 1 | 1 | 1 | 1 | 1 | $99,000 |
| | | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | 1 | 1 | 1 | 1 | 1 | 1 | $102,000 |
| | | | Conservation: Public information | J-32 | 9 | 9 | 9 | 10 | 9 | 8 | $0 |
| | | Colorado | Conservation: Public information - Water shortage met with J-32 | J-32A | 5 | 5 | 5 | 5 | 6 | 7 | $0 |
| | | Nueces | Conservation: Public information - Water shortage met with J-32 | J-32B | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | | Guadalupe | **Vegetative management - UGRA | J-33 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | UGRA Acquisition of Surface Water Rights [2](EKCRWSP) | J-34 | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | 1029 | $1,087,367 |
| | | | KCCC Acquisition of Surface Water Rights [2](EKCRWSP) | J-35 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | $6,342,000 |
| | | | Construction of an Off-Channel Surface Water Storage [2](EKCRWSP) | J-36 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,534,303 |

**Table 5C-1. (Continued) Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Kerr | *Kerr County-Other | Guadalupe | Construction of surface water treatment facilities and transmission lines ²(EKCRWSP) | J-37 | 149 | 149 | 149 | 149 | 149 | 149 | $25,581,000 |
| | | | Construction of ASR facility ²(EKCRWSP) | J-38 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $1,258,000 |
| | | | Construction of Well field for dense, rural areas ²(EKCRWSP) | J-39 | 860 | 860 | 860 | 860 | 860 | 860 | $4,357,000 |
| | | | Construction of Desalination plant ²(EKCRWSP) | J-40 | 860 | 860 | 860 | 860 | 860 | 860 | $14,539,000 |
| | | | Construction of an Ellenburger Aquifer water supply well ²(EKCRWSP) | J-41 | 108 | 108 | 108 | 108 | 108 | 108 | $567,000 |
| | *Kerr County Irrigation | San Antonio | Additional groundwater well | J-42 | 20 | 20 | 20 | 20 | 20 | 20 | $78,000 |
| | * Kerr County Livestock | Colorado | Additional groundwater wells | J-43 | 108 | 108 | 108 | 108 | 108 | 108 | $667,000 |
| | * Kerr County Livestock | Guadalupe | Additional groundwater wells | J-44 | 20 | 20 | 20 | 20 | 20 | 20 | $190,000 |
| | * Kerr County Livestock | San Antonio | Additional groundwater well | J-45 | 20 | 20 | 20 | 20 | 20 | 20 | $65,000 |
| | * Kerr County Mining | Guadalupe | Additional groundwater well | J-46 | 30 | 30 | 30 | 30 | 30 | 30 | $132,000 |
| Kinney | City of Brackettville | Rio Grande | Water loss audit and main-line repair | J-47 | 58 | 58 | 58 | 58 | 58 | 58 | $1,116 |
| | | | Increase supply to Spoford with new water line | J-48 | 3 | 3 | 3 | 3 | 3 | 3 | $751,000 |
| | | | Increase storage facility | J-49 | 3 | 3 | 3 | 3 | 3 | 3 | $288,000 |
| | Fort Clark Springs MUD | | Increase storage facility | J-50 | 620 | 620 | 620 | 620 | 620 | 620 | $1,033,000 |
| | Kinney County Other | | **Vegetative Management | J-51 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | * Kinney County Livestock | | Additional groundwater wells | J-52 | 22 | 22 | 22 | 22 | 22 | 22 | $55,000 |

**Table 5C-1. (Continued) Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Real | * City of Camp Wood | Nueces | Conservation: Public information | J-53 | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | | | Additional groundwater wells | J-54 | 172 | 172 | 172 | 172 | 172 | 172 | $1,887,000 |
| | City of Leakey (Real County Other) | | Water loss audit and main-line repair | J-55 | 1 | 1 | 1 | 1 | 1 | 1 | $52,000 |
| | | | Additional groundwater well | J-56 | 91 | 91 | 91 | 91 | 91 | 91 | $156,000 |
| | | | Develop interconnections between wells within the City | J-57 | 81 | 81 | 81 | 81 | 81 | 81 | $200,000 |
| | Real County Other | | Water loss audit and main-line repair for Real WSC | J-58 | 2 | 2 | 2 | 2 | 2 | 2 | $199,000 |
| | | | **Vegetative Management | J-59 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | Additional well for Oakmont Saddle WSC | J-60 | 54 | 54 | 54 | 54 | 54 | 54 | $420,000 |
| | * Real County Livestock | | Additional groundwater wells | J-61 | 40 | 40 | 40 | 40 | 40 | 40 | $74,000 |
| Val Verde | City of Del Rio | Rio Grande | Water loss audit and main-line repair | J-62 | 119 | 119 | 119 | 119 | 119 | 119 | $8,673,000 |
| | | | Drill & equip new well, connect to distribution system | J-63 | 850 | 850 | 850 | 850 | 850 | 850 | $2,937,000 |
| | | | Water treatment plant expansion | J-64 | | 943 | 943 | 943 | 943 | 943 | $1,841,000 |
| | | | Develop a wastewater reuse program | J-65 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $1,700,000 |
| | Val Verde County Other | | **Vegetative Management | J-66 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | * Val Verde County Mining | | Additional groundwater well | J-67 | 80 | 80 | 80 | 80 | 80 | 80 | $235,000 |
| | | | | **Totals** | **27,414** | **28,412** | **28,441** | **28,452** | **28,460** | **28,465** | **146,202,577** |

**Table 5C-2. WUG Management Supply Factor**

| | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Bandera | 7.6 | 6.8 | 6.5 | 6.3 | 6.2 | 6.2 |
| Brackettville | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| Camp Wood | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 |
| County-Other, Bandera | 1.4 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 |
| County-Other, Edwards | 4.3 | 4.5 | 4.7 | 4.7 | 4.8 | 4.8 |
| County-Other, Kerr | 4.8 | 4.7 | 4.7 | 4.6 | 4.5 | 4.4 |
| County-Other, Kinney | 3.1 | 3.1 | 3.2 | 3.2 | 3.2 | 3.2 |
| County-Other, Real | 4.8 | 5.0 | 5.1 | 5.2 | 5.2 | 5.2 |
| County-Other, Val Verde | 2.3 | 2.0 | 1.7 | 1.5 | 1.4 | 1.2 |
| Del Rio | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 |
| Fort Clark Springs MUD | 3.2 | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 |
| Ingram | 3.3 | 3.5 | 3.6 | 3.6 | 3.6 | 3.6 |
| Irrigation, Bandera | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| Irrigation, Edwards | 2.0 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |
| Irrigation, Kerr | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| Irrigation, Kinney | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Irrigation, Real | 9.9 | 10.4 | 10.8 | 11.3 | 11.9 | 12.4 |
| Irrigation, Val Verde | 1.1 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 |
| Kerrville | 2.2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.0 |
| Laughlin AFB | 2.3 | 2.1 | 1.9 | 1.8 | 1.8 | 1.8 |
| Livestock, Bandera | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Livestock, Edwards | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Livestock, Kerr | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Livestock, Kinney | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Livestock, Real | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Livestock, Val Verde | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Loma Vista Water System | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 |
| Manufacturing, Kerr | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 |
| Mining, Edwards | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| Mining, Kerr | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 |
| Mining, Val Verde | 1.4 | 1.1 | 1.0 | 1.2 | 1.4 | 1.6 |
| Rocksprings | 3.5 | 3.6 | 3.7 | 3.7 | 3.7 | 3.7 |

6

# CHAPTER 6

# REGIONAL WATER PLAN IMPACTS AND CONSISTENCY WITH PROTECTION OF WATER, AGRICULTURAL AND NATURAL RESOURCES

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# 6 REGIONAL WATER PLAN IMPACTS AND CONSISTENCY WITH PROTECTION OF WATER, AGRICULTURAL AND NATURAL RESOURCES

Chapter 6 describes how this *2016 Plan* is consistent with the long-term protection of water resources, agricultural resources, and natural resources that are important to the Plateau Region. In addition, the socioeconomic impact of not meeting water supply needs within the Region is discussed in an analysis report prepared by the Texas Water Development Board and presented in Appendix 6A at the end of this chapter. All planning analyses applied and recommendations made in the development of this *Plan* honor all existing water rights, contracts, and option agreements; and have no impact on navigation on any of the Region's surface water streams and rivers.

## 6.1 PROTECTION OF WATER RESOURCES

Water resources in the Plateau Region as described in Chapter 3 include groundwater in numerous aquifers and surface water occurring in five rivers and their tributaries. The numerous springs, which represent an inter-relational transition point between groundwater and surface water, are also recognized in Chapter 1, Section 1.4.3 and Chapter 3, Section 3.3 for their major importance.

The first step in achieving long-term water resources protection was in the process of estimating each source's availability. Surface water estimates are developed through a water availability model process (WAM) and are based on the quantity of surface water available to meet existing water rights during a drought-of-record.

Groundwater availability estimates are based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs). Establishing conservative levels of water source availability, thus results in less potential of over exploiting the supply.

The next step in establishing the long-term protection of water resources occurs in the water management strategies developed in Chapter 5 to meet potential water supply shortages. Each strategy was evaluated for potential threats to water resources in terms of source depletion (reliability), quality degradation, and impact to environmental habitat.

Water conservation strategies are also recommended for each entity with a supply deficit. Conservation reduces the impact on water supplies by reducing the actual water demand for the supply. Table 5-2 and 5-4 in Chapter 5 provides an overview of these impact evaluations.

Chapters 5 and 7 contain information and recommendations pertaining to water conservation and drought management practices. When enacted, the conservation practices will diminish water demand, the drought management practices will extend supplies over the stress period, and the land management practices will potentially increase aquifer recharge.

## 6.2 PROTECTION OF AGRICULTURAL RESOURCES

Agriculture in the Plateau Region, as described in Chapter 1, Sections 1.2.7 and 1.3.4, and Chapter 3, Section 3.1.10 includes the raising of crops and livestock, as well as a multitude of businesses that support this industry. TWDB's socio-economic analysis (provided in Appendix 6A) reports that two of the six counties in the Region (Bandera and Kerr Counties), are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the water planning horizon (Table 4-1). Estimated impacts to this water use category appear in Table 6-1. According to the TWDB's socio-economic analysis, a negative tax impact was surmised, primarily due to past subsidies from the federal government. Two factors led to reporting any federal tax impacts:

1 Federal support (subsidies) has lessened greatly since data was collected in the *2011 Plan.*

2 It was not considered realistic to report increasing tax revenue collections for a drought of record.

Five of the six counties in the Region are projected to experience water shortages in the livestock water use category for one or more decades within the water planning horizon (Table 4-1). Income loss is estimated to be approximately $5 million, which includes relatively 288 job losses per decade (Table 6-1).

Many of the communities in the Region depend on various forms of the agricultural industry for a significant portion of their economy. It is thus important to the economic health and way of life in these communities to protect water resources that have historically been used in the support of agricultural activities.

The *2016 Plateau Region Water Plan* provides irrigation strategy recommendations for minor projected shortages in parts of Bandera and Kerr Counties in Chapter 5. Also, non-agricultural strategies provided in Chapter 5 include an analysis of potential impact to agricultural interests.

An interim project was performed in 2010 to evaluate the water use by livestock and game animals in the Plateau Region. This report titled "Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area" is available on the UGRA web site at http://www.ugra.org/waterdevelopment.html.

**Table 6-1. Impacts of Water Shortages on Irrigation and Livestock ($ millions)**

| WUG | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Irrigation | $0 | $0 | $0 | $0 | $0 | $0 |
| Job Losses | - | - | - | - | - | - |
| Livestock | $5 | $5 | $5 | $5 | $5 | $5 |
| Job Losses | 288 | 288 | 288 | 288 | 288 | 288 |

* Year 2013 dollars rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.

## 6.3 PROTECTION OF NATURAL RESOURCES

The Plateau Region Water Planning Group has adopted a stance toward the protection of natural resources. Natural resources are defined in Chapter 1, Section 1.2.6 and 1.2.7 as including terrestrial and aquatic habitats that support a diverse environmental community as well as provide recreational and economic opportunities. Environmental and recreational water needs are discussed in Chapter 2, Section 2.3.

The protection of natural resources is closely linked with the protection of water resources as discussed in Section 6.1 above. Where possible, the methodology used to assess groundwater source availability is based on not significantly lowering water levels to a point where spring flows might be impacted. Thus, the intention to protect surface flows is directly related to those natural resources that are dependent on surface water sources or spring flows for their existence.

Environmental impacts were evaluated in the consideration of strategies to meet water-supply deficits. Table 5-4 in Chapter 5 provides a comparative analysis of all selected strategies. Of prime consideration was whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to animals and plants that naturally inhabit the area under consideration.

Although the Planning Group chooses to respect the privacy of private lands by not recommending "Ecologically Unique River and Stream Segments" in this *Water Plan,* the Group recognizes and applauds the conservation work that is undertaken on a daily basis by the majority of all landowners in the Region.

# APPENDIX 6A
# SOCIOECONOMIC IMPACT OF UNMET WATER NEEDS

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# Socioeconomic Impacts of Projected Water Shortages

# for the Region J Regional Water Planning Area

**Prepared in Support of the 2016 Region J Regional Water Plan**

Texas Water
Development Board

Dr. John R. Ellis
Water Use Projections & Planning Division
Texas Water Development Board

Yun Cho, Team Lead
Water Use Projections & Planning Division
Texas Water Development Board

Kevin Kluge, Manager
Water Use Projections & Planning Division
Texas Water Development Board

September, 2015

# Table of Contents

## Executive Summary

Evaluating the social and economic impacts of not meeting identified water needs is a required part of the regional water planning process. The Texas Water Development Board (TWDB) estimates those impacts for regional water planning groups, and summarizes the impacts in the state water plan. The analysis presented is for the Region J Regional Water Planning Group.

Based on projected water demands and existing water supplies, the Region J planning group identified water needs (potential shortages) that would occur within its region under a repeat of the drought of record for six water use categories. The TWDB then estimated the socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

The analysis was performed using an economic modeling software package, IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques, and represents a snapshot of socioeconomic impacts that may occur during a single year during a drought of record within each of the planning decades. For each water use category, the evaluation focused on estimating income losses and job losses. The income losses represent an approximation of gross domestic product (GDP) that would be foregone if water needs are not met.

The analysis also provides estimates of financial transfer impacts, which include tax losses (state, local, and utility tax collections); water trucking costs; and utility revenue losses. In addition, social impacts were estimated, encompassing lost consumer surplus (a welfare economics measure of consumer wellbeing); as well as population and school enrollment losses.

It is estimated that not meeting the identified water needs in Region J would result in an annually combined lost income impact of approximately $62 million in 2020, increasing to $71 million in 2070 (Table ES-1). In 2020, the region would lose approximately 1,400 jobs, and by 2070 job losses would increase to approximately 1,600.

All impact estimates are in year 2013 dollars and were calculated using a variety of data sources and tools including the use of a region-specific IMPLAN model, data from the TWDB annual water use estimates, the U.S. Census Bureau, Texas Agricultural Statistics Service, and Texas Municipal League.

**Table ES-1: Region J Socioeconomic Impact Summary**

| Regional Economic Impacts | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses ($ millions)* | $62 | $71 | $75 | $69 | $69 | $71 |
| Job losses | 1,435 | 1,591 | 1,643 | 1,551 | 1,563 | 1,599 |
| **Financial Transfer Impacts** | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Tax losses on production and imports ($ millions)* | $8 | $12 | $13 | $9 | $8 | $9 |
| Water trucking costs ($ millions)* | $0 | $0 | $0 | $0 | $0 | $0 |
| Utility revenue losses ($ millions)* | $9 | $10 | $10 | $10 | $10 | $10 |
| Utility tax revenue losses ($ millions)* | $0 | $0 | $0 | $0 | $0 | $0 |
| **Social Impacts** | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Consumer surplus losses ($ millions)* | $11 | $11 | $12 | $13 | $13 | $14 |
| Population losses | 263 | 292 | 302 | 285 | 287 | 294 |
| School enrollment losses | 49 | 54 | 56 | 53 | 53 | 54 |

****Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

# 1 Introduction

Water shortages during a repeat of the drought of record would likely curtail or eliminate certain economic activity in businesses and industries that rely heavily on water. Insufficient water supplies could not only have an immediate and real impact on existing businesses and industry, but they could also adversely and chronically affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages could disrupt activity in homes, schools and government and could adversely affect public health and safety. For these reasons, it is important to evaluate and understand how water supply shortages during drought could impact communities throughout the state.

Administrative rules (31 Texas Administrative Code §357.33 (c)) require that regional water planning groups evaluate the social and economic impacts of not meeting water needs as part of the regional water planning process, and rules direct the TWDB staff to provide technical assistance upon request. Staff of the TWDB's Water Use, Projections, & Planning Division designed and conducted this analysis in support of the Region J Regional Water Planning Group.

This document summarizes the results of the analysis and discusses the methodology used to generate the results. Section 1 summarizes the water needs calculation performed by the TWDB based on the regional water planning group's data. Section 2 describes the methodology for the impact assessment and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 3 presents the results for each water use category with results summarized for the region as a whole. Appendix A presents details on the socioeconomic impacts by county.

## 1.1 Identified Regional Water Needs (Potential Shortages)

As part of the regional water planning process, the TWDB adopted water demand projections for each water user group (WUG) with input from the planning groups. WUGs are composed of cities, utilities, combined rural areas (designated as county-other), and the county-wide water use of irrigation, livestock, manufacturing, mining and steam-electric power. The demands are then compared to the existing water supplies of each WUG to determine potential shortages, or needs, by decade. Existing water supplies are legally and physically accessible for immediate use in the event of drought. Projected water demands and existing supplies are compared to identify either a surplus or a need for each WUG.

Table 1-1 summarizes the region's identified water needs in the event of a repeat of drought of the record. Demand management, such as conservation, or the development of new infrastructure to increase supplies are water management strategies that may be recommended by the planning group to meet those needs. This analysis assumes that no strategies are implemented, and that the identified needs correspond to future water shortages. Note that projected water needs generally increase over time, primarily due to anticipated population and economic growth. To provide a general sense of proportion, total projected needs as an overall percentage of total demand by water use category are presented in aggregate in Table 1-1. Projected needs for individual water user groups within the aggregate vary greatly, and may reach 100% for a given WUG and water use category. Detailed water needs by WUG and county appear in Chapter 4 of the 2016 Region J Regional Water Plan.

**Table 1-1 Regional Water Needs Summary by Water Use Category**

| Water Use Category | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Irrigation** | Water Needs (acre-feet per year) | 143 | 143 | 142 | 142 | 141 | 141 |
| | % of the category's total water demand | 1% | 1% | 1% | 1% | 1% | 1% |
| **Livestock** | Water Needs (acre-feet per year) | 214 | 214 | 214 | 214 | 214 | 214 |
| | % of the category's total water demand | 7% | 7% | 7% | 7% | 7% | 7% |
| **Manufacturing** | Water Needs (acre-feet per year) | - | - | - | - | - | - |
| | % of the category's total water demand | - | - | - | - | - | - |
| **Mining** | Water Needs (acre-feet per year) | 38 | 98 | 112 | 76 | 47 | 43 |
| | % of the category's total water demand | 11% | 23% | 25% | 18% | 12% | 11% |
| **Municipal** | Water Needs (acre-feet per year) | 3,462 | 3,768 | 3,925 | 4,033 | 4,143 | 4,228 |
| | % of the category's total water demand | 14% | 14% | 14% | 14% | 14% | 14% |
| **Steam-electric power** | Water Needs (acre-feet per year) | - | - | - | - | - | - |
| | % of the category's total water demand | - | - | - | - | - | - |
| **Total water needs (acre-feet per year)** | | **3,857** | **4,223** | **4,393** | **4,465** | **4,545** | **4,626** |

# 2 Economic Impact Assessment Methodology Summary

This portion of the report provides a summary of the methodology used to estimate the potential economic impacts of future water shortages. The general approach employed in the analysis was to obtain estimates for income and job losses on the smallest geographic level that the available data would support, tie those values to their accompanying historic water use estimate (volume), and thereby determine a maximum impact per acre-foot of shortage for each of the socioeconomic measures. The calculations of economic impacts were based on the overall composition of the economy using many underlying economic "sectors." Sectors in this analysis refer to one or more of the 440 specific production sectors of the economy designated within IMPLAN (Impact for Planning Analysis), the economic impact modeling software used for this assessment. Economic impacts within this report are estimated for approximately 310 of those sectors, with the focus on the more water intense production sectors. The economic impacts for a single water use category consist of an aggregation of impacts to multiple related economic sectors.

## 2.1 Impact Assessment Measures

A required component of the regional and state water plans is to estimate the potential economic impacts of shortages due to a drought of record. Consistent with previous water plans, several key variables were estimated and are described in Table 2-1.

**Table 2-1 Socioeconomic Impact Analysis Measures**

| Regional Economic Impacts | Description |
|---|---|
| **Income losses - value added** | The value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry, sector, or group of sectors within a year. For a shortage, value added is a measure of the income losses to the region, county, or WUG and includes the direct, indirect and induced monetary impacts on the region. |
| **Income losses - electrical power purchase costs** | Proxy for income loss in the form of additional costs of power as a result of impacts of water shortages. |
| **Job losses** | Number of part-time and full-time jobs lost due to the shortage. |
| **Financial Transfer Impacts** | **Description** |
| **Tax losses on production and imports** | Sales and excise taxes (not collected due to the shortage), customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments less subsidies. |
| **Water trucking costs** | Estimate for shipping potable water. |
| **Utility revenue losses** | Foregone utility income due to not selling as much water. |
| **Utility tax revenue losses** | Foregone miscellaneous gross receipts tax collections. |
| **Social Impacts** | **Description** |
| **Consumer surplus losses** | A welfare measure of the lost value to consumers accompanying less water use. |
| **Population losses** | Population losses accompanying job losses. |
| **School enrollment losses** | School enrollment losses (K-12) accompanying job losses. |

### 2.1.1 Regional Economic Impacts

Two key measures were included within the regional economic impacts classification: income losses and job losses. Income losses presented consist of the sum of value added losses and additional purchase costs of electrical power. Job losses are also presented as a primary economic impact measure.

#### *Income Losses - Value Added Losses*

Value added is the value of total output less the value of the intermediate inputs also used in production of the final product. Value added is similar to Gross Domestic Product (GDP), a familiar measure of the productivity of an economy. The loss of value added due to water shortages was estimated by input-output analysis using the IMPLAN software package, and includes the direct, indirect, and induced monetary impacts on the region.

#### *Income Losses - Electric Power Purchase Costs*

The electrical power grid and market within the state is a complex interconnected system. The industry response to water shortages, and the resulting impact on the region, are not easily modeled using traditional input/output impact analysis and the IMPLAN model. Adverse impacts on the region will occur, and were represented in this analysis by the additional costs associated with power purchases from other generating plants within the region or state. Consequently, the analysis employed additional power purchase costs as a proxy for the value added impacts for that water use category, and these are included as a portion of the overall income impact for completeness.

For the purpose of this analysis, it was assumed that power companies with insufficient water will be forced to purchase power on the electrical market at a projected higher rate of 5.60 cents per kilowatt hour. This rate is based upon the average day-ahead market purchase price of electricity in Texas from the recent drought period in 2011.

#### *Job Losses*

The number of jobs lost due to the economic impact was estimated using IMPLAN output associated with the water use categories noted in Table 1-1. Because of the difficulty in predicting outcomes and a lack of relevant data, job loss estimates were not calculated for the steam-electric power production or for certain municipal water use categories.

### 2.1.2 Financial Transfer Impacts

Several of the impact measures estimated within the analysis are presented as supplemental information, providing additional detail concerning potential impacts on a sub-portion of the economy or government. Measures included in this category include lost tax collections (on production and imports), trucking costs for imported water, declines in utility revenues, and declines in utility tax revenue collected by the state. Many of these measures are not solely adverse, with some having both positive and negative impacts. For example, cities and residents would suffer if forced to pay large costs for trucking in potable water. Trucking firms, conversely, would benefit from the transaction. Additional detail for each of these measures follows.

### *Tax Losses on Production and Imports*

Reduced production of goods and services accompanying water shortages adversely impacts the collection of taxes by state and local government. The regional IMPLAN model was used to estimate reduced tax collections associated with the reduced output in the economy.

### *Water Trucking Costs*

In instances where water shortages for a municipal water user group were estimated to be 80 percent or more of water demands, it was assumed that water would be trucked in to support basic consumption and sanitation needs. For water shortages of 80 percent or greater, a fixed cost of $20,000 per acre-foot of water was calculated and presented as an economic cost. This water trucking cost was applied for both the residential and non-residential portions of municipal water needs and only impacted a small number of WUGs statewide.

### *Utility Revenue Losses*

Lost utility income was calculated as the price of water service multiplied by the quantity of water not sold during a drought shortage. Such estimates resulted from city-specific pricing data for both water and wastewater. These water rates were applied to the potential water shortage to determine estimates of lost utility revenue as water providers sold less water during the drought due to restricted supplies.

### *Utility Tax Losses*

Foregone utility tax losses included estimates of uncollected miscellaneous gross receipts taxes. Reduced water sales reduce the amount of utility tax that would be collected by the State of Texas for water and wastewater service sales.

## 2.1.3 Social Impacts

### *Consumer Surplus Losses of Municipal Water Users*

Consumer surplus loss is a measure of impact to the wellbeing of municipal water users when their water use is restricted. Consumer surplus is the difference between how much a consumer is willing and able to pay for the commodity (i.e., water) and how much they actually have to pay. The difference is a benefit to the consumer's wellbeing since they do not have to pay as much for the commodity as they would be willing to pay. However, consumer's access to that water may be limited, and the associated consumer surplus loss is an estimate of the equivalent monetary value of the negative impact to the consumer's wellbeing, for example, associated with a diminished quality of their landscape (i.e., outdoor use). Lost consumer surplus estimates for reduced outdoor and indoor use, as well as residential and commercial/institutional demands, were included in this analysis. Consumer surplus is an attempt to measure effects on wellbeing by monetizing those effects; therefore, these values should not be added to the other monetary impacts estimated in the analysis.

Lost consumer surplus estimates varied widely by location and type. For a 50 percent shortage, the estimated statewide consumer surplus values ranged from $55 to $2,500 per household (residential use), and from $270 to $17,400 per firm (non-residential).

### *Population and School Enrollment Losses*

Population losses due to water shortages, as well as the related loss of school enrollment, were based upon the job loss estimates and upon a recent study of job layoffs and the resulting adjustment of the labor market, including the change in population.[1] The study utilized Bureau of Labor Statistics data regarding layoffs between 1996 and 2013, as well as Internal Revenue Service data regarding migration, to model an estimate of the change in the population as the result of a job layoff event. Layoffs impact both out-migration, as well as in-migration into an area, both of which can negatively affect the population of an area. In addition, the study found that a majority of those who did move following a layoff moved to another labor market rather than an adjacent county. Based on this study, a simplified ratio of job and net population losses was calculated for the state as a whole: for every 100 jobs lost, 18 people were assumed to move out of the area. School enrollment losses were estimated as a proportion of the population lost.

## 2.2 Analysis Context

The context of the economic impact analysis involves situations where there are physical shortages of surface or groundwater due to drought of record conditions. Anticipated shortages may be nonexistent in earlier decades of the planning horizon, yet population growth or greater industrial, agricultural or other sector demands in later decades may result in greater overall demand, exceeding the existing supplies. Estimated socioeconomic impacts measure what would happen if water user groups experience water shortages for a period of one year. Actual socioeconomic impacts would likely become larger as drought of record conditions persist for periods greater than a single year.

### 2.2.1 IMPLAN Model and Data

Input-Output analysis using the IMPLAN (Impact for Planning Analysis) software package was the primary means of estimating value added, jobs, and taxes. This analysis employed county and regional level models to determine key impacts. IMPLAN is an economic impact model, originally developed by the U.S. Forestry Service in the 1970's to model economic activity at varying geographic levels. The model is currently maintained by the Minnesota IMPLAN Group (MIG Inc.) which collects and sells county and state specific data and software. The year 2011 version of IMPLAN, employing data for all 254 Texas counties, was used to provide estimates of value added, jobs, and taxes on production for the economic sectors associated with the water user groups examined in the study. IMPLAN uses 440 sector-specific Industry Codes, and those that rely on water as a primary input were assigned to their relevant planning water user categories (manufacturing, mining, irrigation, etc.). Estimates of value added for a water use category were obtained by summing value added estimates across the relevant IMPLAN sectors

[1] Foote, Andrew, Grosz, Michel, Stevens, Ann. "Locate Your Nearest Exit: Mass Layoffs and Local Labor Market Response." University of California, Davis. April 2015. http://paa2015.princeton.edu/uploads/150194

associated with that water use category. Similar calculations were performed for the job and tax losses on production and import impact estimates.

Note that the value added estimates, as well as the job and tax estimates from IMPLAN, include three components:

- *Direct effects* representing the initial change in the industry analyzed;
- *Indirect effects* that are changes in inter-industry transactions as supplying industries respond to reduced demands from the directly affected industries; and,
- *Induced effects* that reflect changes in local spending that result from reduced household income among employees in the directly and indirectly affected industry sectors.

### 2.2.2 Elasticity of Economic Impacts

The economic impact of a water need is based on the relative size of the water need to the water demand for each water user group (Figure 2-1). Smaller water shortages, for example, less than 5 percent, were anticipated to result in no initial negative economic impact because water users are assumed to have a certain amount of flexibility in dealing with small shortages. As a water shortage deepens, however, such flexibility lessens and results in actual and increasing economic losses, eventually reaching a representative maximum impact estimate per unit volume of water. To account for such ability to adjust, an elasticity adjustment function was used in estimating impacts for several of the measures. Figure 2-1 illustrates the general relationship for the adjustment functions. Negative impacts are assumed to begin accruing when the shortage percentage reaches the lower bound b1 (10 percent in Figure 2-1), with impacts then increasing linearly up to the 100 percent impact level (per unit volume) once the upper bound for adjustment reaches the b2 level shortage (50 percent in Figure 2-1 example).

Initially, the combined total value of the three value added components (direct, indirect, and induced) was calculated and then converted into a per acre-foot economic value based on historical TWDB water use estimates within each particular water use category. As an example, if the total, annual value added for livestock in the region was $2 million and the reported annual volume of water used in that industry was 10,000 acre-feet, the estimated economic value per acre-foot of water shortage would be $200 per acre-foot. Negative economic impacts of shortages were then estimated using this value as the maximum impact estimate ($200 per acre-foot in the example) applied to the anticipated shortage volume in acre-feet and adjusted by the economic impact elasticity function. This adjustment varied with the severity as percentage of water demand of the anticipated shortage. If one employed the sample elasticity function shown in Figure 2-1, a 30% shortage in the water use category would imply an economic impact estimate of 50% of the original $200 per acre-foot impact value (i.e., $100 per acre-foot).

Such adjustments were not required in estimating consumer surplus, nor for the estimates of utility revenue losses or utility tax losses. Estimates of lost consumer surplus relied on city-specific demand curves with the specific lost consumer surplus estimate calculated based on the relative percentage of the city's water shortage. Estimated changes in population as well as changes in school enrollment were indirectly related to the elasticity of job losses.

Assumed values for the bounds b1 and b2 varied with water use category under examination and are presented in Table 2-2.

**Figure 2-1 Example Economic Impact Elasticity Function (as applied to a single water user's shortage)**

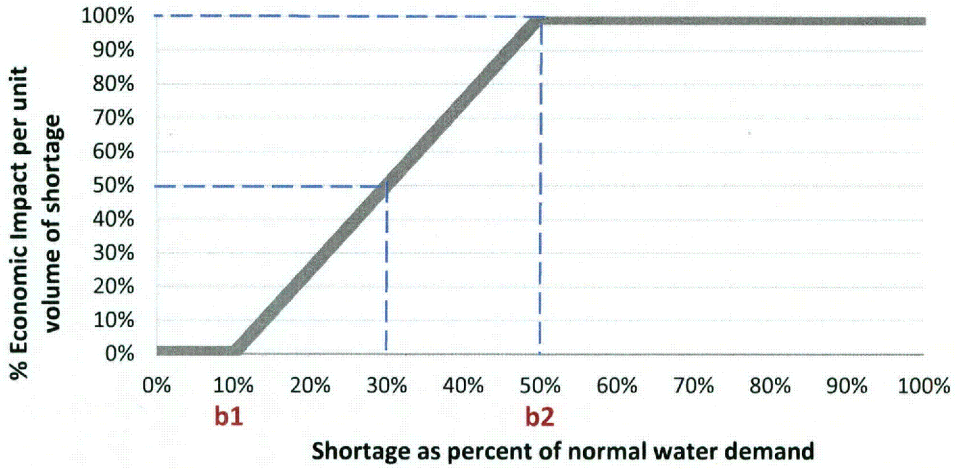


**Table 2-2 Economic Impact Elasticity Function Lower and Upper Bounds**

| Water Use Category | Lower Bound (b1) | Upper Bound (b2) |
|---|---|---|
| Irrigation | 5% | 50% |
| Livestock | 5% | 10% |
| Manufacturing | 10% | 50% |
| Mining | 10% | 50% |
| Municipal (non-residential water intensive) | 50% | 80% |
| Steam-electric power | 20% | 70% |

## 2.3 Analysis Assumptions and Limitations

Modeling of complex systems requires making assumptions and accepting limitations. This is particularly true when attempting to estimate a wide variety of economic impacts over a large geographic area and into future decades. Some of the key assumptions and limitations of the methodology include:

1. The foundation for estimating socioeconomic impacts of water shortages resulting from a drought are the water needs (potential shortages) that were identified as part of the regional water planning process. These needs have some uncertainty associated with them, but serve as a reasonable basis for evaluating potential economic impacts of a drought of record event.

2. All estimated socioeconomic impacts are snapshot estimates of impacts for years in which water needs were identified (i.e., 2020, 2030, 2040, 2050, 2060, and 2070). The estimates are independent and distinct "what if" scenarios for each particular year, and water shortages are assumed to be temporary events resulting from severe drought conditions. The evaluation assumed that no recommended water management strategies are implemented. In other words, growth occurs, future shocks are imposed on an economy at 10-year intervals, and the resulting impacts are estimated. Note that the estimates presented were not cumulative (i.e., summing up expected impacts from today up to the decade noted), but were simply an estimate of the magnitude of annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated supplies and demands for that same decade.

3. Input-output models such as IMPLAN rely on a static profile of the structure of the economy as it appears today. This presumes that the relative contributions of all sectors of the economy would remain the same, regardless of changes in technology, supplies of limited resources, and other structural changes to the economy that may occur into the future. This was a significant assumption and simplification considering the 50-year time period examined in this analysis. To presume an alternative future economic makeup, however, would entail positing many other major assumptions that would very likely generate as much or more error.

4. This analysis is not a cost-benefit analysis. That approach to evaluating the economic feasibility of a specific policy or project employs discounting future benefits and costs to their present value dollars using some assumed discount rate. The methodology employed in this effort to estimate the economic impacts of future water shortages did not use any discounting procedures to weigh future costs differently through time.

5. Monetary figures are reported in constant year 2013 dollars.

6. Impacts are annual estimates. The estimated economic model does not reflect the full extent of impacts that might occur as a result of persistent water shortages occurring over an extended duration. The drought of record in most regions of Texas lasted several years.

7. Value added estimates are the primary estimate of the economic impacts within this report. One may be tempted to add consumer surplus impacts to obtain an estimate of total adverse economic impacts to the region, but the consumer surplus measure represents the change to the wellbeing of households (and other water users), not an actual change in the flow of dollars through the economy. The two categories (value added and consumer surplus) are both valid impacts but should not be summed.

8. The value added, jobs, and taxes on production and import impacts include the direct, indirect and induced effects described in Section 2.2.1. Population and school enrollment losses also indirectly include such effects as they are based on the associated losses in employment. The remaining measures (consumer surplus, utility revenue, utility taxes, additional electrical power purchase costs, and potable water trucking costs), however, do not include any induced or indirect effects.

9. The majority of impacts estimated in this analysis may be considered smaller than those that might occur under drought of record conditions. Input-output models such as IMPLAN only capture "backward linkages" on suppliers (including households that supply labor to directly affected industries). While this is a common limitation in these types of economic impact modeling efforts, it is important to note that "forward linkages" on the industries that use the outputs of the directly affected industries can also be very important. A good example is impacts on livestock operators. Livestock producers tend to suffer substantially during droughts, not because there is not enough water for their stock, but because reductions in available pasture and higher prices for purchased hay have significant economic effects on their operations. Food processors could be in a similar situation if they cannot get the grains or other inputs that they need. These effects are not captured in IMPLAN, which is one reason why the impact estimates are likely conservative.

10. The methodology did not capture "spillover" effects between regions – or the secondary impacts that occur outside of the region where the water shortage is projected to occur.

11. The model did not reflect dynamic economic responses to water shortages as they might occur, nor does the model reflect economic impacts associated with a recovery from a drought of record including:
    a. The likely significant economic rebound to the landscaping industry immediately following a drought;
    b. The cost and years to rebuild liquidated livestock herds (a major capital item in that industry);
    c. Direct impacts on recreational sectors (i.e., stranded docks and reduced tourism); or,
    d. Impacts of negative publicity on Texas' ability to attract population and business in the event that it was not able to provide adequate water supplies for the existing economy.

12. Estimates for job losses and the associated population and school enrollment changes may exceed what would actually occur. In practice, firms may be hesitant to lay off employees, even in difficult economic times. Estimates of population and school enrollment changes are based on regional evaluations and therefore do not accurately reflect what might occur on a statewide basis.

13. The results must be interpreted carefully. It is the general and relative magnitudes of impacts as well as the changes of these impacts over time that should be the focus rather than the absolute numbers. Analyses of this type are much better at predicting relative percent differences brought about by a shock to a complex system (i.e., a water shortage) than the precise size of an impact. To illustrate, assuming that the estimated economic impacts of a drought of record on the manufacturing and mining water user categories are $2 and $1 million, respectively, one should be more confident that the economic impacts on manufacturing are twice as large as those on mining and that these impacts will likely be in the millions of dollars. But one should have less confidence that the actual total economic impact experienced would be $3 million.

# 3 Analysis Results

This section presents a breakdown of the results of the regional analysis for Region J. Projected economic impacts for six water use categories (irrigation, livestock. municipal, manufacturing, mining, and steam-electric power) are also reported by decade.

## 3.1 Overview of the Regional Economy

Table 3-1 presents the 2011 economic baseline as represented by the IMPLAN model and adjusted to 2013 dollars for Region J. In year 2011, Region J generated about $5 billion in gross state product associated with 64,100 jobs based on the 2011 IMPLAN data. These values represent an approximation of the current regional economy for a reference point.

**Table 3-1 Region J Economy**

| Income ($ millions)* | Jobs | Taxes on production and imports ($ millions)* |
|---|---|---|
| $4,967 | 64,121 | $357 |

*[1]Year 2013 dollars based on 2011 IMPLAN model value added estimates for the region.*

The remainder of Section 3 presents estimates of potential economic impacts for each water use category that could reasonably be expected in the event of water shortages associated with a drought of record and if no recommended water management strategies were implemented.

## 3.2 Impacts for Irrigation Water Shortages

Two of the 6 counties in the region are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-2. Note that tax collection impacts were not estimated for this water use category. IMPLAN data indicates a negative tax impact (i.e., increased tax collections) for the associated production sectors, primarily due to past subsidies from the federal government. Two factors led to excluding any reported tax impacts: 1) Federal support (subsidies) has lessened greatly since the year 2011 IMPLAN data was collected, and 2) It was not considered realistic to report increasing tax revenue collections for a drought of record.

**Table 3-2 Impacts of Water Shortages on Irrigation in Region**

| Impact Measure | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses ($ millions)* | $0 | $0 | $0 | $0 | $0 | $0 |
| Job losses | - | - | - | - | - | - |

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

## 3.3 Impacts for Livestock Water Shortages

Five of the 6 counties in the region are projected to experience water shortages in the livestock water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-3. Note that tax impacts are not reported for this water use category for similar reasons that apply to the irrigation water use category described above.

**Table 3-3 Impacts of Water Shortages on Livestock in Region**

| Impact Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses ($ millions)* | $5 | $5 | $5 | $5 | $5 | $5 |
| Jobs losses | 288 | 288 | 288 | 288 | 288 | 288 |

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000*

## 3.4 Impacts for Municipal Water Shortages

Four of the 6 counties in the region are projected to experience water shortages in the municipal water use category for one or more decades within the planning horizon. Impact estimates were made for the two subtypes of use within municipal use: residential, and non-residential. The latter includes commercial and institutional users. Consumer surplus measures were made for both residential and non-residential demands. In addition, available data for the non-residential, water-intensive portion of municipal demand allowed use of IMPLAN and TWDB Water Use Survey data to estimate income loss, jobs, and taxes. Trucking cost estimates, calculated for shortages exceeding 80 percent, assumed a fixed cost of $20,000 per acre-foot to transport water for municipal use. The estimated impacts to this water use category appear in Table 3-4.

**Table 3-4 Impacts of Water Shortages on Municipal Water Users in Region**

| Impact Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses[1] ($ millions)* | $53 | $55 | $56 | $57 | $59 | $61 |
| Job losses[1] | 1,066 | 1,109 | 1,119 | 1,153 | 1,194 | 1,229 |
| Tax losses on production and imports[1] ($ millions)* | $5 | $5 | $5 | $5 | $6 | $6 |
| Consumer surplus losses ($ millions)* | $11 | $11 | $12 | $13 | $13 | $14 |
| Trucking costs ($ millions)* | $0 | $0 | $0 | $0 | $0 | $0 |
| Utility revenue losses ($ millions)* | $9 | $10 | $10 | $10 | $10 | $10 |
| Utility tax revenue losses ($ millions)* | $0 | $0 | $0 | $0 | $0 | $0 |

*[1] Estimates apply to the water-intensive portion of non-residential municipal water use.*
** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

## 3.5 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in the region are projected to occur in none of the 6 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-5.

**Table 3-5 Impacts of Water Shortages on Manufacturing in Region**

| Impacts Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses ($ millions)* | - | - | - | - | - | - |
| Job losses | - | - | - | - | - | - |
| Tax losses on production and Imports ($ millions)* | - | - | - | - | - | - |

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

## 3.6 Impacts of Mining Water Shortages

Mining water shortages in the region are projected to occur in 3 of the 6 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use type appear in Table 3-6.

**Table 3-6 Impacts of Water Shortages on Mining in Region**

| Impact Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income losses ($ millions)* | $5 | $12 | $14 | $7 | $5 | $5 |
| Job losses | 81 | 194 | 236 | 110 | 81 | 81 |
| Tax losses on production and Imports ($ millions)* | $3 | $7 | $8 | $4 | $3 | $3 |

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

## 3.7 Impacts of Steam-Electric Water Shortages

Steam-electric water shortages in the region are projected to occur in none of the 6 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-7.

Note that estimated economic impacts to steam-electric water users:

- Are reflected as an income loss proxy in the form of the estimated additional purchasing costs for power from the electrical grid that could not be generated due to a shortage;
- Do not include estimates of impacts on jobs. Because of the unique conditions of power generators during drought conditions and lack of relevant data, it was assumed that the industry would retain, perhaps relocating or repurposing, their existing staff in order to manage their ongoing operations through a severe drought.
- Does not presume a decline in tax collections. Associated tax collections, in fact, would likely increase under drought conditions since, historically, the demand for electricity increases during times of drought, thereby increasing taxes collected on the additional sales of power.

**Table 3-7 Impacts of Water Shortages on Steam-Electric Power in Region**

| Impact Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| Income Losses ($ millions)* | - | - | - | - | - | - |

** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

## 3.8 Regional Social Impacts

Projected changes in population, based upon several factors (household size, population, and job loss estimates), as well as the accompanying change in school enrollment, were also estimated and are summarized in Table 3-8.

**Table 3-8 Region-wide Social Impacts of Water Shortages in Region**

| Impact Measures | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|
| **Consumer surplus losses ($ millions)*** | $11 | $11 | $12 | $13 | $13 | $14 |
| **Population losses** | 263 | 292 | 302 | 285 | 287 | 294 |
| **School enrollment losses** | 49 | 54 | 56 | 53 | 53 | 54 |

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

# Appendix A - County Level Summary of Estimated Economic Impacts for Region J

County level summary of estimated economic impacts of not meeting identified water needs by water use category and decade (in 2013 dollars, rounded). Values presented only for counties with projected economic impacts for at least one decade.

**** Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000***

| | | Income losses (Million $)* | | | | | | Job losses | | | | | | Consumer Surplus (Million $)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| County | Water Use Category | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| BANDERA | IRRIGATION | $0 | $0 | $0 | $0 | $0 | $0 | - | - | - | - | - | - | - | - | - | - | - | - |
| BANDERA | MUNICIPAL | - | - | - | - | - | - | - | - | - | - | - | - | - | $0 | $0 | $0 | $0 | $0 |
| **BANDERA Total** | | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **$0** | **$0** | **$0** | **$0** | **$0** |
| EDWARDS | MINING | $5 | $5 | $5 | $5 | $5 | $5 | 81 | 81 | 81 | 81 | 81 | 81 | - | - | - | - | - | - |
| EDWARDS | MUNICIPAL | - | - | - | - | - | - | - | - | - | - | - | - | $0 | $0 | $0 | $0 | $0 | $0 |
| **EDWARDS Total** | | **$5** | **$5** | **$5** | **$5** | **$5** | **$5** | **81** | **81** | **81** | **81** | **81** | **81** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| KERR | LIVESTOCK | $4 | $4 | $4 | $4 | $4 | $4 | 238 | 238 | 238 | 238 | 238 | 238 | - | - | - | - | - | - |
| KERR | MINING | $0 | $0 | $0 | $0 | $0 | $0 | - | - | - | - | - | - | - | - | - | - | - | - |
| KERR | MUNICIPAL | $49 | $51 | $52 | $53 | $55 | $57 | 983 | 1,028 | 1,040 | 1,075 | 1,116 | 1,152 | $11 | $11 | $12 | $12 | $13 | $13 |
| **KERR Total** | | **$53** | **$55** | **$55** | **$57** | **$59** | **$61** | **1,221** | **1,266** | **1,278** | **1,313** | **1,354** | **1,390** | **$11** | **$11** | **$12** | **$12** | **$13** | **$13** |
| KINNEY | LIVESTOCK | $0 | $0 | $0 | $0 | $0 | $0 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - |
| **KINNEY Total** | | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **1** | **1** | **1** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **-** |
| REAL | LIVESTOCK | $1 | $1 | $1 | $1 | $1 | $1 | 49 | 49 | 49 | 49 | 49 | 49 | - | - | - | - | - | - |
| REAL | MUNICIPAL | $4 | $4 | $4 | $4 | $4 | $4 | 82 | 80 | 79 | 78 | 77 | 77 | $1 | $1 | $1 | $1 | $1 | $1 |
| **REAL Total** | | **$5** | **$5** | **$5** | **$5** | **$5** | **$5** | **131** | **129** | **127** | **127** | **126** | **126** | **$1** | **$1** | **$1** | **$1** | **$1** | **$1** |
| VAL VERDE | MINING | - | $7 | $9 | $2 | - | - | - | 112 | 155 | 28 | - | - | - | - | - | - | - | - |
| **VAL VERDE Total** | | **-** | **$7** | **$9** | **$2** | **-** | **-** | **-** | **112** | **155** | **28** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **Regional Total** | | **$62** | **$71** | **$75** | **$69** | **$69** | **$71** | **1,435** | **1,591** | **1,643** | **1,551** | **1,563** | **1,599** | **$11** | **$12** | **$12** | **$13** | **$13** | **$14** |

7

# CHAPTER 7
# REGIONAL DROUGHT RESPONSE

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# 7 REGIONAL DROUGHT RESPONSE

Drought is a frequent and inevitable factor in the climate of Texas. Therefore, it is vital to plan for the effect that droughts will have on the use, allocation and conservation of water in the State. Drought management measures have been incorporated as an increasingly important part of water planning at the local, regional and statewide levels. In 2009, the Texas Water Development Board published "Drought Management in the Texas Regional and State Water Planning Process" (http://www.twdb.texas.gov/publications/reports/contracted_reports/doc/0804830819_DroughtMgmt.pdf) which examines the potential benefits and drawbacks of including drought management as a regional water management strategy.

Through the regional water planning process, requirements for drought management planning are found in Title 31 of the Texas Administrative Code (TAC), Part 10, Chapter 357, Subchapter D. Texas Statute reference §357.42 includes requirements regarding drought response information, activities, and recommendations. This chapter examines these specific requirements and identifies significant drought impacts within the Region.

## 7.1 DROUGHT OVERVIEW

The severity of the current drought has significantly impacted the lives of water users, providers and water managers who have been hard-pressed to find solutions to critical supply and demand issues. The severity of the impacts varies, but the overriding sense of urgency to create workable strategies and solutions has been acknowledged and acted upon Statewide. Therefore, it is critical in this planning cycle to address the impact that drought is currently having and will have on the future use, allocation and conservation of water in the State.

There are different types of drought that have been defined in various ways; however, these definitions fall into four primary categories: meteorological, agricultural, hydrological and socioeconomic drought. In the most general sense, drought is a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group or environmental purpose. The State Drought Preparedness Plan provides more specific and detailed definitions and is located at the following link:

https://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/droughtPrepPlan.pdf.

Meteorological drought is quantified by how dry it is (for example, a rain deficit) compared to normal conditions as well as the duration of the dry period. This is typically a region-specific metric, since factors affecting meteorological drought can vary so much in different regions.

Agricultural drought looks at the effects of meteorological drought in terms of agricultural impacts. For example, evapotranspiration, soil moisture and plant stress are measures of agricultural drought, which account for vulnerability of crops through the various growth stages.

Hydrological drought is measured in terms of effects on surface and subsurface waters, such as reservoir stage and capacity, stream flow or groundwater levels in wells. Hydrological drought is usually defined on a river-basin or watershed scale. Hydrological droughts typically lag behind meteorological and agricultural droughts because it takes more time for the evidence of basin-wide impacts to manifest.

Socioeconomic drought occurs when the demand for an economic product (such as hydroelectric power) exceeds supply due to a weather-related deficit. Typically, demand for a good increases with population growth and per capita consumptions. Supply increases due to efficiency technology and the construction of new water projects. If both are increasing, the rate of change between supply and demand is the key. However, when demand exceeds supply, vulnerability is magnified by water shortages during drought.

Several climatological drought indicators have been formulated in order to quantify drought. The Palmer Drought Severity Index (PDSI) was developed in 1965 and is currently used by many federal and state agencies. The PDSI is a soil moisture index that works best in relatively large regions with uniform topography that don't experience extreme climate shifts. PDSI values can lag oncoming drought by several months. The TWDB uses the PDSI to monitor State drought conditions, which has values ranging between -6.0 (driest) to 6.0 (wettest). "Extreme drought" conditions have a PDSI between -6.0 and -4.0, and "severe drought" conditions have a PDSI between -3.99 and -3.0.

An accumulated area graph of the weekly PDSI categories for Texas is included as Figure 7-1. The week of October 4, 2011 has the highest area of the State experiencing extreme drought (88 percent) for the period of record shown (January 2000 through August 2014). Texas did not experience drought conditions from October 2004 through February 2005.

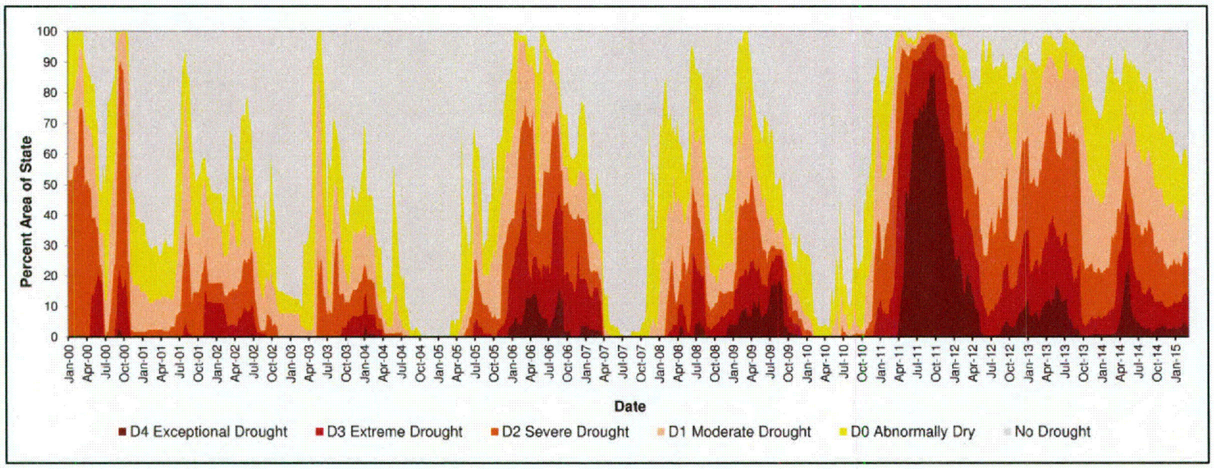
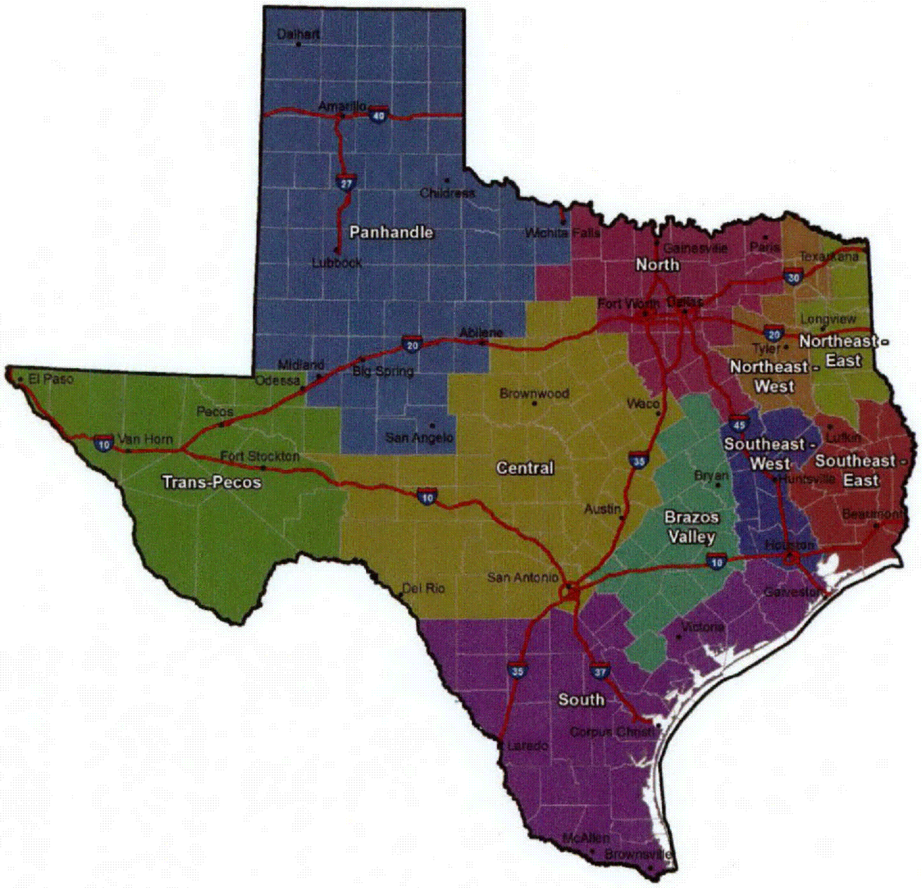



**Figure 7-1. Drought in Texas, 2000-2014**
Source: U.S. Drought Monitor

The Texas A&M Forest Service conducted a survey in 2012 in an attempt to estimate the number of trees lost in Texas after the 2011 drought. The survey considered rural forested area only and did not include trees lost in urban areas. The study split the State into ten regions: Panhandle, Trans Pecos, North, Central, South, Brazos Valley, plus four regions in East Texas (Figure 7-2). The study results indicate that 301 million trees died, with the greatest loss occurring in the Brazos Valley Region, which lost nearly ten percent of trees located on forest land. The Plateau Region is in the Central Region, which lost 6.6 percent of its trees.




| Region | Live trees prior to the drought (million trees) | Drought-related mortality (million trees) | Drought-related mortality (percentage) |
|---|---|---|---|
| Southeast - East | 597.1 | 7.5 | 1.3 |
| Southeast - West | 289.7 | 18.8 | 6.5 |
| Northeast - East | 356.0 | 13.9 | 3.9 |
| Northeast - West | 309.4 | 25.3 | 8.2 |
| North | 370.5 | 30.9 | 8.3 |
| Brazos Valley | 256.4 | 24.9 | 9.7 |
| South | 431.2 | 31.7 | 7.4 |
| Central | 1,540.0 | 102.3 | 6.6 |
| Panhandle | 556.3 | 33.1 | 6.0 |
| Trans-Pecos | 163.4 | 12.2 | 7.5 |
| Total | 4,869.9 | 300.6 | 6.2 |

**Figure 7-2. Texas Tree Mortality Counts in 2012**
Source: Texas A&M Forest Service Survey

The history of drought in Texas has been studied using tree ring data from species such as Douglas Fir, Bald Cypress and Post Oaks located in the Trans-Pecos, the Edwards Plateau and South Central Texas. These data suggest that extended droughts (lasting more than a decade) have occurred in Texas at least once a century since the 1500s (Figure 7-3). A recent study by Cleaveland and others, 2011 (using the PDSI) ranked the current Drought of Record (DOR) from 1948 to 1957 as the second driest since 1500 in the Edwards Plateau. A drought that occurred from 1707 to 1716 has been ranked as the driest, and a drought from 1571 to 1580 was ranked as the third driest in the Edwards Plateau. This study was published in 2011 and does not consider the current drought.

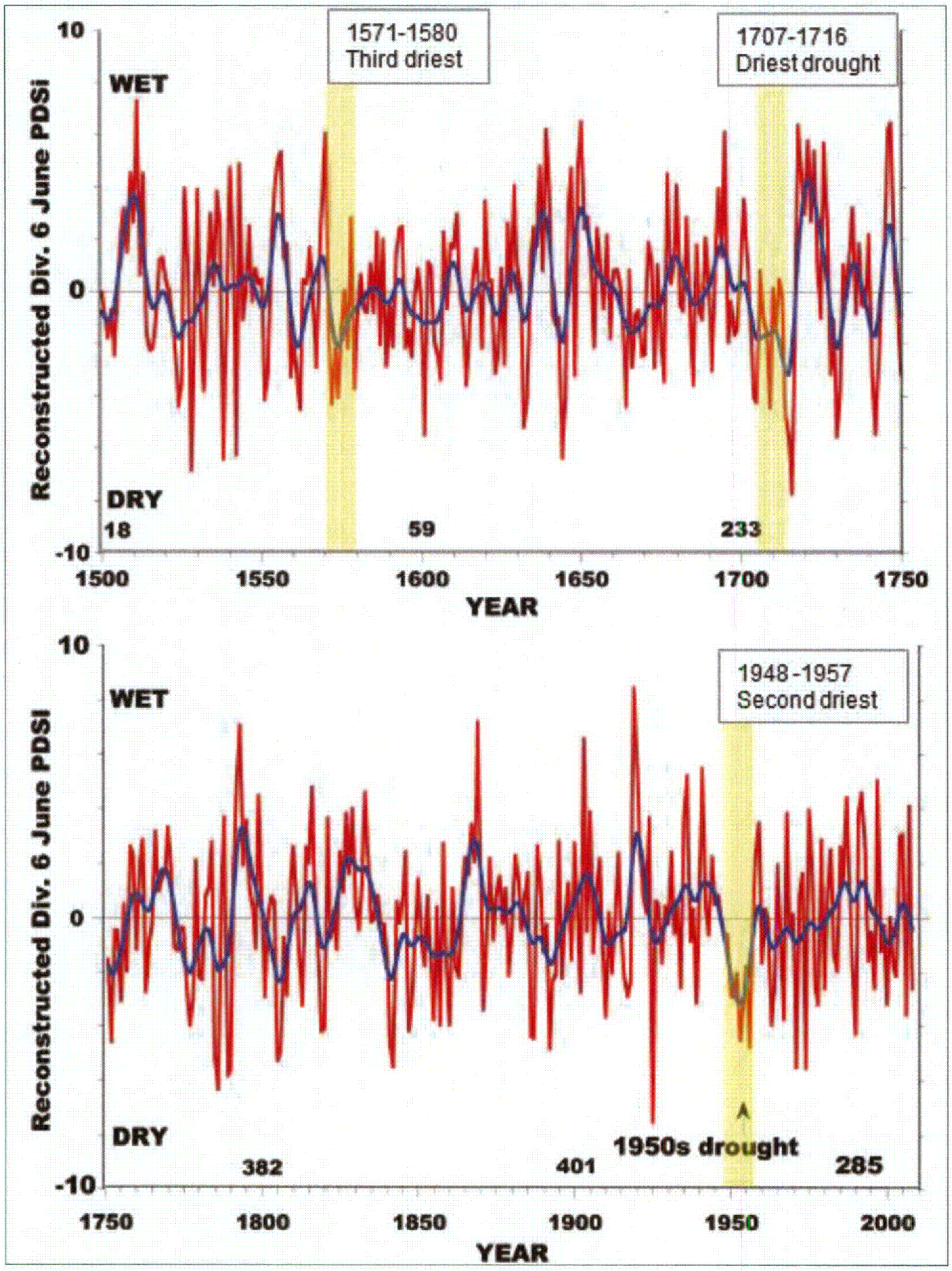



**Figure 7-3. Reconstructed PDSI for Edwards Plateau and Tree Ring Data, Cleveland and other in the Texas Water Journal, Vol 2:54-9**

## 7.2 DROUGHTS IN THE PLATEAU REGION

The climate of the Plateau Region is intermediate to the more humid climates of regions to the east and drier climates of regions to the west. The combination of high temperatures, high potential evapotranspiration and intermediate rainfall totals combine to produce a semi-arid climate with drought conditions during all or parts of some years (Bomar, 1995).

### 7.2.1 Precipitation Indicator

Although residents are generally accustomed to the highly variable climatic conditions typical of the Plateau Region, the relatively low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions.

Comparing the 1950s DOR and the current drought can be done using historic precipitation, stream flow records, spring discharge and water level measurements in wells for locations that have accumulated data measurements since the 1940s.

Precipitation data for quadrangles 807 (west Plateau Region - portions of Edwards, Kinney and Val Verde Counties) and 808 (east Plateau Region - portions of Bandera, Kerr, Real, and Medina Counties) from 1940 through 2013 are shown on Figure 7-4. Average annual rainfall for these quadrangles is 24.6 and 26.5 inches, respectively. These data indicate that the DOR in the 1950s was associated with seven years of below average rainfall (5 inch deficit per year). The current drought indicates a trend toward below average annual rainfall beginning around 2008, but also shows the relatively high-amplitude fluctuation from one year to the next between 2008 and 2013. Years with below average rainfall have a deficit of about 10 inches for the year.

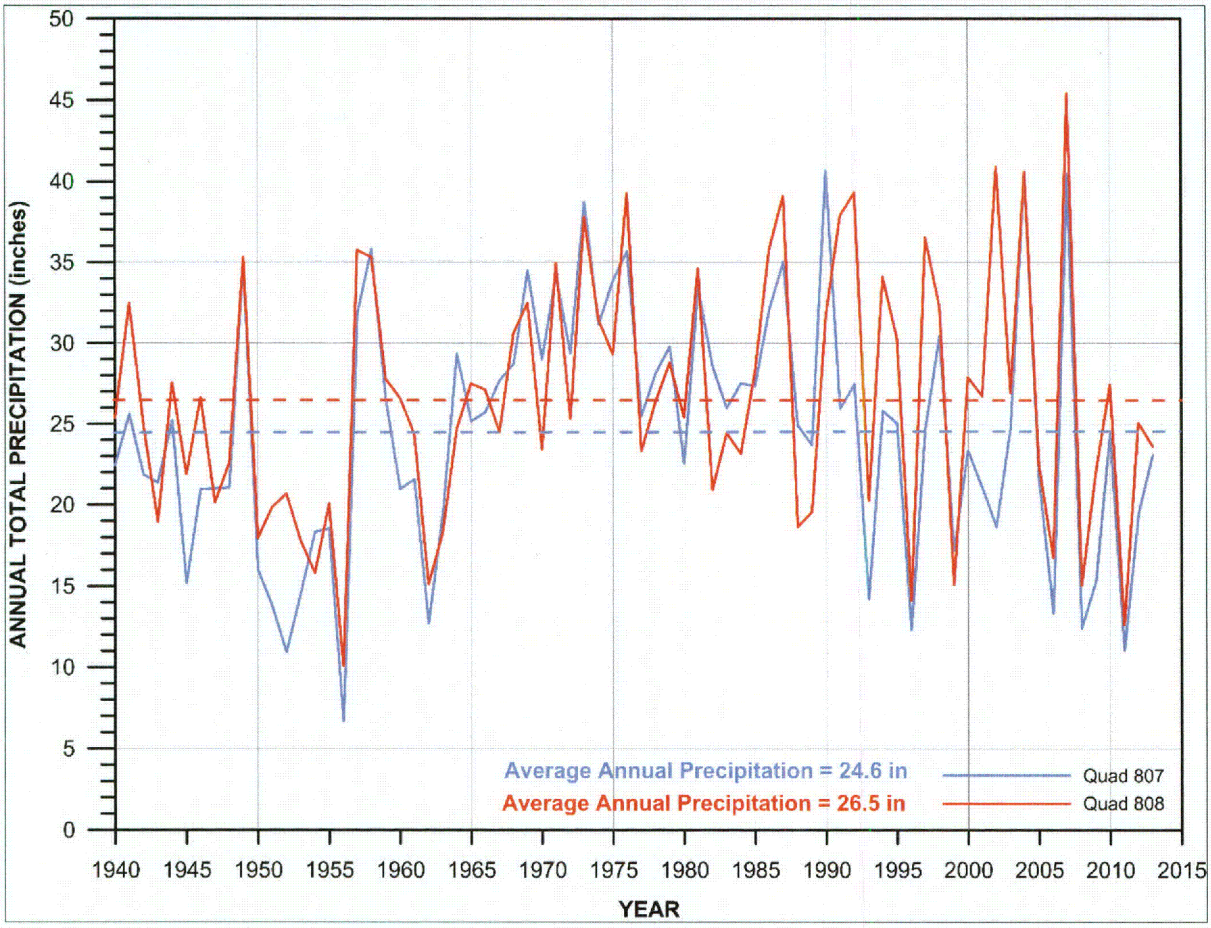



**Figure 7-4. Annual Precipitation, 1940-2013**
Source: TWDB

NWS cooperator station precipitation data was also collected by county for the years during the DOR (1952 through 1958) and the current drought (2006 through 2012). Annual average rainfall by county was grouped by year and by county and is presented in Figure 7-5. One station per county was used to create the graph. This rainfall comparison suggests that the current drought is comparable to the DOR and may possibly be more intense.

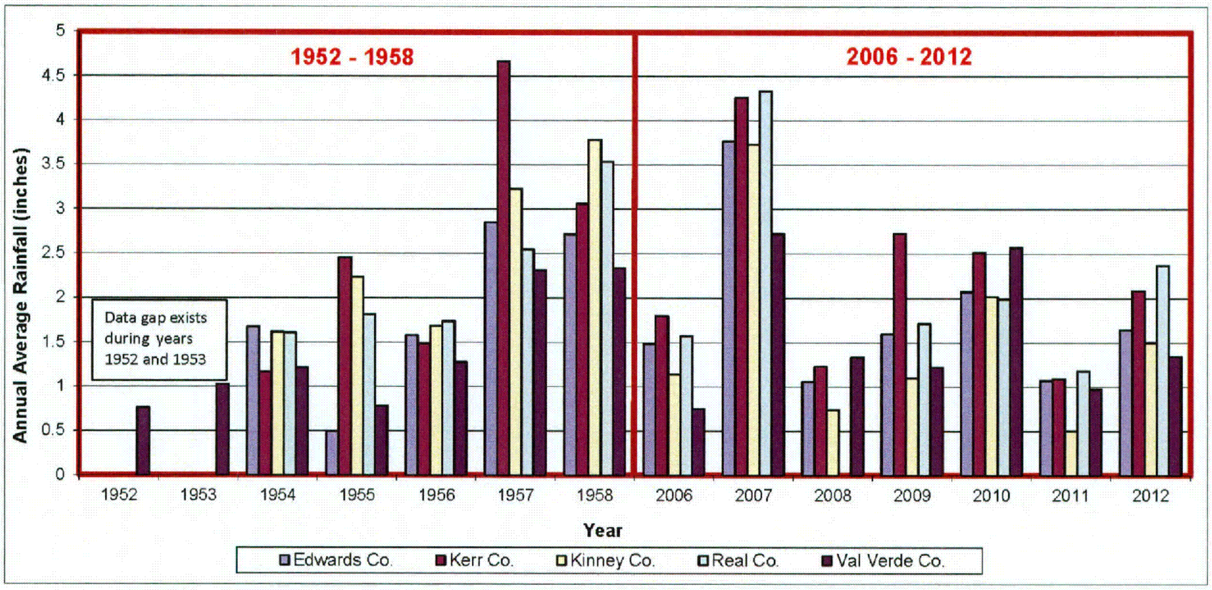



**Figure 7-5. Annual Average Rainfall by County 1952-1958 and 2006-2012**
Source: NWS Coop Stations

### 7.2.2 Stream Flow

The U.S. Geological Survey (USGS) has six stream gages located in or proximal to the Plateau Region that have flow data measurements extending back to 1943 (Figure 7-6). Graphs of the annual mean daily discharge (by calendar year) are presented with the average annual mean daily discharge, in cubic feet per second (cfs). These graphs show that recent stream flow in all river basins decreased suddenly compared to the DOR in the 1950s, and that the decreased flow occurred nearly simultaneously in all basins. Generally, it appears that the current drought is having a more intense and rapid impact on stream flow; however, it is uncertain what portion of the decrease in stream flow can be attributed to a decrease in base flow due to increased groundwater pumping. Also, with the exception of perhaps the West Nueces River gaging station near Brackettville (the most arid station location), there does not appear to be a historical decrease in flow since the DOR as has been observed in the Upper Colorado River basin.

Some general comparisons can be made between the gaging stations during the DOR. It appears that the DOR affected stream flow in the Nueces River basin by 1940, whereas in the Frio and Guadalupe River basins, stream flow was not impacted until after 1940. Since the western counties in the region average about 2 inches of rainfall less than the eastern counties, this impact lag is somewhat intuitive but worth noting nonetheless. Also, a mini-drought or subsequent drought period is apparent in the 1960s. The stream flow data in the Frio, Sabinal and Guadalupe River basins illustrate this more readily than the gages located in the Nueces River basin. Additionally, the gaging data highlights the gradual decrease in stream flow that can be seen during the DOR in the 1950s compared to the sudden decrease of flow that is evident in the recent flow data.

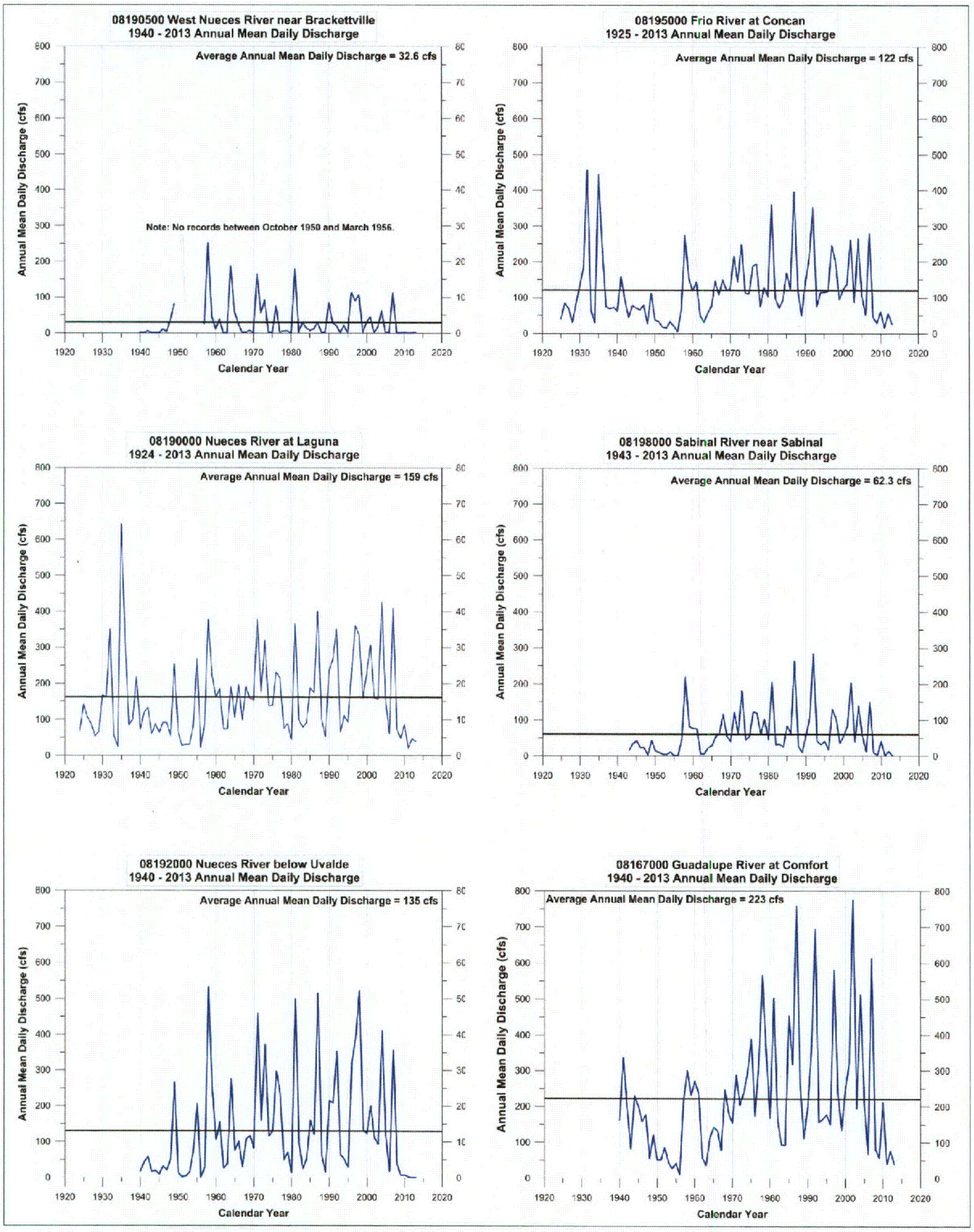



**Figure 7-6. Historic Streamflow Gaging Data**
Source: USGS

### 7.2.3 Spring Discharge Indicator

Historic spring flow at USGS station 0846300 – Las Moras Springs at Brackettville - is available for years 1895 through 2014. These data are shown on Figure 7-7. The available data are instantaneous discharge measurements which do not necessarily occur on a regularly scheduled interval. Spring discharge has dropped below 5 cfs numerous times since 1952 (1953, 1956, 1963, 1964, 1966, 1967, 1969, 1971, 1976, 1978, 1980, 1989, 1995, 1996, 2000, 2006, 2011, 2012 and 2014). The periods with flow less than 5 cfs typically lasted for up to 3 months. The only exception is a ten month period between July 2012 and May 2013. The last measurement on the graph is 1.3 cfs measured on June 12, 2014. A few zero measurements have also occurred (1964, 1967, 1971 and 1996). Most of these occurrences appear to have lasted less than 6 weeks.

San Felipe Springs discharge data were not used because the construction of Lake Amistad in 1968 permanently affected the spring discharge measurements and therefore comparison between the current drought and the DOR would be difficult.

It is uncertain how much of the low flow at Las Moras can be attributed to the anthropological impacts on drought indicators, such as increased groundwater pumping due to drought conditions and increased demands since the 1950s.

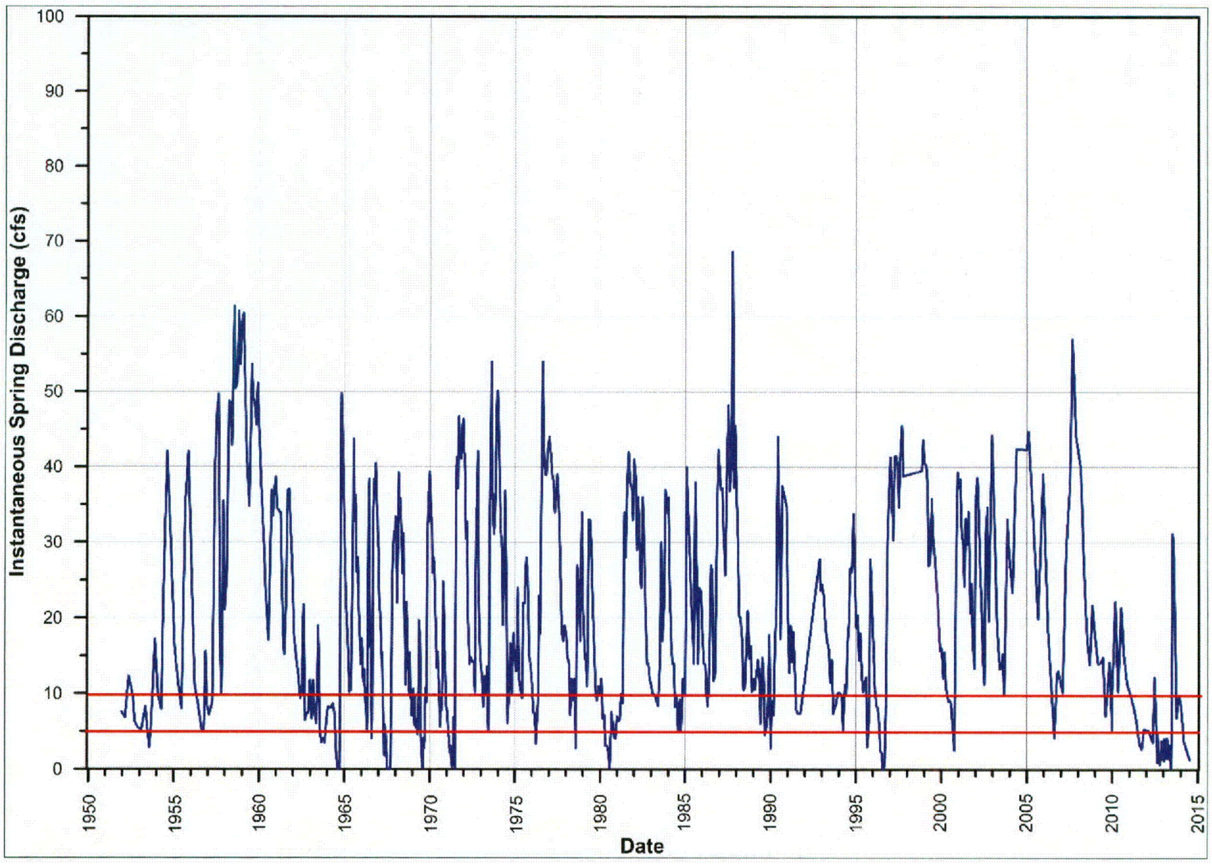



**Figure 7-7. Historic Discharge Measurements at Las Moras Springs**
Source: USGS Groundwater Level Indicator

### 7.2.4 Groundwater Level Indicator

Figure 7-8 and Table 7-9 compare daily water level data from existing real-time monitoring wells with daily precipitation data from nearby NWS Cooperative Weather Stations to illustrate aquifer response to precipitation events. Figure 7-8 represents a well in the Edwards-Trinity (Plateau) Aquifer in Val Verde County. The data suggests that response time in the aquifer is quite rapid and occurs within a few days. It also suggests that the aquifer response appears somewhat dampened when rainfall occurs after a long dry spell, even though the water level in the well have remained relatively constant during the dry conditions. Note that the water levels in the aquifer remain relatively constant and do not begin to decline significantly until May 2014. It is uncertain whether this is primarily a function of decreased rainfall or increased pumping. It is likely due to a combination of factors.

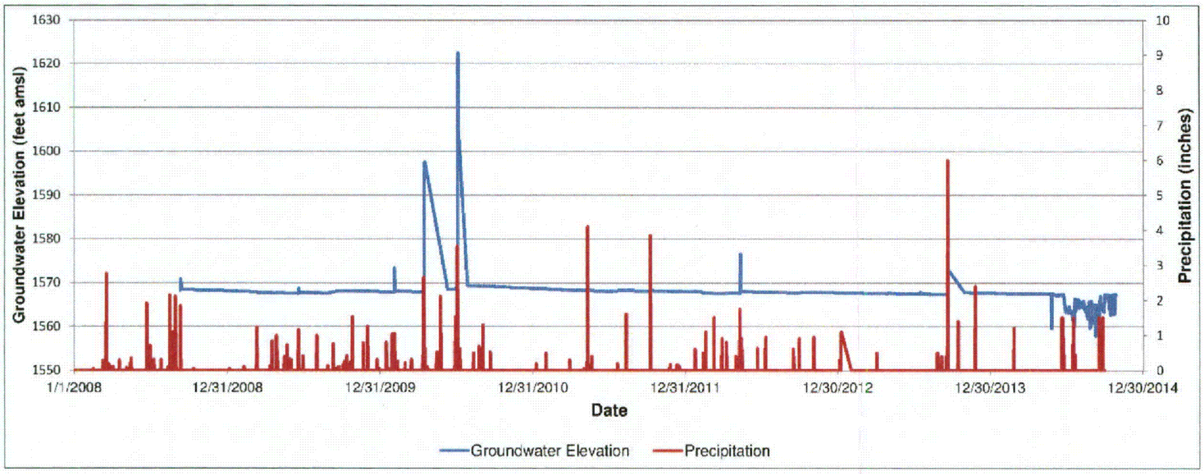



**Figure 7-8. Daily Groundwater Elevation and Daily Precipitation, Edwards-Trinity (Plateau), Val Verde County**

Table 7-9 shows a well completed in the Trinity Aquifer in Real County near Leakey, Texas. Three peak rainfall events dates have been marked on the graph as well as the subsequent groundwater elevation peaks and the dates on which they occurred. These data show that it takes between seven and nine months for the aquifer to respond to precipitation. The last significant rainfall event captured by the data occurred in May 2014 and the subsequent aquifer response is beyond the data limits. The cause for variation in response time is unknown but is likely attributable to seasonal variation in pumping and total rainfall for the previous year. Total water level decline in the well is over 70 feet in a span of seven years. This is likely due to drought conditions in addition to population growth which both contribute to increased pumping.

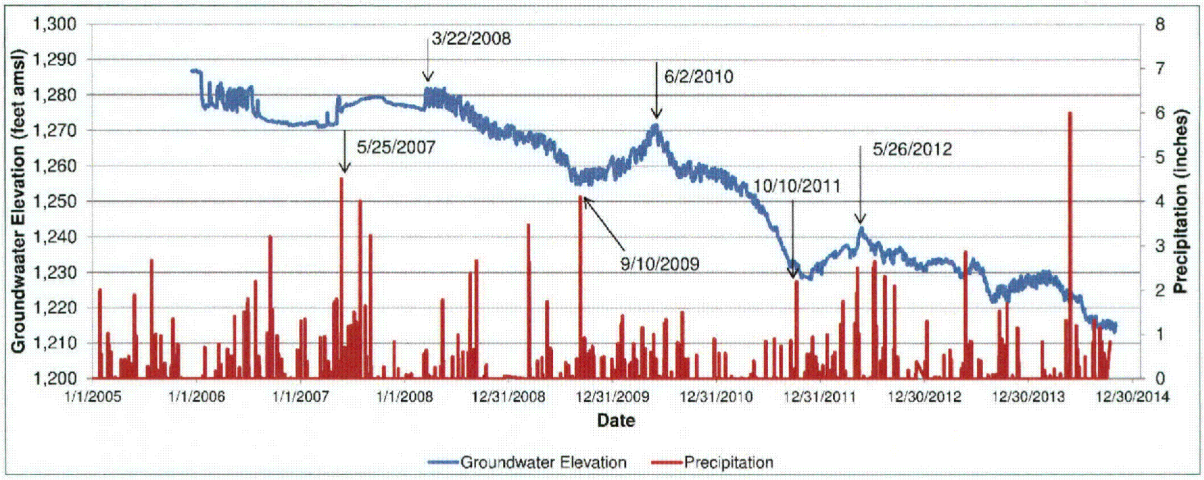



**Figure 7-9. Daily Groundwater Elevation and Daily Precipitation, Trinity Aquifer, Real County**

### 7.2.5 Plateau Region Drought of Record

For the purpose of this planning cycle, the drought of the 1950s is declared the Drought of Record. It is impossible to state whether the current drought ultimately will become the new DOR because we do not know how many years the current drought will last. The DOR in the 1950s lasted for many years so it may be a while before that distinction can be made.

The catalyst for the current drought can be attributed primarily to rainfall deficit (meteorological drought). The hydrological drought that has occurred as a result of rainfall deficit is evident in the decrease in stream flow and spring discharge data that has been presented. However, the greatest unknown factor that these data collectively point to is the impact that can be attributed to anthropological factors.

The hydrological drought (impact on surface waters and groundwater) is a result of both meteorological and socioeconomic drought. To reiterate, socioeconomic drought occurs when demand exceeds supply due to a weather-related deficit. Typically, demand for a product increases with population growth and per capita consumptions. Supply increases due to efficiency technology and the construction of new water projects. If both are increasing, the rate of change between supply and demand is the key. However, when demand exceeds supply, vulnerability is magnified by water shortages during drought.

In future planning cycles, it would be interesting to attempt to quantify how much anthropological factors exacerbate drought severity. Suggested areas of investigation include: base flow studies, sub-watershed scale water balance calculations, and rainfall deficit quantification.

# 7.3 CURRENT DROUGHT PREPARATIONS AND RESPONSE

As mandated by 31 TAC 357.42(a)&(b), this section of the RWP summarizes and assesses all preparations and drought contingency plans that have been adopted by municipalities and GCDs within the Plateau Region. The summary includes what specific triggers are used to determine the onset of each defined drought stage and the associated response actions that have been developed by local entities to decrease water demand during the particular drought stage.

Because of the range of conditions that affected the more than 4,000 water utilities throughout the State in 1997, the Texas Legislature directed the TCEQ to adopt rules establishing common drought plan requirements for water suppliers. As a result, TCEQ requires all wholesale public water providers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to submit drought contingency plans (DCPs). In addition, many Groundwater Conservation Districts also have DCPs that provide education and voluntary action recommendations.

Wholesale water providers and retail public water suppliers serving less than 3,300 connections are now required to prepare and administer DCPs no later than May 1, 2014. Plans are required to be made available for inspection upon request.

DCPs are intended to establish criteria to identify when water supplies may be threatened and the actions that should be taken to ensure these potential threats are minimized. A common feature of drought contingency plans is a structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply decreases and water demand increases. This measured or gradual approach allows for timely and appropriate action as a water shortage develops. The onset and termination of each implementation stage should be defined by specific "triggering" criteria. Triggering criteria are intended to ensure that: 1) timely action is taken in response to a developing situation, and 2) the response is appropriate to the level of severity of the situation. Each water-supply entity is responsible for establishing its own DCP that includes appropriate triggering criteria and responses.

## 7.3.1 Drought Response Triggers

Drought response triggers should be specific to each water supplier and should be based on an assessment of the water user's vulnerability. In some cases it may be more appropriate to establish triggers based on a supply source volumetric indicator such as a lake surface elevation or an aquifer static water level. Similarly, triggers might be based on supply levels remaining in an elevated or ground storage tank within the water distribution system; this is not a recommended approach, as the warning of supply depletion would be only three to four days. Triggers based on demand levels can also be effective, if the demands are very closely and frequently monitored. Whichever method is employed, trigger criteria should be defined on well-established relationships between the benchmark and historical experience. If historical observations have not been made then common sense must prevail until such time that more specific data can be presented.

## 7.3.2 Surface Water Triggers

Surface water sources are among the first reliable indicators of the onset of hydrologic drought, as defined in Section 1.2.5. Diminished spring discharge and stream flow, for example, can be monitored daily by city, county, and state agencies. Of particular interest, however, are the levels to which spring discharge and stream flow are reduced before the onset of drought is declared and appropriate response measures are initiated in the region. Cities that rely exclusively on spring flow for municipal water are particularly vulnerable to drought-induced reductions in discharge, especially if alternative sources of supply have not been developed to make up potential shortfalls created by lower discharge. As an operating definition of hydrologic drought, it is recommended that reductions of spring discharge between 25 percent and 33 percent (compared with average discharge and flow) be considered effective hydrologic drought triggers in the Plateau Region. For example, surface water triggers are used in conjunction with system capacity triggers by the City of Del Rio (see section 7.3.4).

### 7.3.3 Groundwater Triggers

Groundwater triggers that indicate the onset of drought are not as easily identified as factors related to surface-water systems. This is attributable to (1) the rapid response of stream discharge and reservoir storage to short-term changes in climatic conditions within a region and within adjoining areas where surface drainage originates, and (2) the typically slower response of groundwater systems to recharge processes. Although climatic conditions over a period of one or two years might have a significant impact on the availability of surface water, aquifers of the same area might not show comparable levels of response for much longer periods of time, depending on the location and size of recharge areas in a basin, the distribution of precipitation over recharge areas, the amount of recharge, and the extent to which aquifers are developed and exploited by major users of groundwater. It is recognized, however, that karstic formations such as the Edwards-Trinity (Plateau) may produce rapid recharge rates in aquifers.

With the exception of the Trinity Aquifer of Bandera and Kerr Counties, all other aquifers in the rural counties are unlikely to experience significant water-level declines, based on comparisons between projected water demand, aquifer recharge and storage. In these areas, water levels are expected to remain constant or relatively constant over the 50-year planning period (see Figure 7-8). Observation wells in major recharge areas and in areas adjacent to municipal well fields in the rural counties might provide a sufficient number of points to monitor water levels, provided that water-level measurements are made on a regular basis for long periods of time. Water levels below specified elevations for a pre-determined period of time might be interpreted to be reasonable groundwater indicators of drought conditions in any basin.

Basins that do not receive sufficient recharge to offset natural discharge and pumpage may be depleted of groundwater (e.g., mined). This is especially the case with the Trinity Aquifer of Bandera and Kerr Counties. The rate and extent of groundwater mining in any area are related to the timeframe and the extent to which withdrawals exceed recharge. In such basins, water levels may fall over long periods of time, eventually reaching a point at which the cost of lifting water to the surface becomes an economical concern. Thus, water levels in such areas may not be a satisfactory drought trigger. Instead, communities might consider the rate at which water levels decline in response to increased demand as a sufficient indicator of drought. Entities that utilize groundwater triggers include: Bandera, Rocksprings, Ingram, Loma Vista Water Supply, Brackettville and Fort Clark Springs MUD.

### 7.3.4 System Capacity Triggers

Because of the above described problems with using water levels as drought-condition indicators, several municipal water-supply entities in the Plateau Region that rely on groundwater generally establish drought-condition triggers based on levels of demand that exceed a percentage of the systems production capacity. Rocksprings, Ingram (Aqua Texas), Loma Vista Water System, Camp Wood, City of Del Rio and City of Kerrville utilize drought triggers that consider demand and system capacity components.

For example, the City of Del Rio has determined triggers based upon a baseline plant operational capacity of 18.2 mgd and spring discharge as shown in Figure 7-10. Mild (stage 1) response is triggered when spring flow is 40 mgd, moderate (stage 2) at 30 mgd, severe (stage 3) at 25 mgd and critical (stage 4) at 20 mgd.

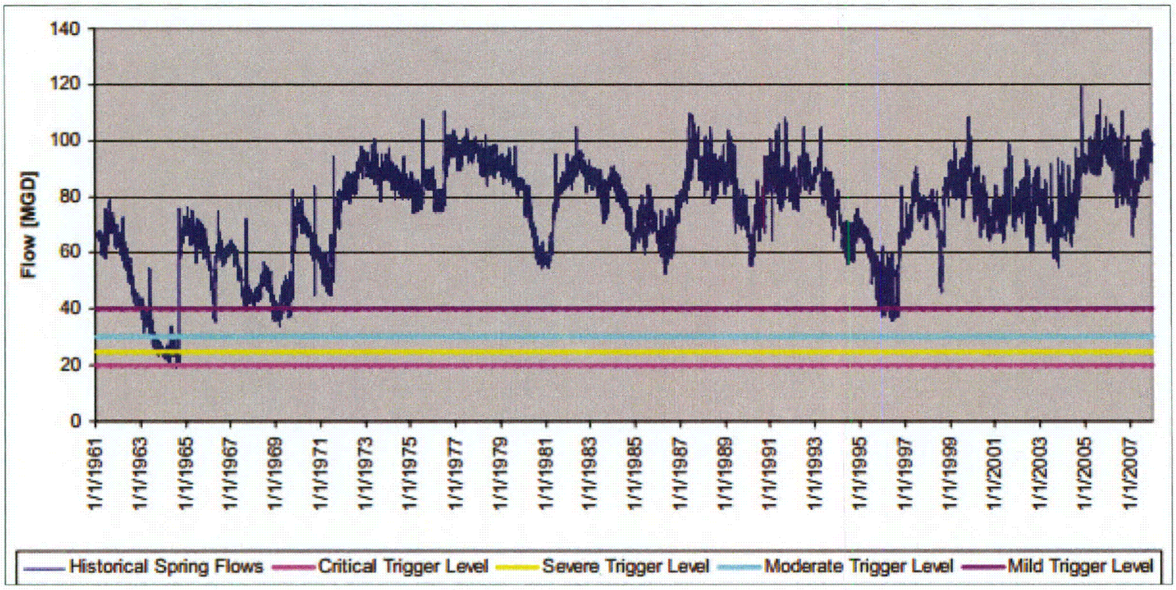



**Figure 7-10. City of Del Rio Drought Triggers**
Source: City of Del Rio

### 7.3.5 Municipal and Wholesale Water Provider Drought Contingency Plans

The TCEQ requires all retail public water suppliers serving 3,300 connections or more and wholesale public water providers to submit a drought contingency plan as a way to prepare and respond to water shortages. The amended *Title 30, Texas Administrative Code, Chapter 288* became effective on December 6, 2012 addressing TCEQ's guidelines and plan requirements. The forms for wholesale public water providers, retail public water suppliers and irrigation districts are available at:

http:// www.tceq.state.tx.us/permitting/water_supply/water_rights/contingency.html.

Drought contingency plans for municipal uses by public water suppliers must document coordination with the regional water planning groups to ensure consistency with the regional water plans. The following entities have prepared drought contingency plans which are assessable at the specified websites:

- City of Bandera (http://cityofbandera.org)
- City of Kerrville (http://kerrvilletx.gov)
- City of Rocksprings (http://edwardscountychamber.org)
- City of Camp Wood
- Wiedenfeld Water Works (http://wiedenfeldwater.com)
- City of Ingram (Aqua Texas) (http://aquaamerica.com)
- Loma Vista Water System (Aqua Texas) (http://aquaamerica.com)
- City of Brackettville (http://thecityofbrackettville.com)
- Fort Clark Springs Municipal Water District
- City of Del Rio (Wholesale Water Provider) (http://cityofdelrio.com)
- City of Leakey

A list of entities, their supply source, specific triggers and actions, for each drought stage is provided in Table 7-1. DCPs were not provided to the Regional Planning Group by Laughlin AFB.

**Table 7-1. Municipal Mandated Drought Triggers and Actions**

| Water Supply Entity | Water Supply Source | Drought Trigger | Drought Stage and Response | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mild | Moderate | Severe | Critical | Emergency |
| City of Bandera | Trinity | Multi-stage drop in water levels in the Dallas Street Municipal Well. | Voluntary conservation May 1 - Sept 30. | Depth to water between 516 and 531 feet. | Depth to water between 532 and 546 feet. | Depth to water between 547 and 566 feet. | Depth to water below 567 feet, or system failure. |
| | | | Voluntary usage reduction. | Reduce demand by 20%. | Reduce demand by 35%. | Reduce demand by 50%. | Reduce demand by 90%. |
| City of Rocksprings | Edwards-Trinity (Plateau) | Based on a comparison of the daily water demand to the static water level of the Sharp Well. | Depth to water reaches 429 feet for 3 consecutive days. | Depth to water reaches 445 feet for 3 consecutive days. | Depth to water reaches 461 feet for 3 consecutive days. | N/A | Depth to water reaches 477 feet for 3 consecutive days. |
| | | | Reduce demand by 10%. | Reduce demand by 20%. | Reduce demand by 30%. | N/A | Notify state emergency response officials. |
| City of Kerrville | Upper Guadalupe River and Trinity Aquifer | Based on a comparison of demand and system's safe operating capacity, which is the maximum amount of water the city can safely deliver to the distribution system. Safe capacity is calculated using the following sources: 1) the WTP, 2) ASR, 3) City wells and 4) other potable sources. | Seven-day average demand exceeds 65% of the system's safe operating capacity. | Seven-day average demand exceeds 75% of the system's safe operating capacity. | Seven-day average demand exceeds 85% of the system's safe operating capacity. | Seven-day average demand exceeds 95% of the system's safe operating capacity. | Seven-day average demand exceeds 100% of the system's safe operating capacity. |
| | | | Implement landscape watering schedule; no operation of fountains/ponds. | Landscape watering with hand held hose only; non-essential water use prohibited. | No application for new, additional, or expanded water service connections. | Landscape watering with potable water prohibited. | Allocation of available water; notify state emergency response officials. |
| City of Ingram (Aqua Texas) | Trinity | Demand-based triggers include the following components: 1) percent of water treatment capacity, 2) total daily demand as percent of pumping capacity, 3) storage capacity (tank level) and 4) well pump run time. | Voluntary conservation late Spring and Summer. | 75%, tank level within 4 feet of low-level lock out, 16 hours. | 85%, tank level within 3 feet of low-level lock out, 20 hours. | 95%, tank level reaches low-level lock out, 22 hours. | |
| | | | Reduce demand by 5%. | Reduce demand by 10%. | Reduce demand by 20%. | Reduce demand by 40%. | N/A |

**Table 7-1. (Continued) Municipal Mandated Drought Triggers and Actions**

| Water Supply Entity | Water Supply Source | Drought Trigger | Drought Stage and Response | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mild | Moderate | Severe | Critical | Emergency |
| City of Ingram (Aqua Texas) | Purchased supply | Supply-based triggers are utilized for systems Aqua provides water from either a district, authority or wholesale supplier. | Upon notification by district, authority, or wholesale supplier, Aqua may implement equivalent stage and restrictions. | | | | |
| City of Brackettville | Edwards-Trinity (Plateau) | Multi-stage drop in water levels in city well. | Depth to water reaches 50 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 65 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 85 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 110 feet or less while pumping (based on 10-day moving average). | |
| | | | Reduce demand by 10%. | Reduce demand by 15%. | Reduce demand by 25%. | N/A | Notify state emergency response officials. |
| Fort Clark Springs Municipal Water District | Edwards-Trinity (Plateau) | Multi-stage drop in water levels in municipal well. | Depth to water reaches 25 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 35 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 50 feet or less while pumping (based on 10-day moving average). | Depth to water reaches 75 feet or less while pumping (based on 10-day moving average). | |
| | | | Voluntary - reduce demand by 10%. | Reduce demand by 15%. | Reduce demand by 25%. | N/A | Notify state emergency response officials. |
| City of Camp Wood | Spring flow from Edwards-Trinity (Plateau) | Base on system capacity limits. | Low distribution pressure for more than 6 hours. | Demand exceeds 70% of safe operating capacity (based on seven-day average). | Demand exceeds 80% of safe operating capacity (based on seven-day average). | Demand exceeds 90% of safe operating capacity (based on seven-day average). | Major system failures or supply contamination. |
| | | | Voluntary - reduce demand by 6%. | Reduce demand by 6%. | Reduce demand by 11%. | Reduce demand by 20%. | Reduce demand by 30%. |
| City of Leakey | Frio River Alluvium | | NO DCP | | | | |

**Table 7-1. (Continued) Municipal Mandated Drought Triggers and Actions**

| Water Supply Entity | Water Supply Source | Drought Trigger | Drought Stage and Response | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mild | Moderate | Severe | Critical | Emergency |
| City of Del Rio | San Felipe Springs Edwards-Trinity (Plateau) | Water levels in Bedell Street Storage Reservoirs are less than a designated depth; San Felipe Spring flow drops below a specific flow rate. | Water levels are less than 100 % full; San Felipe Spring flow is less than 40 mgd. | Water levels are less than 30 feet; San Felipe Spring flow is less than 25 mgd. | Water levels are less than 25 feet; San Felipe Spring flow is less than 20 mgd. | Water levels are less than 20 feet; San Felipe Spring flow is less than 15 mgd. | Water levels are less than 15 feet; San Felipe Spring flow is less than 10 mgd. |
| | | | Reduce demand to 95% of the 30 day average prior to initiation. | Reduce demand to 90% of the 30 day average prior to initiation. | Reduce demand to 80% of the 30 day average prior to initiation. | Reduce demand to 70% of the 30 day average prior to initiation. | Notify state emergency response officials. |
| Wiedenfeld Water Works | Trinity (HGCD MW-7, HGCD MW-11, HGCD MW-ISD, Cedar Springs well, 169 Greenwood well, CCGCD Langford, and EAA J17 well). | Cumulative point system based upon water levels and daily pumping time (in minutes) in 7 different wells. Two if the wells monitor both upper and lower Trinity water levels. | | 3 points | 6 points | 8 points | |
| | | | N/A | Reduce non-essential & outdoor use by 50% of summer water use. | Elimination of non-essential & outdoor use. | Allocation of available water. | N/A |
| Loma Vista Water Supply (Aqua Texas) | Trinity | Demand-based triggers include the following components: 1) percent of water treatment capacity, 2) total daily demand as percent of pumping capacity, 3) storage capacity (tank level) and 4) well pump run time. | Voluntary conservation late Spring and Summer. | 75%, tank level within 4 feet of low-level lock out, 16 hours. | 85%, tank level within 3 feet of low-level lock out, 20 hours. | 95%, tank level reaches low-level lock out, 22 hours. | |
| | | | Reduce demand by 5%. | Reduce demand by 10%. | Reduce demand by 20%. | Reduce demand by 40%. | N/A |
| | Purchased supply | Supply-based triggers are utilized for systems Aqua provides water from either a district, authority or wholesale supplier. | Upon notification by district, authority, or wholesale supplier, Aqua may implement equivalent stage and restrictions. | | | | |

### 7.3.6 Groundwater Conservation District Drought Contingency Plans

A discussion of the creation and the goals of the four Groundwater Conservation Districts (GCDs) formed in the Plateau Region are discussed in more detail in Chapter 5, Section 5.3.4. This section will focus on summarizing drought management by the Districts.

Four districts are currently in operation within the planning region:

- Bandera County River Authority and Groundwater District (http://bcragd.org)
- Headwaters Groundwater Conservation District (Kerr County) (http://hgcd.org)
- Kinney County Groundwater Conservation District (http://kinneycogcd-state-tx.us)
- Real-Edwards Conservation and Reclamation District (http://recrd.org)

Groundwater Conservation Districts are required to define management goals that specifically address drought conditions within their groundwater management plans. These are delineated via management objectives and performance standards. Drought Contingency Plans have also been adopted by three of the four GCDs in the Plateau region. Following are the District's drought management objectives.

#### 7.3.6.1 Bandera County River Authority and Groundwater District

**Management Objective 1** – Record the Palmer Drought Severity Index once at the first of the month and when drought conditions exist, implement to Drought Management Plan as adopted in April 2009.

**Management Objective 2** – Evaluate groundwater availability each year by monitoring water levels of the aquifer from at least six monitor wells with continuous recorders within Bandera County.

The District has implemented a drought management plan to aid in groundwater conservation and is designed to reduce pumpage of the aquifer during the different drought stages. The triggers and actions incorporated into the drought plan are summarized in Table 7-2. These five drought stages are mandated restrictions for permitted wells and recommended restrictions for exempt wells.

**Table 7-2. Bandera County River Authority and Groundwater District Drought Triggers and Actions**

| Stage & Description | 1 – Mild | 2 – Moderate | 3 – Severe | 4 – Extreme | 5 - Exceptional |
|---|---|---|---|---|---|
| Trigger | Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. | | | | |
| Conservation Goal (percent reduction in pumpage) | 10% | 20% | 30% | 40% | 50% |

### 7.3.6.2 Headwaters Groundwater Conservation District

**Management Objective** – Monitor drought conditions by reviewing aquifer data monthly and declaring drought stages based on the District's defined drought triggers.

The District has implemented a drought management plan to aid in groundwater conservation and is designed to reduce pumpage of the aquifer during the different drought stages. The triggers and actions incorporated into the drought plan are summarized in Table 7-3.

**Table 7-3. Headwaters Groundwater Conservation District Drought Triggers and Actions**

| Stage & Description | 1 – Mild | 2 – Moderate | 3 – Severe | 4 – Extreme |
|---|---|---|---|---|
| Trigger | 1410 feet amsl | 1400 feet amsl | 1390 feet amsl | 1380 feet amsl |
| Conservation Goal (percent reduction in pumpage) | 10% | 20% | 30% | 40% |

The HGCD Drought Index Levels which are the average water level in 4 selected monitor wells (Stonehenge, HGCD MW #11 Middle Trinity, County Agriculture Barn, and HGCD MW # 7 Middle Trinity). The District will also monitor and consider the Palmer Drought Severity Index (PDSI) and the Guadalupe River Flow Rate at Kerrville in initiating drought stages and notices of impending drought or extremely dry conditions. Drought stages may be initiated at the discretion of the District depending on the ability of the City of Kerrville to draw surface water from the Guadalupe River.

These four drought stages invoke mandated restrictions for permitted wells and recommended restrictions for exempt wells.

### 7.3.6.3 Kinney County Groundwater Conservation District

Management Objective – Once a month, the District will download the latest drought information from the National Weather Service – Climate Prediction Center website. A report on the drought data obtained from the National Weather Service will be included in the regular monthly meeting agenda and retained in the meeting minutes kept at the District office.

### 7.3.6.4 Real-Edwards Conservation and Reclamation District

Management Objective – Curtailment of Groundwater Withdrawal. To accomplish this objective, the annual amount of groundwater permitted by the District for withdrawal from the portion of the aquifers located within the District may be curtailed during periods of extreme drought in the recharge zones of the aquifers or because of other conditions that cause significant declines in groundwater surface elevations. Such curtailment may be triggered by the District's Board of Directors based on the groundwater elevation measured in the District's monitoring well(s) and/or stream flow measurements along with other indices such as rainfall and soil moisture. District staff currently monitors three locations along the Frio River and its tributaries and two locations on the Nueces River. A weir box will be placed on Old Faithful Spring and measurements will be routinely taken at that location.

The triggers and actions incorporated into the drought plan are summarized in Table 7-4.

**Table 7-4. Real-Edwards Conservation and Reclamation District Drought Triggers and Actions**

| Stage & Description | 1 – Mild | 2 – Moderate | 3 – Severe | 4 – Extreme |
|---|---|---|---|---|
| Trigger | PDSI -1 or less | PDSI -2 or less | PDSI -3 or less | PDSI -4 or less |
| Conservation Goal (percent reduction in pumpage) | Voluntary | 10% | 20% | 30% |

The Palmer Drought Severity Index, which is an index based on regional meteorological and hydrological data such as rainfall, temperature and soil moisture content will be used as the primary triggering criteria for the initiation and termination of the drought plan.

The four drought stages are mandated restrictions for permitted wells during stages 2, 3, and 4 and recommended restrictions for exempt wells.

## 7.4 EXISTING AND POTENTIAL EMERGENCY INTERCONNECTS

According to Texas Statute §357.42(d),(e) regional water planning groups are to collect information on existing major water infrastructure facilities that may be used in the event of an emergency shortage of water. Pertinent information includes identifying the potential user(s) of the interconnect, the potential supplier(s), the estimated potential volume of supply that could be provided, and a general description of the facility. Texas Water Code §16.053(c) requires information regarding facility locations to remain confidential. This section provides general information regarding existing and potential emergency interconnects among water user groups within the Plateau Region.

The RWPG is required to gather information pertinent to major water infrastructure facilities that are currently or could potentially be utilized during emergency water shortages. Major water infrastructure facilities within the Plateau Region were identified through a survey process in order to better evaluate existing and potentially feasible emergency interconnects. There are no existing emergency interconnects. There are only two potential interconnects that have been identified within the Plateau Region in the current planning cycle, as shown in Table 7-5.

**Table 7-5. Potential Emergency Interconnects to Major Water Facilities**

| Entity Providing Supply | Entity Receiving Supply |
|---|---|
| City of Kerrville | Cherokee Mobile Home Park |
| City of Del Rio | Laughlin AFB and the Landings at Laughlin |

## 7.5 EMERGENCY RESPONSES TO LOCAL DROUGHT CONDITIONS

Texas Statute §357.42(g) requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2010 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts.

This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. This review was limited and did not require technical analyses or evaluations following in accordance with 31 TAC §357.34.

In the Plateau Region, there are fifteen municipal and County-Other WUGs that have a 2010 Census population of less than 7,500 and rely upon a sole source of water. Thirteen WUGs rely on groundwater, two WUGs rely on surface water (City of Camp Wood and City of Del Rio) and three WUGs (City of Ingram, Loma Vista Water Supply and Laughlin AFB) may rely on water purchased from another entity.

Potential emergency water supply sources that might be used by small sole-source municipal WUGs or County-Other WUGs include the following:

- New local groundwater well
- Emergency interconnect
- Use of other named local supply
- Trucked-in water delivery
- Brackish groundwater limited treatment
- Brackish groundwater desalination
- Release from upstream reservoir
- Curtailment of upstream and/or downstream water rights

Based upon personal communication with the WUGs within the Plateau Region, the addition of a new local groundwater well was identified for all entities as a potential emergency water supply source. The Bandera County FWSD #1 (Bandera county-other) would also consider the curtailment of proximal water rights, and the City of Bandera would also consider trucked-in water delivery as a feasible option under emergency conditions. The entities along with feasible potential emergency water supply options have been included in Table 7-6.

## Table 7-6. Emergency Responses to Local Drought Conditions

| Entity | | | | | | Implementation Requirements | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water User Group Name | County | 2014 Population Served by Water System (per TCEQ) | 2014 Service Connections (per TCEQ) | 2020 Population | 2020 Demand (AF/year) | Drill additional groundwater wells | Brackish groundwater limited treatment | Brackish groundwater desalination | Emergency interconnect | Other named local supply | Trucked - in water | Type of infrastructure required | Entity providing supply | Other local entities required to participate | Emergency agreements already in place |
| City of Bandera | Bandera | 1,862 | 1,016 | 1,045 | 191 | ▪ | | | ▪ | | ▪ | Well | City | | |
| City of Rocksprings | Edwards | 1,857 | 619 | 1,254 | 295 | ▪ | | | ▪ | | ▪ | Well | City | | |
| Ingram Water Supply | Kerr | 5,238 | 1,746 | 1,837 | 165 | ▪ | | | | | ▪ | Well | | | |
| City of Brackettville | Kinney | 3,309 | 1,103 | 3,448 | 417 | ▪ | | | | | ▪ | Well | | | |
| Fort Clark Springs MUD | Kinney | 1,200 | 917 | 1,262 | 620 | ▪ | | | | | ▪ | Well | | | |
| City of Camp Wood | Real | 1,263 | 421 | 698 | 134 | ▪ | | | ▪ | | ▪ | Well | City | | |
| Laughlin Air Force Base | Val Verde | 3,000 | 860 | 1,756 | 1,012 | ▪ | | | ▪ | | ▪ | Well | City of Del Rio | | |
| **County Other** | | | | | | | | | | | | | | | |
| Bandera County FWSD 1 | Bandera | 948 | 316 | | | ▪ | | | ▪ | | ▪ | Well | District | | |
| Bandera River Ranch 1 | Bandera | 744 | 248 | | | ▪ | | | ▪ | | ▪ | Well | WSC | | |
| Barksdale WSC | Edwards | 249 | 83 | | | ▪ | | | | | ▪ | Well | | | |
| Center Point North Water System | Kerr | 240 | 80 | | | ▪ | | | | | ▪ | Well | | | |
| Center Point Taylor System | Kerr | 489 | 163 | | | ▪ | | | ▪ | | ▪ | Well | District | | |
| Center Point Wiedenfeld Works | Kerr | 153 | 51 | | | ▪ | | | ▪ | | ▪ | Piping | Aqua Texas | | |
| Cedar Springs MHP | Kerr | 138 | 46 | | | ▪ | | | ▪ | | ▪ | Piping | Ingram Oaks Park | | |
| Heritage Park Water System | Kerr | 78 | 26 | | | ▪ | | | ▪ | | ▪ | Piping | Aqua Texas | | |
| Hills & Dales Wiedenfeld Water Works | Kerr | 225 | 75 | | | ▪ | | | ▪ | | ▪ | Piping | Aqua Texas | | |
| Oak Ridge Estates Water System | Kerr | 117 | 39 | | | ▪ | | | | | ▪ | Well | | | |
| Southern Hills Wiedenfeld Water Works | Kerr | 819 | 273 | | | ▪ | | | ▪ | | ▪ | Piping | Aqua Texas | | |
| Verde Park Estates Wiedenfeld Water Works | Kerr | 216 | 72 | | | ▪ | | | ▪ | | ▪ | Piping | Elmwood MHP | | |
| Vista Hills | Kerr | 39 | 13 | | | ▪ | | | | | ▪ | Well | | | |
| Westwood Water System | Kerr | 321 | 107 | | | ▪ | | | | | ▪ | Well | | | |
| Windwood Oaks Water System | Kerr | 57 | 19 | | | ▪ | | | ▪ | | ▪ | Piping | The Woods Sub. | | |
| Woodhaven Mobile Home Park | Kerr | 102 | 34 | | | ▪ | | | ▪ | | ▪ | Piping | Aqua Texas | | |
| Flying L Ranch PUD | Bandera | 804 | 268 | | | ▪ | | | | | ▪ | Well | | | |
| City of Leakey | Real | 1,668 | 556 | | | ▪ | | | ▪ | | ▪ | System Interconnect | City | | |
| Medina WSC | Bandera | 723 | 241 | | | ▪ | | | | | ▪ | Well | | | |

In order to qualify for emergency funds that are earmarked for emergency groundwater supply wells, entities must have a drought plan in place and be currently listed as an entity that is limiting water use to avoid shortages. This list is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at: https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html.

There is some assistance available through the Texas Department of Agriculture and the Texas Water Development Board. There are requirements, deadlines, and a specific application process. Contact the TWDB by e-mail, <Financial_Assistance@twdb.texas.gov>, or call 512-463-7853. Contact the Texas Department of Agriculture, Community Development Block Grants, or call 512-936-7891. Funding is limited.

Other TCEQ Guidance resources:

- Emergency and Temporary Use of Wells for Public Water Supplies (RG-485)
- https://www.tceq.texas.gov/publications/rg/rg-485.html
- Questions from the TCEQ's Workshops on Drought Emergency Planning: Answers to Help Drinking-Water Systems Prepare for Emergencies https://www.tceq.texas.gov/assets/public/response/drought/workshop-questions071312.pdf
- Video: Workshop on Drought Emergency Planning for Public Water Systems in Texas
- http://www.youtube.com/watch?v=BdlF9CEcGPI&feature=plcp&context=C34378a7UDOEgsToPDskJNYWXf5I3pKq8tW9pkVqQU

# 7.6 REGION-SPECIFIC MODEL DROUGHT CONTINGENCY PLANS

As mandated by TAC 357.42(c)&(i), the RWPGs shall develop drought response recommendations regarding the management of existing groundwater and surface water sources in the RWPA designated in accordance with §357.32. The RWPGs shall make drought preparation and response recommendations regarding the development of, content contained within, and implementation of local drought contingency plans. The RWPGs shall develop region-specific model drought contingency plans that shall be presented in the RWP which shall be consistent with 30 TAC Chapter 288 requirements.

A new component of the RWP introduced in this planning cycle is Regional Drought Planning, which essentially expands the conceptualization and application of drought planning by specific entities to encompass the entire Plateau Region. The approach utilized in developing a region-specific drought plan will consider the following: 1) all regional groundwater and surface water sources, 2) current drought plans that are being utilized by user entities within the region, and 3) current monitoring stations within the region that have evolved since the previous planning cycle.

The goals of this approach are: 1) to gain a comprehensive view of what particular resources are being monitored by entities within the region, 2) determine which resources are not being monitored, 3) determine which users do not fall under the umbrella of existing DCPs, 3) identify potential monitoring stations with publicly accessible real-time data that currently exist, and 4) determine how these data can be utilized for the water user groups that do are not subject to existing DCPs, and ultimately 5) development of a regional model drought contingency plan.

As discussed in Section 7.2, several GCDs, towns/cities and various public supply systems have written drought management plans or drought contingency plans and have provided them for inclusion in the *Regional Plan.*

## 7.6.1 Regional Groundwater Resources and Monitoring

The six groundwater resources identified within the Plateau Region and their contribution to total regional groundwater supply are:

- Edwards-Trinity (Plateau) (57%)
- Trinity (36%)
- Edwards (BFZ) (less than 4%)
- Austin Chalk (less than 3%)
- Frio River Alluvium (less than 1%)
- Nueces River Alluvium (less than 1%)
- The aquifer contribution to the regional supply calculation is based upon historical pumping averages for years 2007 through 2011.

Current drought contingency plans were detailed in Section 7.3.5 and Table 7-1. State well numbers of the monitoring wells used by municipal entities that utilize groundwater triggers are shown in Table 7-7. A map of these locations is included as Figure 7-11.

**Table 7-7. Current Municipal Trigger Monitoring Wells**

| Water Supply Entity | County | Water Supply Source | Well ID |
|---|---|---|---|
| City of Rocksprings | Edwards | Edwards-Trinity (Plateau) | 55-63-803 Sharp Well |
| City of Bandera | Bandera | Trinity | 69-24-102 Dallas Street Well |
| Fort Clark Springs MUD | Kinney | Edwards-Trinity (Plateau) | 70-45-504 Well #1 |
| City of Brackettville | Kinney | Edwards-Trinity (Plateau) | 70-45-601 Well #1 |

The previous *2006* and *2011 Plateau Regional Water Plans* identified wells that could potentially be used for drought monitoring. Table 7-8 provides a selection of groundwater trigger wells included in the *2011 Plan*, with an updated status and history of measurements.

**Table 7-8. RWP Groundwater Trigger Monitoring Wells**

| Aquifer | County | Well ID | Monitoring Agency | Period of Record and Measurement Count | Current Status |
|---|---|---|---|---|---|
| Trinity | Bandera | 69-16-902 (Purple Sage Well) | Unknown | 1 measurement | Inactive - Replaced by BCRAGCD network |
| Edwards-Trinity | Edwards | 55-63-803 (City of Rocksprings) | TWDB | 1953 – 2014 (34 measurements) | Active |
| Trinity | Kerr | 56-63-916 | HGCD (Donna Drive well) | 1977 – 2014 (326 measurements) | Currently active in HGCD network |
| Edwards-Trinity | Kerr | 56-53-304 | Not being monitored | 1966 – 1997 (16 measurements) | Inactive - Replaced by HGCD network |
| Edwards-Trinity | Kinney | Ring Well | Unknown | Unknown | Unknown |
| Edwards (BFZ) | Kinney | 70-38-902 | TWDB | 1973 – 2013 (113 measurements) | Active |
| Austin Chalk | Kinney | 70-45-404 | TWDB | 1937 – 2008 (91 measurements) | Unknown |
| Frio River Alluvium | Real | 69-18-302 (City of Leakey) | Unknown | 2 measurements on WIID | Unknown |
| Edwards-Trinity | Val Verde | Old Y Well | City of Del Rio | 2013 - 2014 | Active |
| Edwards-Trinity | Val Verde | Agarita Well | City of Del Rio | Unknown | Active |
| Edwards-Trinity | Val Verde | Tiera del Largo Well | City of Del Rio | Unknown | Active |

The TWDB has recently created a component of their website called Water Data for Texas (similar to the U.S. Geological Survey's NWIS server) that is a collective of real-time monitoring data from both groundwater wells and reservoir stage-capacity gages. Table 7-9 is a summary of the 26 groundwater wells located within Region J. These locations are included on Figure 7-11.

**Table 7-9. Currently Active (Real-Time) Monitoring Wells**
Source: Water Data for Texas

| County | State Well Number | Aquifer | Aquifer Type | Entity/Cooperator | Data Transmission | Start Date Period of Record |
|---|---|---|---|---|---|---|
| Bandera | 6912206 | Edwards-Trinity (Plateau) | Unconfined | U.S. Geological Survey | Satellite | 11/6/2012 |
| Bandera | 6924225 | Trinity | Confined | Texas Water Development Board | Satellite | 8/11/2008 |
| Edwards | 5564503 | Edwards-Trinity (Plateau) | Unconfined | U.S. Geological Survey | Satellite | 11/6/2012 |
| Kerr | 5643901 | Trinity | Confined | Headwaters GCD | Satellite | 5/6/2009 |
| Kerr | 5652704 | Trinity | Confined | Headwaters GCD | Satellite | 12/9/2010 |
| Kerr | 5654106 | Trinity | Confined | Headwaters GCD | Satellite | 11/29/2010 |
| Kerr | 5654405 | Trinity | Confined | Texas Water Development Board | Satellite | 8/10/2004 |
| Kerr | 5655805 | Trinity | Confined | Headwaters GCD | Satellite | 3/15/2007 |
| Kerr | 5659201 | Trinity | Confined | Headwaters GCD | Satellite | 5/6/2009 |
| Kerr | 5661101 | Trinity | Confined | Headwaters GCD | Satellite | 3/13/2007 |
| Kerr | 5661102 | Edwards-Trinity (Plateau) | Unconfined | Headwaters GCD | Data Card | 3/13/2007 |
| Kerr | 5663922 | Trinity | Confined | Texas Water Development Board | Satellite | 12/5/2002 |
| Kerr | 5663923 | Trinity | Confined | Headwaters GCD | Satellite | 7/5/2010 |
| Kerr | 5663924 | Trinity | Confined | Headwaters GCD | Satellite | 7/12/2010 |
| Kerr | 5664301 | Trinity | Confined | Headwaters GCD | Satellite | 3/20/2013 |
| Kerr | 5664302 | Edwards-Trinity (Plateau) | Unconfined | Headwaters GCD | Satellite | 3/20/2013 |
| Kerr | 5757805 | Trinity | Confined | Headwaters GCD | Satellite | 7/16/2008 |
| Kerr | 6801703 | Trinity | Confined | Headwaters GCD | Satellite | 10/5/2009 |
| Kerr | 6801704 | Trinity | Confined | Headwaters GCD | Satellite | 5/14/2009 |
| Kerr | 6904503 | Trinity | Confined | Headwaters GCD | Satellite | 10/6/2009 |
| Kerr | 6907107 | Trinity | Confined | Headwaters GCD | Satellite | 5/8/2008 |
| Kerr | 6908304 | Trinity | Confined | Headwaters GCD | Satellite | 3/2/2008 |
| Kerr | 6908305 | Trinity | Confined | Headwaters GCD | Satellite | 3/2/2008 |
| Real | 6919401 | Trinity | Confined | Texas Water Development Board | Satellite | 2/15/1993 |
| Val Verde | 5463401 | Edwards-Trinity (Plateau) | Unconfined | Texas Water Development Board | Satellite | 9/9/2008 |
| Val Verde | 7001707 | Edwards-Trinity (Plateau) | Unconfined | Texas Water Development Board | Data Card | 8/6/2007 |

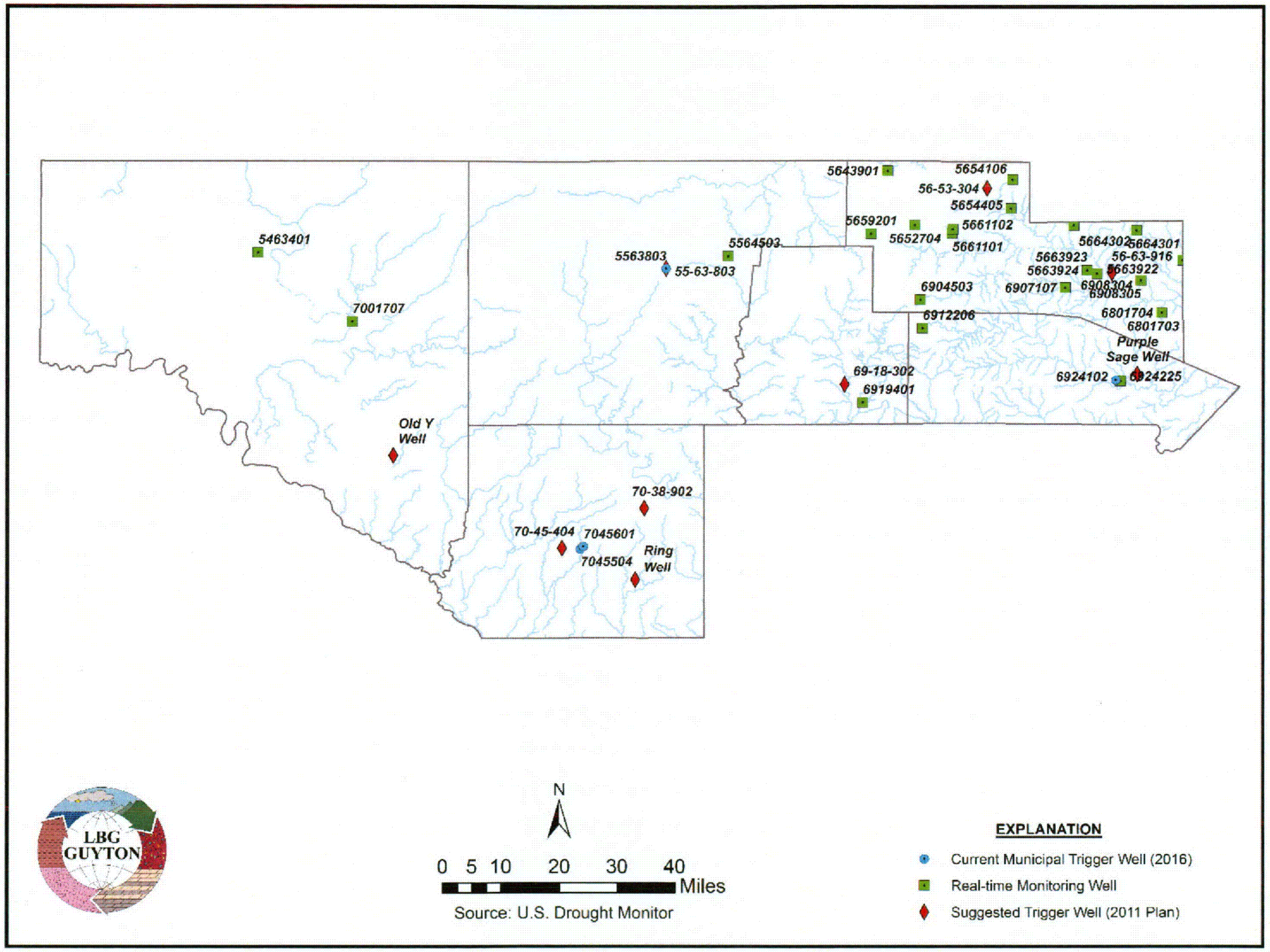



**Figure 7-11. Regional Monitoring and Trigger Wells**

### 7.6.2 Regional Surface Water Resources and Monitoring

The five surface water basins identified within the Plateau Region and their contribution to total regional surface water supply are:

- Rio Grande Basin (75%)
- Nueces River Basin (15%)
- Guadalupe River Basin (8%)
- Colorado River Basin (1%)
- San Antonio River Basin (0.5%)

The basin contribution to the regional supply calculation is based upon the WAM Run 3 (Full Authorization) availability numbers.

Surface water features that are actively being monitored by an entity within the Plateau Region are detailed in Table 7-10.

**Table 7-10. Surface Water Sources Currently Monitored by Regional Entities**
Source: Plateau Region Drought Contingency Plans

| Entity | County | Water Supply Source | Station ID | Measuring Agency | Period of Record | Current Measurement Frequency |
|---|---|---|---|---|---|---|
| City of Del Rio | Val Verde | San Felipe Springs | 08-4530.00 (gage on creek) | IBWC | 1931-2014 | 15 minutes |
| Headwaters GCD | Kerr | Guadalupe River | 08166200 | USGS | 1986-2014 | Daily |
| Real-Edwards CRD | Real | Frio River | Fulgham's crossing, Leakey Springs crossing, Mill Creek crossing, Frio River Place crossing | RECRD | Unknown | Monthly |
| Real-Edwards CRD | Real | Frio River West Prong | Rancho Real crossing, Kent Creek crossing | RECRD | Unknown | Monthly |
| Real-Edwards CRD | Edwards | Nueces River | McDonald's Crossing, Nueces River Dam | RECRD | Unknown | Monthly |

The only station that is utilized as an active trigger is San Felipe Springs. The other stations are included in this table to present a complete list of surface water locations that are currently being monitored within the Region. Note that the Guadalupe River is considered to be an optional trigger for HGCD. The Frio and Nueces crossings that are measured by the RECRD are posted on their website monthly.

A list of all currently active stream flow, spring flow and reservoir stage gaging stations are listed in Table 7-11. The USGS stations have real-time data that is publicly accessible online. These locations are shown on Figure 7-12.

**Table 7-11. Currently Active Surface Water Gaging Locations**
Source: Water Data for Texas

| County | Station ID | Station Name | Agency |
|---|---|---|---|
| **Rio Grande Basin** | | | |
| Val Verde | 8449100 | Dolan Ck abv Devils River nr Comstock, TX | USGS |
| Val Verde | 8447410 | Pecos Rv nr Langtry, TX | USGS |
| Val Verde | 08-3772.00 | Rio Grande at Foster Ranch near Langtry, TX | IBWC |
| Val Verde | 08-4508.00 | International Amistad Reservoir Storage | IBWC |
| Val Verde | 08-4530.00 | San Felipe Creek | IBWC |
| Kinney | 8456300 | Las Moras Spgs at Brackettville, TX (main channel) | USGS |
| **Nueces River Basin** | | | |
| Kinney | 8190500 | W Nueces Rv nr Brackettville, TX | USGS |
| Real | 818998070 | E Prong Nueces Rv abv Camp Eagle nr Rocksprings,TX | USGS |
| Edwards | 818999010 | Nueces Rv nr Barksdale, TX | USGS |
| Real | 8194755 | E Frio Rv nr Leakey, TX | USGS |
| Bandera | 8197936 | Sabinal Rv bl Mill Ck nr Vanderpool, TX | USGS |
| **Colorado River Basin** | | | |
| No gages are located in this basin within Region J | | | |
| **Guadalupe River Basin** | | | |
| Kerr | 8165300 | N Fk Guadalupe Rv nr Hunt, TX | USGS |
| Kerr | 8165500 | Guadalupe Rv at Hunt, TX | USGS |
| Kerr | 8166000 | Johnson Ck nr Ingram, TX | USGS |
| Kerr | 8166140 | Guadalupe Rv abv Bear Ck at Kerrville, TX | USGS |
| Kerr | 8166200 | Guadalupe Rv at Kerrville, TX | USGS |
| Kerr | 8166250 | Guadalupe Rv nr Center Point, TX | USGS |
| **San Antonio River Basin** | | | |
| Bandera | 817887350 | Medina Rv at Patterson Rd at Medina, TX | USGS |
| Bandera | 8178880 | Medina Rv at Bandera, TX | USGS |
| Medina | 8179500 | Medina Lk nr San Antonio, TX | USGS |

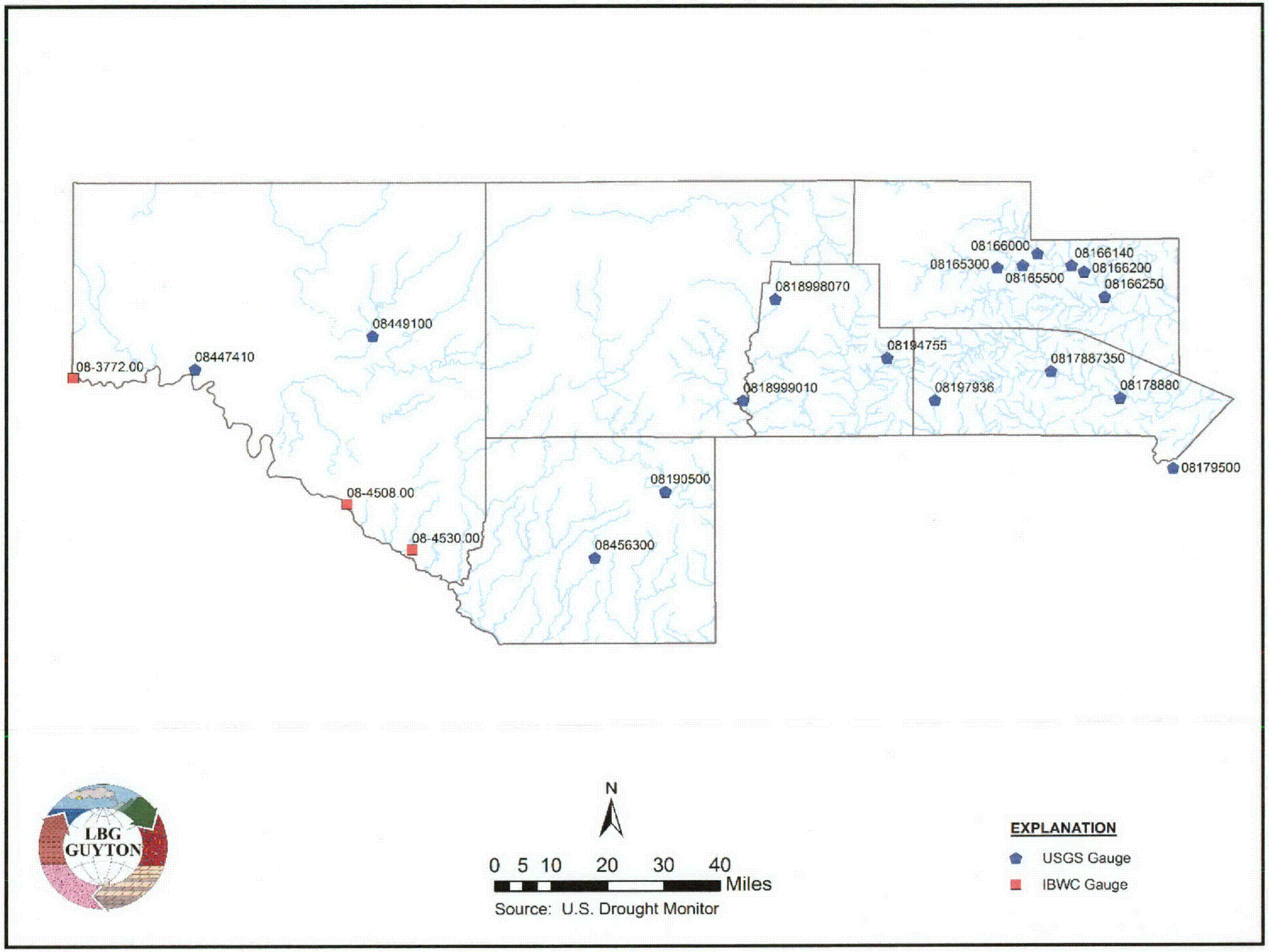



**Figure 7-12. Currently Active Surface Water Gaging Locations**

### 7.6.3 Regional Model Drought Contingency Plan

The Regional Model DCP summary table (Table 7-12) provides an overview of all existing regional water sources, WUGs, monitoring wells, gaging stations as well as recommended drought triggers and actions. The intent of including the monitoring wells and stations is to provide a comprehensive region-wide assessment of what current tools are available to WUGs and districts to monitor resources within the Plateau region.

The Regional Model DCP will undoubtedly change over time in order to address particular needs and issues of the Region's users. Therefore, this initial version of the model plan will primarily focus on identifying all sources, users and monitoring tools in order to find the particular components within the Region that are not currently incorporated into any existing drought plan but could potentially utilize existing data resources. Another focus of this first model plan will consider consistency of existing plans within the Region. Entities that have adopted drought plans will only be assessed to this end, therefore fine tuning existing triggers of existing municipal drought plans is not a goal of the model plan beyond an effort toward achieving consistent responses/actions to drought across the Region. No triggers have been recommended for modification; however, an effort has been made to make the percent reduction of demand/use a little more aggressive and more equitable across the board. Additionally, 'voluntary conservation' has been removed as a stage 1 action. Conservation is a BMP that ideally will ultimately be practiced on a daily basis, and not merely as a reaction to drought conditions, therefore it has been removed as an action in the Regional Model DCP.

Smaller PWS entities (county-other), manufacturing, power, and irrigation water wells that exceed GCD exempt well production thresholds are subject to drought actions imposed by the conservation districts. Exempt well users are requested to voluntarily follow the actions specified by the Districts for non-exempt users. Generally, the water user groups within the Region that are not included in these plans (or included on a voluntary basis) are: 1) all exempt water wells in counties with established GCDs, and 2) all users in Val Verde County except those who are provided water by the City of Del Rio.

**Table 7-12. Recommended Regional Drought Plan Triggers and Actions**

| Source Name | Source Type (SW or GW) | Source User Entity | Current WUG Monitoring | Real-time Source Monitoring | Factors to be Considered | Recommendations | Specific Triggers | | | | | | | | Specific Actions (Percent Reduction Demand/ Use) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Source Manager | | | | Users | | | | Source Manager | | | | Users | | | |
| | | | | | | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| | | | | | | | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical |
| Edwards - Trinity (Plateau) | GW | City of Rocksprings | 55-63-803 (Sharp well) | USGS well 55-64-503 | Plan in place | Add stage 4. Could add additional trigger well. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | City of Brackettville | 70-45-601 (Well #1) | --- | Plan in place | Add stage 4. Could add additional trigger well. | | | | | | | | | 10 | 15 | 25 | 35 | 10 | 15 | 25 | 35 |
| | | Fort Clark Springs MUD | 70-45-504 (Well #1) | --- | Plan in place | Remove voluntary conservation as a stage | | | | | | | | | 10 | 15 | 25 | 35 | 10 | 15 | 25 | 35 |
| | | City of Del Rio | No groundwater triggers | --- | Plan in place | Make stage 1 a 10% demand reduction. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Laughlin AFB | | | | | | | | | | | | | | | | | | | | |
| | | County Other | N/A | 69-12-206 (Bandera)<br>55-64-503 (Edwards)<br>56-61-102 (Kerr)<br>56-64-302 (Kerr)<br>54-63-401 (Val Verde)<br>70-01-707 (Val Verde) | District plans in place | Make stage 1 a 10% demand reduction (REGRD only). | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation | | | | | | | | | | | | | | | | | | | | |
| | | MAN, MIN, STK | | | | | | | | | | | | | | | | | | | | |
| Trinity | GW | City of Bandera | 69-24-102 (Dallas Street Well) | TWDB 69-24-225 | Plan in place | Remove voluntary conservation as a stage. Could add additional trigger well. | | | | | | | | | 10 | 20 | 35 | 50 | 10 | 20 | 35 | 50 |
| | | City of Kerrville | component of SOC calc | --- | Plan in place | No change. | | | | | | | | | - | - | - | - | - | - | - | - |
| | | City of Ingram | wells a component of demand triggers | --- | Plan in place | Remove voluntary conservation as a stage. Make stage 1 a 10% demand reduction. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | County Other | N/A | 69-19-401 (Real)<br>18 HGCD wells (Kerr) | District plans in place | No change. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation | | | | | | | | | | | | | | | | | | | | |
| | | MAN, MIN, STK | | | | | | | | | | | | | | | | | | | | |
| Edwards (BFZ) | GW | County Other | N/A | 70-38-902 (Kinney) | No drought plan | Upgrade well with telemetry; add to TWDB network; establish triggers | | | | | | | | | - | - | - | - | - | - | - | - |
| | | Irrigation | | | | | | | | | | | | | | | | | | | | |
| | | MAN, MIN, STK | | | | | | | | | | | | | | | | | | | | |
| Austin Chalk | GW | County Other | N/A | 70-45-404 | No drought plan | Upgrade well with telemetry; add to TWDB network; establish triggers | | | | | | | | | - | - | - | - | - | - | - | - |
| | | Irrigation | | | | | | | | | | | | | | | | | | | | |
| | | MAN, MIN, STK | | | | | | | | | | | | | | | | | | | | |
| Frio River Alluvium | GW | City of Leakey | 69-18-302 | 69-18-302 | District plan in place | Remove voluntary conservation as a stage, upgrade well with telemetry; add to TWDB network; establish triggers | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation | N/A | | | | | | | | | | | | | | | | | | | |
| | | County Other | | | | | | | | | | | | | | | | | | | | |
| Nueces River Alluvium | GW | Community of Barksdale | Unknown | USGS station 0818999010 | District plan in place | Remove voluntary conservation as a stage, use USGS station 0818999010 to establish triggers. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation | N/A | | | | | | | | | | | | | | | | | | | |
| | | County Other | | | | | | | | | | | | | | | | | | | | |

**Table 7-12. (Continued) Recommended Regional Drought Plan Triggers and Actions**

| Source Name | Source Type (SW or GW) | Source User Entity | Current WUG Monitoring | Real-time Source Monitoring | Factors to be Considered | Recommendations | Specific Triggers | | | | | | | | Specific Actions (Percent Reduction Demand/ Use) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Source Manager | | | | Users | | | | Source Manager | | | | Users | | | |
| | | | | | | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| | | | | | | | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical | Mild | Mod | Severe | Critical |
| **Rio Grande Basin** | | | | | | | | | | | | | | | | | | | | | | |
| Las Moras Springs | SW | City of Brackettville | N/A | USGS station 08456300 | Plan in place | Add stage 4. | | | | | | | | | 10 | 15 | 25 | 35 | 10 | 15 | 25 | 35 |
| San Felipe Springs | | City of Del Rio | stages triggered by spring discharge | --- | Plan in place | Increase stage 1 to a 10% demand reduction. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| San Felipe Creek | | | N/A | IBWC station 08-4530.00 | No drought plan | | | | | | | | | | | | | | | | | |
| Rio Grande | | County Other | | IBWC station 08-3772.00 | | | | | | | | | | | | | | | | | | |
| Pecos River | | Irrigation | | USGS station 08447410 | | | | | | | | | | | | | | | | | | |
| Devils River | | MAN, MIN, STK | | USGS station 08449100 | | | | | | | | | | | | | | | | | | |
| Amistad Reservoir | | | | IBWC station 08-4508.00 | | | | | | | | | | | | | | | | | | |
| Cienegas Creek | | | | --- | | | | | | | | | | | | | | | | | | |
| **Nueces River Basin** | | | | | | | | | | | | | | | | | | | | | | |
| Old Faithful Springs | SW | City of Camp Wood | REGRD weir box | REGRD weir box | Plan in place | Remove voluntary conservation as a stage. Make stage 1 a 10% mandated demand reduction. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| West Nueces River | | | N/A | USGS station 08190500 | No drought plan | | | | | | | | | | | | | | | | | |
| Nueces River Basin | | County Other | | USGS station 0818999010 | | | | | | | | | | | | | | | | | | |
| Frio River | | Irrigation | | USGS station 08194755 | | | | | | | | | | | | | | | | | | |
| Sabinal River | | MAN, MIN, STK | | USGS station 08197936 | | | | | | | | | | | | | | | | | | |
| Hondo Creek | | | | N/A | | | | | | | | | | | | | | | | | | |
| **Colorado River Basin** | | | | | | | | | | | | | | | | | | | | | | |
| Llano River | SW | County Other | N/A | N/A | District plans in place (HGCD and REGRD) | Make stage 1 a 10% demand reduction (REGRD only). | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation | | | | | | | | | | | | | | | | | | | | |
| | | MAN, MIN, STK | | | | | | | | | | | | | | | | | | | | |
| **San Antonio River Basin** | | | | | | | | | | | | | | | | | | | | | | |
| Medina River | SW | County Other | N/A | USGS station 08178880 | | | | | | | | | | | | | | | | | | |
| Medina Lake | | Irrigation, MAN, Min, STK | N/A | USGS station 08179500 | | | | | | | | | | | | | | | | | | |
| **Guadalupe River Basin** | | | | | | | | | | | | | | | | | | | | | | |
| Guadalupe River | SW | City of Kerrville | component of SOC calc | --- | Plan in place | No change. | | | | | | | | | - | - | - | - | - | - | - | - |
| | | County Other | N/A | USGS station 08166250 | District plan in place | No change. | | | | | | | | | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 |
| | | Irrigation, MAN, Min, STK | N/A | | | | | | | | | | | | | | | | | | | |

### 7.6.4 WUG-Specific Model Drought Contingency Plans

Model drought contingency plans were developed for the Plateau region and can be accessed online at http://www.ugra.org/waterdevelopment.html. Each plan identifies four drought stages: mild, moderate, severe and emergency. The recommended responses range from notification of drought conditions and voluntary reductions in the "mild" stage to mandatory restrictions during an "emergency" stage. Entities using the model plan can select the trigger conditions for the different stages and appropriate responses for each stage.

#### 7.6.4.1 Public Water Supplier

Drought contingency plans have previously been adopted by the majority public suppliers and municipalities in the Plateau Region, although some suppliers did not provide any adopted plans. Current triggers and response actions for participating entities are summarized in Table 7-1. Recommended changes to existing response actions are detailed in Table 7-12.

#### 7.6.4.2 Irrigation

Irrigation wells located within a municipality are subject to the triggers and response actions designated by the city's drought plan. Non-exempt irrigation wells located outside of a municipality but within a GCD are subject to the triggers and response actions of the GCD. Exempt irrigation wells located within a GCD are requested to comply voluntarily with response actions that have been mandated for non-exempt well owners. No response actions have been designated for irrigators located in Val Verde County except for those located within the City of Del Rio's jurisdictional boundary.

#### 7.6.4.3 Wholesale Water Provider

The only wholesale water provider in the Plateau Region is the City of Del Rio. Generally, triggers are invoked when water levels in the Bedell Street Storage Reservoirs are less than a designated depth and San Felipe Spring flow drops below a specific flow rate. Currently adopted triggers and actions are summarized below in Table 7-13.

**Table 7-13. City of Del Rio Drought Triggers and Response Actions**

| Stage & Description | 1 – Mild | 2 – Moderate | 3 – Severe | 4 – Extreme | 5 – Emergency |
|---|---|---|---|---|---|
| Trigger | Water levels are less than 100% full; San Felipe Spring flow is less than 40 mgd. | Water levels are less than 30 feet; San Felipe Spring flow is less than 25 mgd. | Water levels are less than 25 feet; San Felipe Spring flow is less than 20 mgd. | Water levels are less than 20 feet; San Felipe Spring flow is less than 15 mgd. | Water levels are less than 15 feet; San Felipe Spring flow is less than 10 mgd. |
| Conservation Goal (percent reduction in pumpage) | Reduce demand to 95% of the 30 day average prior to initiation | Reduce demand to 90% of the 30 day average prior to initiation | Reduce demand to 80% of the 30 day average prior to initiation | Reduce demand to 70% of the 30 day average prior to initiation | Notify state |

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8

# CHAPTER 8

# POLICY RECOMMENDATIONS AND UNIQUE SITES

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# 8 POLICY RECOMMENDATIONS

The regional water planning process offers an opportunity to make recommendations pertaining to the development and management of the groundwater and surface water resources of the State of Texas. This chapter contains specific suggestions and decisions made by the Plateau Water Planning Group (PWPG). Regional water planning remains a learning and improving process for the State of Texas. Because of the complex nature of this undertaking, many ideas and approaches to the problems of water-resource management are either refined or changed significantly as all participants in the planning process learn more about the Region's water resources and about what is required to produce a plan that will benefit all areas of the Region. The PWPG supports the continuation of the regional planning process and recommends certain modifications intended to strengthen its effectiveness.

The following recommendations by the PWPG are derived from careful consideration of many issues covered during the course of the planning exercise including needed legislative actions, state funding and assistance, water supply management planning, and needed studies and data. Issues concerning ecologically unique river and stream segments and sites for the construction of reservoirs are covered. The recommendations in the following sections are designed to present new and/or modified approaches to key technical, administrative, institutional, and policy matters that will help to streamline the planning process, and to offer guidance to future planners with regard to specific issues of concern within the Region.

# 8.1 RECOMMENDATIONS

## 8.1.1 Watershed Management Practices

Selective vegetative (brush) management, as a tool to improve watershed yields and water quality, is a strategy of great interest in the Plateau Region, as well as in surrounding planning regions. A balanced approach to brush control contributes to the land's ability to absorb, retain, filter, and slow rainfall runoff. However, a narrow goal only to encourage the enhancement of runoff should be avoided.

The State should draft legislation based upon the best available science and input from all stakeholders to provide a cost-share funding program to landowners in the targeted watersheds for selective brush management and required other practices. It is generally recognized that brush infestations are the symptom of deeper ecological disturbances such as fire control, drought, grazing mismanagement, wildlife overpopulations and other causes. As such, the cost-share program should involve a long-range contract between the State and the landowner for at least ten (10) years of post-treatment management with required brush re-invasion treatments. To accurately assess the benefits, treated watersheds will require thorough monitoring of groundwater, springs and surface waters by appropriate state and federal agencies. Information and assistance are available from the USDA Natural Resources Conservation Service (NRCS) and the Texas State Soil and Water Conservation Board.

Currently, Texas Parks & Wildlife Department (TPWD) has a program specifically developed for landowners involving brush management in areas possibly containing endangered species. As has been proven on the Kerr Wildlife Management Area (TPWD) with long-term studies, selective brush management coupled with good rangeland management can benefit endangered species and ranchers as well. It is highly likely that watershed values will fit into the same package to provide a win-win situation for all.

## 8.1.2 Riparian Stewardship

The interaction between soil, water and vegetation in the floodplains and along streambeds constitutes riparian function, which buffers and slows floodwaters, filters sediment, improves natural infiltration and recharge of alluvial aquifers, and enhances water quality. The PWPG encourages riparian landowners to learn and implement land stewardship practices that support healthy riparian function. The PWPG continues to encourage funding for projects aimed at the eradication and long-term suppression of salt cedar, Arundo donax, and other nuisance phreatophytes in the Regional watersheds.

## 8.1.3 Conservation Management of State-Owned Lands

All state-owned land should be managed in ways that enhance water conservation. State agencies need to take the lead in water conservation and it should start on state-owned properties. Unless State agencies set good conservation examples for the public, any public program encouraging such conservation will likely be perceived as "do as I say, not as I do", something that never plays well. Considering that approximately 95 percent of Texas land is privately owned, the State needs to be convincing when making recommendations to the public if it hopes to be successful.

### 8.1.4 Rainwater Harvesting as an Alternative Source of Water

Rainwater harvesting programs should be supported by the State. Rainwater harvesting is one way to meet rural or urban domestic water demands, as well as use for limited irrigation, such as vineyards, orchards or small farms under drip irrigation. Livestock and wildlife can also be provided supplemental water by rainwater harvesting. This should be widely encouraged by funded education programs and cost-share funding to individual homeowners, farmers, businesses, public entities and ranchers.

### 8.1.5 Conservation and Drought Planning

Because portions of the Plateau Region are particularly susceptible to water-supply shortages during periods of drought conditions, these areas are especially encouraged to develop conservation oriented management plans. Likewise, water-user entities within these areas should become actively involved in the regional water planning activities associated with this *Plan*.

# 8.2 WATER MANAGEMENT RECOMMENDATIONS

## 8.2.1 Headwaters GCD Access to Groundwater under State-Owned Land

The Texas Legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property (Water Code Chapter §36.002 Ownership of Groundwater). Water Code Chapter §36.104 states that a groundwater district may purchase, sell, transport and distribute surface water or groundwater. For the long-term benefit of meeting the future water demands of the citizens in Kerr County, Texas, the PWPG recommends that the State of Texas enter into a long-term lease agreement or contract that will allow the Headwaters Groundwater Conservation District to retain/acquire the groundwater rights located under all State-owned property within the boundaries of Kerr County. This will provide for:

- better long-term management of local groundwater sources,
- additional drilling sites for test/monitor wells,
- more county-wide data collection and monitoring of aquifer conditions, and
- increased availability of scientific data for local water management planning.

The District's enabling legislation (*Special District Local Laws Code Chapter 8842 Section 102.B*) states that the District may contract with a state agency or another governmental body to carry out any function of the District. The access right to groundwater underlying State-owned land would be included in the District's Management Plan.

## 8.2.2 Val Verde County Groundwater Management

The PWPG considers all groundwater sources recognized in this *Plan* as being critical to the future health and economic welfare of the Plateau Region. Because of the reliance on groundwater to meet current and future water needs, the PWPG recommends that a local Groundwater Conservation Districts be formed in Val Verde County to administer sound, reasonable, and scientifically-based management objectives.

## 8.2.3 GCD Management of Brackish Groundwater

Brackish-quality groundwater is recognized State-wide as an underutilized water supply source, and programs are in place in the State's water agencies to encourage the development of this source to meet future water supply shortages. Science recognizes that most of these brackish aquifers represent a down-dip component of an aquifer's fresh water zone, and that the withdrawal of water from the brackish portion may impact the updip fresh-water portion of the same aquifer. The Legislature has declared that groundwater conservation districts are the State's recognized authority to locally manage groundwater sources. The PWPG affirms that local groundwater conservation districts have the authority and should retain the authority to manage the brackish portion of aquifers.

### 8.2.4 Recharge Structures

Recharge structures are a relatively low cost method of enhancing aquifer recharge if sited to provide adequate streambed water percolation based upon the best available science. Recharge structures such as small dams, gabions, or terraces can provide multiple benefits under ideal conditions as has been proven along the Edwards Aquifer Recharge Zone. This interest in recharge structures should be encouraged, funding provided, and perhaps some streamlining of any required permitting procedures as possible and as advised. Programs and funding should be available to identify appropriate locations for recharge structures and technical assistance provided for construction and maintenance.

# 8.3 WATER PLANNING RECOMMENDATIONS

## 8.3.1 Transient Population Impact on Water Demand

Municipal water use reports capture the total amount of water produced and distributed by the city. In concept, this volume includes water consumed by both permanent and transient populations within the community. However, the counties of the Plateau Region have a high transient influx of vacationers and hunters that frequent the more remote areas and are not likely included in the water demand estimates. Likewise, there are a high percentage of second-home owners in the rural counties that is also not accounted. Officials in the most rural counties in the Region estimate that as much as 70 percent of landowners are not permanent residents. This transient water demand likely has a significant impact on water demand estimates used by the planning group. The PWPG encourages the TWDB to consider this water-use category and develop a method for estimating its impact.

## 8.3.2 Better Methodologies for Estimating Population and Water Demand

The revision of population and demand estimates should be discussed by regional water planning groups and put before the public for several months, and then be presented to the planning groups for consideration and adoption. This will allow more time for water users within the Region to hear about the planning effort and to have input to the revisions of population, water demand, and water supply.

Modification of demand numbers should be allowed further into the planning process. Demand errors may not be discovered until the supply-demand analysis is performed. Some entities or water-use categories may have been overlooked early in the process and their demands need to be added later for the supply-demand analyses to match.

## 8.3.3 County-Other Demand Distribution

In the regional water planning process, water supply demand is determined on a county and river basin basis and is then evenly distributed over the designated area. In some cases this results in a misrepresentation of the actual rural density within segments of the county-river basin area. The primary disadvantage of this is that a high-density rural area may have a legitimate need of water supply management even though the county-river basin statistical numbers do not indicate a supply shortage. A recommended water management strategy in an area such as this does not register as high of a priority as it realistically should. The PWPG therefore recommends that the TWDB develop a planning process that will justifiably recognize the high-priority needs of such County-Other areas.

## 8.3.4 Irrigation Surveys

Irrigation application is the largest use of water in the State, yet its quantification is probably the least accurate. Irrigation use is only being accurately determined in areas where groundwater conservation districts are requiring the installation of irrigation well flow meters and where irrigation districts record surface water diversions. Elsewhere, planning group members directly involved in the agricultural industry have viewed irrigation surveys with skepticism in many counties. Nursery farms, greenhouse operations, wildlife and exotic animal food plots, and non-municipal golf courses are just a few of the irrigation activities that are often overlooked in the surveys. The TWDB is encouraged to develop a more confident means of estimating actual irrigation use.

### 8.3.5 Peak-Use Management

Drought management plans need to be developed based on peak use demand instead of annual production capabilities. The current Plan is based on drought-of-record conditions on an annual basis. While this is a good starting point in the planning process, it would be beneficial to also plan based on peak demand during a year. For example, current planning does not address water needs during the peak use period of summer months. During the summer, in many areas of the State, severe water problems may exist that are not apparent based on an annual water management plan. This results in a plan that may indicate that water supply needs are satisfied for a region, when in reality such needs may not be satisfied throughout the year. This presents a significant problem in the current planning process.

### 8.3.6 MAG Availability Alternative

Modeled Available Groundwater (MAG) is the quantitative limit set by Groundwater Management Areas for groundwater use in a given area, and is the cap for groundwater source use in regional water planning. The PWPG recommends that MAGs be used as the water planning cap unless the Planning Group obtains written permission from a Groundwater Conservation District (GCD) to allow a water management strategy to be recommended that uses more groundwater then the MAG cap.

- This approach assumes that the strategy is consistent with the GCD Management Plan, but allows for minor supply shortages to be covered without excessive administrative actions;
- Allows the GCD to apply local knowledge to account for variations in permitting approaches and usage patterns;
- The approach could also be used in areas with no GCDs.

### 8.3.7 Regional Planning Coordination

The two regional planning processes developed by the Legislature (Regional Water Planning and Groundwater Management Areas) have in some cases resulted in conflicting methodologies of reaching long-term planning goals. The PWPG encourages better communication between the stakeholders at earlier stages of both processes in the future. The PWPG also encourages the Legislature to examine ways in which both planning processes can better interact for the good of all citizens and economies in the impacted regions.

### 8.3.8 Training for New Regional Water Planning Group Members

The TWDB is encouraged to continue providing training opportunities for new planning group members. Planning group members provide better input to the planning process when they fully understand the requirements, schedules, and the multitude of internal components of the regional plan.

### 8.3.9 Require Participation of State Agencies Involved with the Planning Process

Representatives of State agencies involved in the regional planning process could effectively derail a regional plan at the end of the planning period - without attending as much as one meeting. The PWPG recommends that nonvoting members of State agencies be required to attend and provide input at every planning group meeting. If an agency's nonvoting representative does not contribute or fails to attend meetings, then that agency should not be permitted to object to or alter contents of a planning group's adopted plan. It should be noted that TWDB and TPWD staff were very active (and much appreciated) in the Plateau Region planning process.

## 8.4 NEEDS STUDIES AND DATA

The State should fund or conduct specific studies that will shed more information on specific water-resource issues. The questions unanswered by current sources of information are critical to future PWPG decisions. The following are recommendations pertaining to specific studies and data acquisition that the PWPG believes would provide significant insight into specific planning issues in the Region.

### 8.4.1 Edwards-Trinity (Plateau) Aquifer

All six counties in the Plateau Region are partially or fully underlain by the Edwards- Trinity (Plateau) Aquifer. Even though a groundwater availability model (GAM) has been constructed for this aquifer, there remain many hydrological questions about the aquifer. Specific counties are embroiled in controversy pertaining to groundwater supply availability. At issue is the disagreement about the total amount of water in the county that is available on an annual basis to meet all of the counties projected water demands now and into the future, and the amount of groundwater in excess of that amount that might be available for other purposes other than in-county use. All concerned agree that sound science is needed to assess this quantification.

A basic, unbiased, scientific study that encompasses the hydrologic characterization of the Edwards-Trinity (Plateau) Aquifer and adjacent associated aquifers (Edwards-BFZ and Austin Chalk) and the inter-formational flow between them, their contribution to surface water flows, and the historical withdrawals from the aquifers is needed in order for the local groundwater management entities and the PWPG to make sound management decisions and recommendations.

### 8.4.2 Unpermitted Withdrawals of Riparian Water

A significant amount of unpermitted riparian water is withdrawn from rivers and their tributaries in the Region. Unpermitted pumping is particularly escalated during drought periods when increased withdrawals occur for irrigation of lawns. This water use is unaccounted for in the Water Availability Models that are developed for these waterways. State water agencies should devise a survey method to establish a reasonable estimate of these diversions.

### 8.4.3 Emphasis on Basic TWDB Water Evaluation Studies

In the past, the TWDB has provided significant knowledge concerning the groundwater resources in the State in the form of basic data and reports. The Board's current emphasis on groundwater modeling with its intended use as a water management planning tool is recognized as an important advancement in providing planning tools. However, the Board should not abandon its important basic data gathering and evaluation responsibility. The Board should emphasize more realistic and useful groundwater studies that include the extensive field data collection necessary for such studies.

### 8.4.4 Radionuclides in Trinity Aquifer Groundwater

Recent groundwater sampling by groundwater conservation districts have identified elevated levels of radionuclides in the Trinity Aquifer. Further studies are needed to identify the specific source of the radionuclides, map their areal distribution and concentration, determine their health concerns, and monitor their changing concentrations over time.

### 8.4.5 Groundwater / Surface Water Relationship

The PWPG defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. This water supply policy definition can best be achieved when the relationship between groundwater and surface water is fully understood. The PWPG encourages the State (TWDB) to embrace this concept and focus water availability studies on this topic.

### 8.4.6 Impact of Transient Water Demand in Rural Counties

The concern pertaining to transient population water demand in rural counties was expressed in Section 8.3.1. A study is needed to quantify this impact that is not based solely on the resident population but rather considers the total count of individuals within the respective area.

### 8.4.7 Underestimated Water Demand of Exotic Animals

The PWPG investigated the water use generated by the expanding exotic animal industry within the Region (see Appendix 2B of the *2011 Plan*) and expects to build on this information to generate more accurate water demand estimates in future regional plans. The PWPG encourages the TWDB and other agencies to continue funding for this endeavor in the Plateau Region and throughout the State.

### 8.4.8 Upper Guadalupe River Basin Groundwater / Springflow Analysis

Surface water base flow in the three branches of the upper Guadalupe River in western Kerr County is derived almost exclusively from groundwater discharge through springs. Both the PWPG and members of Groundwater Management Area 9 recognize the need to manage groundwater use in this area where critical surface water/groundwater interaction occurs. However, developing management decisions is impaired by the lack of current understanding of how groundwater level elevations relate to spring flow rates. Only one monitoring well is in place that provides continuous water level readings, and no attempt has thus far been made to relate this recent data to spring flows. A study is needed to evaluate this critical interaction so that future management decisions can be based on a more substantial level of scientific knowledge.

## 8.5 CONSIDERATION OF ECOLOGICALLY UNIQUE RIVER AND STREAM SEGMENTS

Under regional planning guidelines (§357.43), each planning region may recommend specific river or stream segments to be considered by the legislature for designation as ecologically unique. The legislative designation of a river or stream segment would only mean that the State could not finance the construction of a reservoir that would impact the segment. The intent is to provide a means of protecting the segments from activities that may threaten their environmental integrity.

Texas Parks and Wildlife Department (TPWD) provided a list of stream segments that were identified as meeting ecologically unique criteria. This list and map can be viewed in Appendix 8B of the *2011 Plan*. For each segment, TPWD lists qualities of each segment that support the stream's candidacy. These qualities may include but are not limited to biological function, hydrological function, location with respect to conservation areas, water quality, the presence of state- or federally-listed threatened or endangered species, and the critical habitat for such species.

The Plateau Region contains some of the most ecologically pristine areas in the State. The preservation of this natural environment is an important component of the Region's economy, which is closely tied to these natural resources. The PWPG recognizes the uniqueness of this Region and has followed a policy throughout this planning period of always considering the impact that their decisions have on the area's ecological resources. The PWPG also recognize the extent of Region L designated ecologically unique stream segments that extend upstream to the southern boundary of the Plateau Region. However, because the subsequent ramifications of designation are not fully understood, the PWPG has chosen to refrain from recommending specific segments for designation as "ecologically unique" at this time. The PWPG strongly maintains that all river and stream segments in the Plateau Region are vitally important and their flows constitute a major consideration in adoption of this *2016 Plan*.

# 8.6 CONSIDERATION OF UNIQUE SITES FOR RESERVOIR CONSTRUCTION

Regional water planning guidelines (§357.43) instruct that planning groups may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation, and expected beneficiaries of the water supply to be developed at the site. The following criteria shall be used to determine if a site is unique for reservoir construction:

1 Site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted plan.

2 The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors make the site uniquely suited for:

- reservoir development to provide water supply for the current planning period; or
- where it might reasonably be needed to meet needs beyond the 50-year planning period.

Following consideration of the above criteria the PWPG makes no recommendation of unique sites for reservoir construction.

9

# CHAPTER 9

# WATER INFRASTRUCTURE FINANCIAL ANAYLSIS

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# 9 WATER INFRASTRUCTURE FINANCIAL ANALYSIS

The Infrastructure Financing Report (IFR) survey presented in this chapter identifies the state financing options proposed by entities in this *Plan* to meet future infrastructure needs. Chapter 5 provides recommended water management strategies for numerous communities in the Plateau Region that either have a projected water supply deficit, or have an identified desire for a water supply infrastructure project, which may require state financial assistance. These entities were surveyed to determine their proposed method(s) for financing the estimated capital costs involved in implementing the water supply strategies recommended in the *2016 Plateau Region Water Plan.*

Unlike infrastructure financing surveys conducted for previous regional water plans, questions during this planning cycle focused on projected needs for financial assistance from programs administered by the TWDB. The TWDB will aggregate the projected requests for funding from these programs from the 16 water planning regions to provide a picture of estimated long-term infrastructure funding needs to the State Legislature.

# 9.1 TWDB FUNDING PROGRAMS

The TWDB offers financial assistance for the planning, design and construction of projects identified in regional water plans or the State Water Plan. Programs available include the State Water Implementation Fund for Texas (SWIFT), Water Infrastructure Fund (WIF), the State Participation Fund (SP), and the Economically Distressed Areas Program (EDAP). In order to be eligible to apply for funding from any of these sources, the applicant must be a political subdivision of the State, or in some cases a water supply corporation and the proposed project must be a recommended water management strategy in the most recent approved Regional Water Plan or State Water Plan.

## 9.1.1 State Water Implementation Fund for Texas (SWIFT)

The Texas Legislature created the SWIFT to provide affordable, ongoing state financial assistance for projects in the State Water Plan. Passed by the Legislature and approved by Texas voters through a constitutional amendment, the SWIFT helps communities develop and optimize water supplies at cost-effective rates. The program provides low-interest loans, extended repayment terms, deferral of loan repayments, and incremental repurchase terms for projects with state ownership aspects. Recognizing the benefit of conservation and the needs of rural Texas, the legislation directed that not less than 10% of the SWIFT funding should support projects for rural communities and agricultural water conservation; and not less than 20% of the funds should support water conservation and reuse projects.

## 9.1.2 Water Infrastructure Fund (WIF)

The Water Infrastructure Fund (WIF) provides subsidized interest rate loans for planning, design and construction. The WIF-Deferred fund offers the option of deferring all interest and principal payments for up to 10 years for planning, design and permitting costs, while the WIF-Construction fund offers subsidized interest for all construction costs including planning, acquisition, design, and construction.

## 9.1.3 State Participation Fund (SP)

The State Participation Fund (SP) is geared towards large projects which are regional in scope and meant to capitalize on economies of scale in design and construction, but where the local project sponsors are unable to assume the debt for an optimally sized facility. The TWDB assumes a temporary ownership interest in the project, and the local sponsor repays the cost of the funding through purchase payments on a deferred schedule. The goal of the program is to build a project that will be the right size for future needs, even if that results in the short term in building excess capacity, rather than constructing one or more smaller projects now.

## 9.1.4 Rural and Economically Distressed Areas (EDAP)

Both grants and zero percent interest loans for planning, design and construction costs are offered through these programs, which are available to eligible small, low-income communities. Rural and economically distressed areas that meet population, income and other criteria are eligible to apply for these funds. EDAP funding eligibility also requires adoption of the Texas Model Subdivision Rules by the applicant planning entities.

## 9.2 INFRASTRUCTURE FINANCE SURVEY

The survey instrument is prefaced with an explanation of its purpose in identifying the need for financial assistance programs offered by the State of Texas and administered by the TWDB. The available funding programs (SWIFT, WIF, SP and EDAP) are summarized, and the survey participant is asked to: 1) identify the amounts they might request from each funding source for each identified project or strategy; and 2) the earliest date the funds would be needed, by fund type. Water user groups with multiple strategies to meet future water needs are only surveyed for strategies with a capital cost.

All communities listed in Chapter 5, Table 5-2 with water management strategies were presented with surveys provided by the TWDB. The survey along with supporting documentation that summarized the water management strategies included in the Regional Plan for that entity were delivered to the mayor or the city/utility manager and follow-up contacts were made with each entity to encourage response to the survey. The following Table 9-1 presents the actions taken on these surveys.

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**Table 9-1. Infrastructure Finance Survey**

| Political Subdivision Name | Strategy ID | Project Name | Total Project Capital Cost | Earliest Year of Need | Planning, Design Permitting & Acquisition Amount | Construction Funding Amount | Total Anticipated State Funding Amount | % State Participation in Excess Capacity of Project | % of Capital Cost Political Subdivision is Unable to Pay | Options for Unmet Capital Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| City of Bandera | J-1 | Reuse treated wastewater effluent for irrigation use | $450,000 | 2018 | $67,500 | $382,500 | $450,000 | 0 | 100 | CDBG, USDA-Rural, D-Fund, SRF |
| | J-2 | Promote design & install rainwater harvesting systems | $56,000 | 2017 | $11,400 | $47,600 | $76,000 | 0 | 100 | CDBG, USDA-Rural, D-Fund, SRF |
| | J-3 | Surface Water Acquisition, Treatment and ASR | $29,450,000 | 2020 | $4,417,500 | $25,032,500 | $29,450,000 | 50 | 90 | CDBG, USDA-Rural, D-Fund, SRF, SWIFT, State Participation |
| | J-4 | Additional Lower Trinity well & lay necessary pipeline | $2,284,000 | 2017 | $342,600 | $1,941,400 | $2,284,000 | 0 | 25 | CDBG, USDA-Rural, D-Fund, SRF |
| | J-5 | Additional Middle Trinity wells within City water infrastructure | $779,000 | 2017 | $116,850 | $662,150 | $779,000 | 0 | 25 | CDBG, USDA-Rural, D-Fund, SRF |
| Bandera County-Other | J-6 | Water loss audit & main-line repair for Bandera County FWSD #1 | $163,000 | 2016 | $0 | $163,000 | $163,000 | 0 | 100 | CDBG, USDA, SRF |
| | J-7 | Water loss audit & main-line repair for Bandera River Ranch #1 | $463,000 | - | - | - | - | - | - | No Response |
| | J-8 | Water loss audit & main-line repair for Medina WSC | $447,000 | - | - | - | - | - | - | No Response |
| | J-10 | Additional well for Pebble Beach Subdivision | $3,717,000 | 2017 | $557,550 | $3,159,450 | $3,717,000 | 50 | 75 | CDBG, USDA-Rural, SWIFT |
| | J-11 | Additional wells to provide emergency supply to VFD | $2,824,000 | - | - | - | - | - | - | No Response |
| | J-12 | Additional wells to help Medina Lake area | $1,377,000 | - | - | - | - | - | - | No Response |
| Bandera County Irrigation | J-13 | Additional groundwater wells | $244,000 | - | - | - | - | - | - | No Response |
| Bandera County Livestock | J-14 | Additional groundwater well | $103,000 | - | - | - | - | - | - | No Response |
| City of Rocksprings | J-15 | Water loss audit & main-line repair | $129,000 | - | - | - | - | - | - | No Response |
| | J-16 | Additional groundwater well | $650,000 | - | - | - | - | - | - | No Response |
| Edwards County - Other | J-17 | Water loss audit & main-line repair for Barksdale WSC | $203,000 | - | - | - | - | - | - | No Response |
| | J-18 | Additional well in the Nueces River Alluvium Aquifer | $114,000 | - | - | - | - | - | - | No Response |
| Edwards County Livestock | J-20 | Additional groundwater wells | $105,000 | - | $200 | - | $0 | 0 | 0 | No State funds for these projects. All private funds. |
| Edwards County Mining | J-21 | Additional groundwater wells | $109,000 | - | $200 | - | $0 | 0 | 0 | No State funds for these projects. All private funds. |
| City of Kerrville | J-22 | Increase wastewater reuse | $23,000,000 | - | - | - | - | - | - | No Response |
| | J-23 | Water loss audit & main-line repair | $9,339,000 | - | - | - | - | - | - | No Response |
| | J-24 | Purchase water from UGRA | $4,103,791 | - | - | - | - | - | - | No Response |
| | J-25 | Increased water treatment & ASR capacity | $11,543,000 | - | - | - | - | - | - | No Response |
| Loma Vista WSC | J-27 | Additional groundwater well | $728,000 | - | - | - | - | - | - | No Response |
| Kerr County-Other | J-28 | Water loss audit & main-line repair for Center Point WWW | $33,000 | - | - | - | - | - | - | No Response |
| | J-29 | Water loss audit & main-line repair for Hills & Dales WWW | $138,000 | - | - | - | - | - | - | No Response |
| | J-30 | Water loss audit & main-line repair for Rustic Hills Water | $99,000 | - | - | - | - | - | - | No Response |
| | J-31 | Water loss audit & main-line repair for Verde Park Estates WWW | $102,000 | - | - | - | - | - | - | No Response |
| | J-34 | UGRA acquisition of surface water rights | $1,087,367 | - | - | - | - | - | - | No Response |

**Table 9-1. (Continued) Infrastructure Finance Survey**

| Political Subdivision Name | Strategy ID | Project Name | Total Project Capital Cost | Earliest Year of Need | Planning, Design Permitting & Acquisition Amount | Construction Funding Amount | Total Anticipated State Funding Amount | % State Participation in Excess Capacity of Project | % of Capital Cost Political Subdivision is Unable to Pay | Options for Unmet Capital Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| Kerr County-Other | J-35 | KCCC acquisition of surface water rights | $462,140 | - | - | - | - | - | - | No Response |
| | J-36 | Construction of an off-channel surface water storage | $7,534,303 | - | - | - | - | - | - | No Response |
| | J-37 | Construction of surface water treatment plant facilities and distribution lines (CCP-UGRA) | $25,581,000 | - | - | - | - | - | - | No Response |
| | J-38 | ASR facility (CCP-UGRA) | $1,258,000 | - | - | - | - | - | - | No Response |
| | J-39 | Well field for dense, rural areas (CCP-UGRA) | $4,357,000 | - | - | - | - | - | - | No Response |
| | J-40 | Desalination plant (CCP-UGRA) | $14,539,000 | - | - | - | - | - | - | No Response |
| | J-41 | Construction of an Ellenburger Aquifer water supply well (CCP-UGRA) | $567,000 | - | - | - | - | - | - | No Response |
| Kerr County Irrigation | J-42 | Additional groundwater well | $78,000 | - | - | - | - | - | - | No Response |
| Kerr County Livestock | J-43 | Additional groundwater wells | $667,000 | - | - | - | - | - | - | Received survey but did not feel qualified to provide the data |
| | J-44 | Additional groundwater wells | $190,000 | - | - | - | - | - | - | Received survey but did not feel qualified to provide the data |
| | J-45 | Additional groundwater well | $65,000 | - | - | - | - | - | - | Received survey but did not feel qualified to provide the data |
| Kerr County Mining | J-46 | Additional groundwater well | $132,000 | - | - | - | - | - | - | No Response |
| City of Brackettville | J-47 | Water loss audit & main-line repair | $1,116 | - | - | - | - | - | - | No Response |
| | J-48 | Increase supply to Spoford with new water line | $751,000 | - | - | - | - | - | - | No Response |
| | J-49 | Increase storage facility | $288,000 | - | - | - | - | - | - | No Response |
| Fort Clark Springs MUD | J-50 | Increase storage facility | $1,033,000 | - | - | - | - | - | - | No Response |
| Kinney County Livestock | J-52 | Additional groundwater wells | $55,000 | - | - | - | - | - | - | No Response |
| City of Camp Wood | J-54 | Additional groundwater wells | $1,887,000 | - | - | - | - | - | - | No Response |
| City of Leakey (Real County Other) | J-55 | Water loss audit & main-line repair | $52,000 | - | - | - | - | - | - | No Response |
| | J-56 | Additional groundwater well | $156,000 | - | - | - | - | - | - | No Response |
| | J-57 | Develop interconnections between wells within the City | $200,000 | - | - | - | - | - | - | No Response |
| Real WSC (Real County Other) | J-58 | Water loss audit & main-line repair | $199,000 | - | - | - | - | - | - | No Response |
| Oakmont Saddle WSC (Real County Other) | J-60 | Additional well for Oakmont Saddle WSC | $420,000 | - | - | - | - | - | - | No Response |
| Real County Livestock | J-61 | Additional groundwater wells | $74,000 | - | $200 | - | $0 | 0 | 0 | No State funds for these projects. All private funds. |
| City of Del Rio | J-62 | Water loss audit & main-line repair | $8,673,000 | 2016 | $250,000 | $8,000,000 | $8,673,000 | 0 | 100 | Potentially fund with Certificates of Obligation but this will increase tax rates. |
| | J-63 | Drill & equip new well, connect to distribution system | $2,937,000 | 2016 | $120,000 | $1,500,000 | $2,937,000 | 100 | 100 | Potentially fund with Certificates of Obligation but this will increase tax rates. |
| | J-64 | Water treatment plant expansion | $1,841,000 | 2017 | $200,000 | $1,800,000 | $1,841,000 | 0 | 100 | CDBG, USDA-Rural, D-Fund, SRF, SWIFT, State Participation |
| | J-65 | Develop a wastewater reuse program | $1,700,000 | 2019 | $170,000 | $1,530,000 | $1,700,000 | 0 | 100 | CDBG, USDA-Rural, D-Fund, SRF, SWIFT, State Participation |
| Val Verde County Mining | J-67 | Additional groundwater well | $235,000 | - | - | - | - | - | - | No Response |

10

# CHAPTER 10
# PUBLIC PARTICIPATION AND PLAN ADOPTION

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# 10 PUBLIC PARTICIPATION AND PLAN ADOPTION

Chapter 10 contains an overview of the Plateau Water Planning Group (PWPG) representation, administrative planning process, specific activities that insured that the public was informed and involved in the planning process, and the implementation of the *Plan*. Chapter 10 appendices contain responses to comments on the Initially Prepared Plan by the Public (Appendix 10A), TWDB (Appendix 10B), and TPWD (Appendix 10C). Public comment letters were provided by the Hill Country Alliance, and the Llano River Field Station-Texas Tech University.

## 10.1 PLATEAU WATER PLANNING GROUP

The TWDB appointed an initial coordinating body or PWPG for the original Region J based on names submitted by the public for consideration. The PWPG then voted to change its name to Plateau and expanded its membership based on their knowledge of additional persons who could appropriately represent water user groups (Table 10-1). State planning provisions mandate that one or more representatives of the following water user groups be seated on each planning group: agriculture, counties, electric generating utilities, environment, industries, municipalities, river authorities, public, small business, water districts, and water utilities. An electric generating utility does not exist within the Plateau Region and is therefore not represented. In addition to the other 10 categories, the PWPG chose to appoint a member to represent the tourism industry because of its prevalence in the Region. Also, to insure adequate geographic representation, the PWPG made sure that at least one member was selected from each of the six counties. Membership was also extended to represent the three Groundwater Management Areas within the Region. Staff persons from both the Texas Parks and Wildlife Department and the Texas Department of Agriculture were also appointed as non- voting members. The PWPG members voluntarily devote considerable amounts of their time to the planning process.

**Table 10-1. Plateau Water Planning Group Members (Effective February 19, 2015)**

| Name | Water-use Category | County |
|---|---|---|
| Jonathan Letz, *Chair* | Small Businesses | Kerr |
| Jerry Simpton, *Vice Chair* | Other | Val Verde |
| Vacant | Industries | Kerr |
| William Feathergail Wilson | Other | Bandera |
| Homer T. Stevens, Jr. | Tourism | Bandera |
| Jerry Heffley | Water Utilities | Kerr |
| Charlie Wiedenfeld | Water Utilities | Kerr |
| Ray Buck *(UGRA–Political Entity)* | River Authorities | Kerr |
| Gene Williams | Water Districts | Kerr |
| David Maulk | Water Districts | Bandera |
| Roland Trees | Water Districts | Real |
| Rene Villareal | Water Districts | Kinney |
| Zach Davis | Agriculture | Kinney |
| Tully Shahan | Environment | Kinney |
| Lee Sweeten | Counties | Edwards |
| Stuart Barron | Municipalities | Kerr |
| Otila Gonzalez | Municipalities | Val Verde |
| Mitch Lomas | Municipalities | Val Verde |
| Thomas M. Qualia | Public | Val Verde |
| Joel Pigg | GMA7 | |
| David Jeffery | GMA9 | |
| Genell Hobbs | GMA10 | |

## 10.2 ADMINISTRATIVE PROCESS AND PROJECT MANAGEMENT

The PWPG functions through procedures set forth in their adopted bylaws and follow planning guidelines establish by Legislative rule and TWDB contractual guidelines. With planning funds administered through TWDB, the PWPG then hires technical consultants to perform the work of preparing the regional plan for planning group review and adoption. Work required completing the Plan follows well-defined guidelines intended to meet the mandated legislation and to establish a degree of format uniformity between plans submitted by all 16 planning regions. The PWPG operates its administrative function through the Upper Guadalupe River Authority (UGRA), which oversees contractual and budgetary obligations. All meetings of the PWPG are open to the public and meet Open Meetings Act requirements.

## 10.3 PLANNING GROUP MEETINGS AND PUBLIC HEARINGS

All meetings of the PWPG, including committee meetings, are open to the public where visitors are afforded the opportunity and encouraged to voice their opinions, concerns, or suggestions. Meeting locations are rotated evenly between all six counties so that all citizens within the Region have an equal opportunity to attend. In accordance with the State Open Meetings Act, meeting notices are posted with the County Commissioners' Courts of each county.

A public hearing was held in Rocksprings on July 23, 2015 to receive comments on the *2016 Initially Prepared Plan*. Notice of the Public Hearings was sent to 334 down-river water rights holders as well as to each county commissioner's court and designated libraries. Hard copies of the *Initially Prepared Plan* were placed in the courthouse and a designated library in each of the Regions' six counties listed below, and an electronic copy of the draft *Plan* was made available on the Upper Guadalupe River Authority web site http://www.ugra.org/waterdevelopment.html. The public was given a full month prior to the hearing to review the document.

- Bandera County Library
- Butt-Holdsworth Memorial Library (Kerr County)
- Claud H. Gilmer Memorial Library (Edwards County)
- Kinney County Public Library
- Real County Public Library
- Val Verde County Library

Prior to receiving official comments during the public hearing, a question and answer session was held so that the public attendees would have an opportunity to gain a better understanding of how the draft *Plan* was formulated. Six people representing the public attended the hearing, along with a majority of the planning group members. At the conclusion of the hearing, the public was notified that there would be a 60-day period in which the PWPG would continue to receive written comments. The TWDB and TPWD also reviewed the *Initially Prepared Plan* and provided comments. Responses to public comments are provided in Appendix 10A, Appendix 10B and Appendix 10C. On October 29, 2015, the PWPG met in a public forum and approved the final *2016 Plateau Region Water Plan* for submittal to the TWDB.

## 10.4 COORDINATION WITH OTHER REGIONS

Coordination with other regions was accomplished through liaisons shared with adjacent regions (Regions E, F, K, L and M) and through active participation in Chairs Conferences scheduled by the TWDB.

## 10.5 PLAN IMPLEMENTATION

Following final adoption of the *2016 Plateau Region Water Plan*, copies of the *Plan* were provided to each municipality and county commissioners' court in the Region. An electronic copy of the *Plan* is also available on the UGRA and TWDB web sites.

# APPENDIX 10A
# RESPONSE TO PUBLIC COMMENTS

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education
conservation
cooperation

hill country alliance

August 10, 2015

Mr. Jonathan Letz, Chairman
Plateau Water Planning Group (Region J)
700 Main Street, Ste. 101
Kerrville, TX 78028

Mr. Letz,

Please find below the Hill Country Alliance's Public Comments to the Plateau Water Planning Group (Region J) *2016 Initially Prepared Plan* submittal to the *2017 State Water Plan*.

HCA appreciates the good work that the Plateau Water Planning Group does to protect and preserve the natural resources that make the Hill Country a self-sustaining gift to future generations. We respectfully request that the Plateau Water Planning Group address, and to the extent possible, incorporate these recommendations into policy and practice.

Thank you,
Charlie Flatten
Water Policy Program Manager
Hill Country Alliance
512/694.1121

CC: John Ashworth, LBG-Guyton

**Hill Country Alliance Public Comment**
**Region J 2016 Initially Prepared Regional Water Plan (IPP)**

The Regional Water Planning Groups (RWPGs) play a critical role in our state's water planning process, and the Hill Country Alliance is appreciative of the huge effort that is involved in drafting the initially prepared *Regional Water Plans* (IPPs). Our comments reflect the collective vision of our Hill Country supporters, stakeholders, businesses and elected officials for a state water plan that recognizes the need to protect long-term spring-flow, healthy water catchment areas and sustained groundwater resources for current and future generations. Our comments include broad recommendations for the improvement of the regional planning process, specific policy commendations drawn from policies outlined in the IPPs, recommendations for additional study and research, and comments on specific Water Management Strategies. Hill Country Alliance acknowledges that some of our recommendations may require action by the Texas Water Development Board and/or the Legislature, and may not be the sole responsibility of this Regional Planning Group; however, this planning group should press for the incorporation of these recommended concepts, as they are able.

**<u>Broad Recommendations:</u>** Only by constantly seeking improvements to the regional water planning process can we ensure that the State Water Plan continues to improve in its ability to ensure water supply for future generations.

- In order to provide water for future generations, Hill Country Alliance recommends that the RWPGs adopt and apply a set of **guiding principles** that will serve as a blueprint for long-term water sustainability. For example: *The economy and land values of Texas depend on meeting its water needs in a way that does no harm to rivers, streams, springs, and aquifers.*

- Considering the challenge and cost of providing surging numbers of new water customers with finite water supplies, outdated infrastructure-intensive water management strategies need to be minimized in favor of innovative localized modern ***water neutral* solutions** that have been proven around the country. The RWPGs should prioritize and encourage decentralized systems and new technologies that capture, use, and reuse water in place. Where this is not practicable, priority should be given to a water neutral growth policy that requires offsetting the projected water demand of new development with water efficiency measures to create a "Net Zero" or neutral impact on overall service area demands.

- Additional definition is needed for Water Management Strategies (WMS). The Regional and State Water Plan is being criticized as less a planning document and more a **'wish list'** beset with duplicative and expensive over-planning. In 2013, the Texas Legislature provided for requirements that WMS be prioritized in order to better manage the growing list of strategies. Better definition of WMS categories and vigorous prioritization will help control the redundant and exceedingly lengthy lists.

- The two-tier system of **WMS categorization needs to be revisited** and strengthened in such a way that *Recommended Strategies* promote healthy sustainable watersheds, fulfill <u>all</u> of the TWDB's minimum prioritization criteria, and are not duplicated by a similar strategy that would fulfill the same need. The *Alternate Strategy* category should be reserved for those strategies that are duplicate or do not fulfill the TWDB's minimum criteria.

- The RWPG **consulting firms** are excellent, and provide a valuable service in the planning process. However, to avoid the perception or temptation of **conflict of interest**, the RWPGs, like other agencies, should create and enact a conflict of interest policy.

**<u>Specific Policy Recommendations:</u>** The IPPs have numerous Specific Policy Recommendations that HCA supports. We would like to commend the RWPGs for the inclusion of these policies, and encourage their adoption as part of the Regional Water Plans.

- RWPGs should prioritize strategies that protect the inherent **interconnectivity of surface water and groundwater.**

- RWPGs should de-prioritize water management strategies that dewater one region to meet the speculated need of another in the form of inter-basin pipeline transfers or otherwise.

- RWPGs should discontinue the practice of considering Water Management Strategies that rely on Groundwater that has exceeded its **MAG limitations.**

- It is vital that the state assess the **sustainability of water-consuming growth patterns** that regional water planning efforts will directly or indirectly support.

- **Counties should have additional authority** for land use planning and for regulating development based on water availability and protection of water resources.

- **Eminent Domain** powers should be recognized as contributing to the disruption of the values that undisturbed landscapes bring to natural hydrologic and ecologic functions. Given the Regional Water Planning Group's lack of authority to ignore current legal precedent, they should use their prioritization powers (HB 4, 2013) to minimize projects where using eminent domain would be necessary.

- **Rainwater harvesting** should be widely encouraged to meet rural and urban domestic water demands, as well as use for limited irrigation, such as vineyards, orchards or small farms under drip irrigation. Livestock and wildlife can also be provided supplemental water by rainwater harvesting.

- The **revision of population and demand estimates** should be put before the public for review before being presented to the planning groups for consideration and adoption.

- Due to the importance of spring-flow on the base-flow of our rivers, it is reasonable that the RWPGs encourage Hill Country Groundwater Conservation Districts to consider **management rules based on spring-flow.**

- The RWPGs should encourage better communication between the two regional planning processes developed by the Legislature (**RWPGs and GMAs**) to improve conflicting methodologies of reaching long-term planning goals.

- The Hill Country contains some of the most ecologically pristine areas in the State. The preservation of this natural environment via designation of **Unique Stream Segments** is an important component of the Region's economy. Hill Country Alliance recommends that Region J actively promote the designation of its listed unique stream segments in the 2017 legislature as Region L did in the last Legislature.

- The RWPGs should support vegetative management programs that improve the land's ability to absorb, retain, filter and slow rainwater. A **balanced approach to brush control** can be beneficial, however, a narrow goal only to "encourage the enhancement of runoff (**WSEP**)" must be avoided. Any program to incentivize land practices for the benefit of water supply must be for the purpose of improving the overall health and function of water catchment areas for the long-term.

- The RWPGs should continue to encourage funding for projects that empower landowners to better manage their lands for the long-term health of our water supply.

- Water-user groups should develop more uniform **conservation oriented management** plans and should be required to bring down their **Gallons per Capita per Day** usage to reflect the climatic realities of the region.

**Study and Data Needs:** The State should fund or conduct these specific studies to shed more information on specific water resource issues that are critical to future RWPG decisions.

- **Aquifer Science -** The Hill Country is underlain by limestone aquifers in which there are many remaining hydrological questions. A basic, unbiased, scientific study that encompasses the hydrologic characterization of the inter-formational flow between these adjacent and associated aquifers and their contribution to surface water flows is needed in order for the local groundwater management entities and the RWPGs to make informed management decisions and recommendations that maintain sustainable systems.

- **Trinity Aquifer -** The Hill Country RWPGs should explore the creation of a Regional Trinity GCD. A small regional GCD was recommended by the TCEQ for Hays, Travis and Comal Counties in 2010. This concept should be revisited and studied for the broader Hill Country Trinity region.

- **Headwaters Groundwater/Spring-flow Analysis -** Surface water base-flow in most Hill Country Rivers is derived almost exclusively from groundwater discharge through springs. However, development of management practices is impaired by a lack of understanding about how groundwater level elevations relate to spring-flow rates. Few monitoring wells are in place that can provide continuous water level readings, and no attempt has thus far been made to relate this data to spring-flows. A study is needed to evaluate this critical interaction so that future management decisions can be based on a more substantial level of scientific knowledge.

- **Groundwater/Surface Water Relationship -** The RWPGs should encourage the State (TWDB) to embrace this concept and focus water availability studies on this topic. This water supply policy definition can best be achieved when the relationship between groundwater and surface water is fully understood.

- **Unpermitted Withdrawals of Riparian Water -** A significant amount of unpermitted riparian water is withdrawn from rivers that is unaccounted for in the Water Availability Models. State water agencies should devise a survey method to establish a reasonable estimate of these diversions.

- **Optimization of Water Conservation and Efficiency -** A number of water utilities and communities in Texas have established enviable track records of success in reducing per capita water use and promoting a water conservation ethic, thereby stretching existing water supplies. However, this record of success is not universal in Texas, and indeed many communities and utilities have made minimal or no efforts to advance water conservation and efficiency. A study is needed of the additional opportunities in the Hill Country and in Texas to advance water conservation and efficiency, the potential for reducing future water demands through enhanced conservation and efficiency, and the steps needed to achieve that goal.

- **Conservation And Drought Management** - There is a need for the funding of educational programs by State agencies to assist Regional Water Planning Groups in educating both the public and private sectors about conservation and drought management. The Regional Planning group should push for the funding of programs such as the *State Water Conservation Education Program*, and the *Water IQ-Know Your Water* campaign, formally established (but unfunded) by the Texas Legislature with the passage of SB 3/HB 4 in 2007.

**Regionally Specific *Water Management Strategy* Evaluations:**

**REGION J:**

- HCA notes that 31 out of a total of 69 strategies (45%) are categorized as Conservation, Reuse, or Rainwater Strategies.

- Region J should be commended for recommending these conservation, reuse, and rainwater harvest strategies as net-zero water supply projects.

- The remaining 55% of the strategies consist of infrastructure improvements, groundwater expansion, desalination, and aquifer storage and recovery projects. Of those projects, the majority represents groundwater expansion.

- Hill Country Alliance would recommend in *those* cases that alternative supplies such as rainwater projects be explored. Rainwater projects represent fiscally comparable and resource viable alternatives to aquifer reliance.

- Region J should be commended for recommending strategies that exclude inter-basin pipeline construction, and recommending those that have only nominal environmental impacts.

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LLANO RIVER FIELD STATION
Texas Tech University @ Junction

Mr. Jonathan Letz
Plateau Water Planning Group (Region J)
700 Main Street, Suite 101
Kerrville, Texas 78028

September 15, 2015

Dear Mr. Letz:

Thank you for the opportunity to provide comments on the draft Plateau Water Planning Group Initially Prepared Plan (IPP). The planning group is to be commended for their efforts.

As part of the Healthy Watersheds Initiative under the Clean Water Act, the Llano River Field Station at Texas Tech University in Junction is preparing a Watershed Protection Plan (WPP) for the Upper Llano River Watershed, which includes the North and South Llano Rivers. The South Llano River watershed contains portions of Edwards, Kerr, and Real counties, all within the Plateau (Region J) planning area.

The implementation of the Upper Llano River WPP is slated to begin in 2016. Implementation efforts will focus on procuring funding from a wide variety of sources to achieve stakeholder goals developed for the Plan. These goals include the control of invasive species (Giant Cane/*Arundo donax* and Elephant Ears/*Colocasia esculenta*) in the watershed and management of encroaching woody species (specifically *Ashe-juniper* and mesquite) through removal of 9,000 acres annually in the watershed.

The Plateau Water Planning Group IPP identifies Vegetative Management *(Arundo donax)* for both Edwards and Real County and Vegetative Management (*Ashe-juniper)* for Kerr County. Given that the WPP specifically identifies strategies to control invasive species and manage encroaching woody species, the Llano River Field Station believes that the strategies identified in the IPP should be expanded to include Vegetation Management (*Arundo donax* and Elephant Ear) specifically for Edwards County and Vegetation Management (*Ashe-juniper* and mesquite) for Edwards, Real, and Kerr County.

We appreciate the opportunity to comment and are available to provide any additional information necessary to expand the scope of vegetative management in the IPP.

Sincerely,

Tyson Broad
Watershed Coordinator
Upper Llano River Watershed Protection Plan
Llano River Field Station – Texas Tech University
(325) 248-3137

# RESPONSE TO PUBLIC COMMENTS

A public hearing on the *2016 Plateau Region Initially Prepared Plan (IPP)* was held on July 23, 2015. Mr. Charlie Flatten, representing the Hill Country Alliance (HCA), introduced his organization and stated that the HCA would be mailing their responses to the *IPP* at a later date. No other public comments were offered. Included below are two comment letters received from the Hill Country Alliance and the Llano River Field Station – Texas Tech University, Junction, TX.

The Plateau Water Planning Group (PWPG) greatly appreciates the attention given to the *Plateau Region IPP* by these two organizations and has diligently attempted to incorporate appropriate suggestions into the final *2016 Plateau Region Water Plan*. Following are the PWPG's response to these comment letters.

<u>Hill Country Alliance</u>

The PWPG has maintained a guiding principal in the development of the *Plan* to recognize the economic importance of maintaining the natural resources of the Region, including rivers, streams, springs and aquifers. Future water management strategy recommendations put conservation as the first step in developing new water supplies. Other strategies requiring new infrastructure are presented such that developed water supplies do not exceed current water rights for surface water or MAG levels for groundwater sources. A balanced approach to brush control and land management is strongly endorsed, along with recommendations to the proper control of invasive species in the Region's watersheds. The PWPG recognizes and agrees with many other suggestions provided by HCA and, if not already incorporated into the *2016 Plan*, will continue to consider the recommendations during the next planning period.

<u>Llano River Field Station – Texas Tech University</u>

The PWPG recognizes the Llano River Field Station's role in preparing the Watershed Protection Plan for the Upper Llano River and has added a discussion about this project in Chapter 1, Section 1.2.7. The PRWPG has also included a more complete discussion on named invasive species in Vegetative Management strategies in all counties.

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# APPENDIX 10B
# RESPONSE TO TWDB COMMENTS

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# TWDB Comments on the Initially Prepared 2016 Plateau (Region J) Regional Water Plan

| Level 1: | Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements. |
|---|---|

1. Tables ES-7 and 5-2: The plan presents strategy yields in decimals of acre-feet. Please present data in the plan as whole numbers in the final, adopted regional water plan. *[Contract Exhibit 'C', Section 12.1.3]*

   - **Strategy yields have been corrected and are no longer presented in decimals of acre-feet in Tables ES-7 and 5-2.**

2. Tables ES-7 and 5-2 and pages ES-8 and 5-24: Some conservation water management strategies for municipal water user groups (WUGs) appear to be combined with brush management strategies. For example, strategies for Bandera, Kerr, Kinney, Real, and Val Verde County-Other are identified as "Conservation-Vegetative Management." Additionally, reuse and rainwater harvesting strategies J-1, J-2, J-22, J-66, and J-67 are identified as conservation strategies in Table 5-2 and the plan defines reuse, vegetative management, and rainwater harvesting as conservation on pages ES-8 and 5-24. Unless the projects are directly interdependent, and reflected as such in DB17, each project and strategy type must be associated with volumes of water provided by a single strategy type and should not be lumped together with other types of strategies. Strategy types must remain independent of one another for purposes of accounting of water availability, to reflect implementation, and to facilitate project prioritizations. Please review as appropriate throughout the final, adopted regional water plan and in the regional water planning database. *[31 Texas Administrative Code (TAC) §357.34(e); Contract Exhibit 'D', Section 5.3]*

   - **All Executive Summary tables and Chapter 5 tables have been corrected to reflect a single strategy type.**

3. Page 1-22, Section 1.2.7: Chapter 1 includes a general discussion of agricultural and natural resources and notes that the water supply needs of agriculture and natural resources are directly influenced by the quantity and quality of water, but does not appear to specifically identify each threat, if any, to agriculture and natural resources. The plan also does not appear to include a discussion of how any threats will be addressed or affected by the water management strategies evaluated in the plan. Please include a discussion of each threat to agricultural and natural resources and a discussion of how that threat will be addressed or affected by the water management strategies evaluated in the final, adopted regional water plan. *[31 TAC §357.30(7),(12)]*

   - **Additional language covering the above issues has been added to the last paragraph of Section 1.2.7.**

4. It is not clear whether the plan presents contractual obligations of WUGs and Wholesale Water Providers (WWPs). Please confirm that the plan includes the current contractual obligations of WUG and WWPs in addition to any demands projected for the WUGs and WWPs in the final, adopted regional water plan. *[31 TAC §357.31(c)]*

   - **Recognition and protection of existing water rights, water contracts, and option agreements is stated in in the 10th paragraph of Chapter 1 Section 1.1.1. This statement is now also added to the first paragraph of Chapter 5-Section 5.2.1.**

5. Please include a summary of the the municipal demand savings due to plumbing fixture requirements (as previously provided by TWDB) in the final, adopted regional water plan. *[31 TAC §357.31(d)]*

   - **A summary of the municipal demand savings due to plumbing fixture requirements is added to Chapter 2 Section 2.2.2.**

6. Pages 3-28, Section 3.2.8: It is not clear whether the plan utilizes the most current WAM Run 3 for the water availability analysis of Canyon Reservoir. If the most current WAM was utilized, please clarify in the final, adopted regional water plan. If not, please present the firm yield using the most current WAM in the final, adopted regional water plan. *[31 TAC §357.32(c)]*

   - **Section 3.2.8 Canyon Reservoir is eliminated from the Plan. Canyon Reservoir is not located in Region J nor is it a source of supply for Region J WUGs.**

7. Chapter 3: The plan does not appear to tabulate the local supplies used in the plan, along with an explanation of the basis of the associated local supply water volumes. Please include the required information on local supplies in the final, adopted regional water plan. *[Contract Exhibit 'C', Section 3.3]*

   - **A Section 3.5 Local Supply has been added to Chapter 3.**

8. Please clarify how the run-of-river availabilities were calculated for municipal water users to ensure that all monthly demands are fully met for the entire simulation of the unmodified WAM Run 3 in the final, adopted regional water plan. *[Contract Exhibit 'C', Section 3.4]*

   - **Municipal run-of-river availability is revised in second paragraph of Chapter 3 Section 3.2.**

9. The plan does not appear to include projected needs associated with each WWP, by category of use and county and river basin splits. Please include WWP needs in the final, adopted regional water plan. *[31 TAC §357.33(b),(d)]*

   - **Table 4-2 has been added to Chapter 4, which shows the WWP needs analysis.**

10. Table 5-1: The plan does not appear to identify potentially feasible water management strategies for all WUGs and WWPs with identified needs. Please include documentation that potentially feasible water management strategy types, as required by statute and rule, were considered for identified needs in the final, adopted regional water plan. *[Texas Water Code §16.053(e)(5), 31 TAC §357.34(a)]*

    - **Table 5-1 only lists the "potentially feasible" strategies from which "recommended" strategies shown in Table 5-2 were selected. All WUGs and WWPs with needs are addressed with strategies including conservation considerations.**

11. Strategies J-9, J-19, J-33, J-51, J-59, and J-68: For the brush control/vegetative management water management strategies evaluated, please include a technical analysis of the quantified yield and clarify that the quantified supply from the strategy is available during drought of record conditions in the final, adopted regional water plan. *[31 TAC §357.34(b)]*

    - **The following paragraph is added to the appropriate vegetative management strategies:**
      **An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield referenced is an increase in the average annual runoff from the treated watershed, and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be considered to be zero. For the Val Verde County / Edwards Aquifer / Upper Nueces River study, the estimated average annual volume of water supplied is 0.145 acre-feet per acre.**

12. Table 5-2: The plan's "Summary of Water Management Strategy Evaluations" is incomplete (e.g., blank fields exist in the table for most of the strategies presented) for strategy supply, total capital cost, quality, reliability, recreation, environmental factors and strategy impacts. Please provide a complete summary of water management strategy evaluations in the final, adopted regional water plan. *[31 TAC §357.34(d)(2)]*

    - **Table 5-2 is now complete with all cells containing appropriate values.**

13. Page 5-9, Table 5-2 and Appendix 5A: The plan appears to include water management strategies with incomplete strategy evaluations (due to lack of information, these strategies are inferred to provide zero supply). For example, Reuse for the City of Bandera (page 5A-1); Additional Well and Storage Capacity for the City of Rocksprings; Reuse for the City of Kerrville; Water Transfer from Canyon Lake for Kerr County-Other; Well Interconnections for the City of Leakey; Expand Treatment Plant, Increase Storage Facility, and Develop Reuse for City of Del Rio; and Receive Reuse for Laughlin AFB. Please complete the technical analyses of these recommended and alternative water

management strategies, including regarding project yields, in the final, adopted regional water plan. *[31 TAC §357.34(d)(3)]*

- **Table 5-2 and Appendix 5A are now complete.**

14. The technical evaluations of the water management strategies do not appear to estimate water losses from the associated strategies. Please include an estimate of water losses in the final, adopted regional water plan, for example in a format of an estimated percent loss. *[31 TAC §357.34(d)(3)(A); Contract Exhibit 'C', Section 5.1.1]*

    - **An estimated percent strategy supply loss is stated in the first paragraph of Chapter 5 Section 5.2.1.**

15. Appendix 5A: From the information presented in the plan, it is not clear that all required capital cost components were evaluated for each strategy. Additionally, it is not clear whether the Unified Costing Model was utilized f or cost estimates or if other project-specific costing methodologies were utilized. Please clarify the costing methodology (e.g., data sources) utilized for any water management strategy cost estimates that were not produced using the Unified Costing Model and include the cost output sheets from the Unified Costing Model, for example as an Appendix, in the final, adopted regional water plan. *[31 TAC §357.34(d)(3)(A), Contract Exhibit 'C', Sections 5.1.2 and 5.1.2.1]*

    - **A statement about the use of the Unified Costing Tool and other cost estimating procedures is provided in Chapter 5 Section 5.2.1.**

16. The plan in some instances, does not appear to include a quantitative reporting of environmental factors. For example, page 5A-17 provides qualitative descriptions as "low" impacts but the plan does not appear to include quantification of the non-zero impacts. Additionally, Tables 5-2 and 5-4 present a numeric scoring system but it is unclear if the scoring system is based upon quantitative data. Please include quantitative reporting in the final, adopted regional water plan. *[31 TAC §357.34(d)(3)(B)]*

    - **Qualitative and quantitative ranges for applicable columns in Tables 5-2 and 5-4 are provided in Appendix 5B.**

17. The plan in some instances, does not appear to include a quantitative reporting of impacts to agricultural resources. For example, pages 5A-12, 5A-15, and 5A-17 state that the aquifer is currently being used for agricultural purposes but does not appear to include quantification of impacts, if any. Additionally, Tables 5-2 and 5-4 present a numeric, qualitative scoring system but it is unclear if the scoring system is based upon quantitative data. Please include quantitative reporting of impacts to agricultural resources in the final, adopted regional water plan. *[31 TAC §357.34(d)(3)(C)]*

    - **Qualitative and quantitative ranges for applicable columns in Tables 5-2 and 5-4 are provided in Appendix 5B.**

18. Appendix 5A: The plan in some instances, does not include sufficent specificity describing the technical basis for and configurations of water management strategies. For example, Strategy J-3 does not provide adequate information to determine if sufficient surface water supply exists to implement the strategy. Please provide sufficient information in the final, adopted regional water plan for state agencies to make consistency determinations. *[31 TAC §357.34(d) and (e)]*

    - **Strategy J-3 has been revised to better describe the reliable supply (3,100 ac-ft/yr) based on WAM Run 3 analysis. The strategy supply is also changed to show 500 ac-ft/yr starting in 2020, increasing to 1,000 ac-ft/yr in 2040, and again increasing to 1,500 in 2060. This change is also reflected in Tables 5-2 and 5-3, and in DB17.**

19. Appendix 5A: Evaluations for Strategies J-10, J-12, J-50, J-57, and J-64 are unclear as to what are the recommended components of the strategies. The descriptions appear to include water storage and distribution improvements directly associated with a retail system and replacement of equipment that is nearing the end of its useful life. Water management strategy components included in regional water plans must be limited to the infrastructure required to develop and convey increased water supplies from sources and to treat the water for end user requirements. Maintenance or replacement of existing equipment or wells shall not be included as a recommended strategy with capital costs. Please remove these costs from the final, adopted regional water plan. *[31 TAC §357.34(d)(3)(A), Contract Exhibit 'C', Section 5.1.2.2 and 5.1.2.3]*

    - **Above listed strategies have been revised to specifically designate included strategy infrastructural components.**

20. Appendix 5A and Table 5-2: The plan appears to include water management strategies with treatment infrastructure that does not increase the volume of supply to water user groups. For example, Reuse for the City of Bandera; Additional Well and Storage Capacity for the City of Rocksprings; Reuse for the City of Kerrville; Water Transfer from Canyon Lake for Kerr County-Other; Well Interconnections for the City of Leakey; Expand Treatment Plant, Increase Storage Facility, and Develop Reuse for City of Del Rio; and Receive Reuse for Laughlin AFB. Regional water plans must not include any strategies or costs that are associated with simply maintaining existing water supplies or replacing infrastructure. Plans may include only infrastructure costs that are associated with volumetric increases of treated water supplies delivered to water user groups or that result in more efficient use of existing supplies. Please revise as appropriate throughout the final, adopted regional water plan. *[31 TAC §357.34(d)(3)(A), Contract Exhibit 'C', Sections 5.1.2.2 and 5.1.2.3]*

    - **Strategy text revisions have been made to designated strategies to show increased supply volumes.**

21. Appendix 5A: Strategy J-67 appears to be a duplicate of J-66 and has incomplete evaluation information. Strategies J-16, J-65, and J-38 appear to provide incomplete evaluation information. Please provide complete evaluation information in the final, adopted regional water plan. *[31 TAC §357.34(d) and (e)]*

    - **IPP Strategies J66 and J-67 have been changed to J-64 and J-65. Strategy J-65 evaluation now states that the strategy supply is reliant on Strategy J-64. All strategies have been updated to include all required information.**

22. Page 5A-13: Strategy J-12 states that "it is not economically feasible" to drill Lower Trinity wells, yet it recommends drilling a new well into the Lower Trinity. Please reconcile and confirm the economic feasibility of this strategy in the final, adopted regional water plan. *[31 TAC §357.34(e)]*

    - **The following statement is clarified – it is not economically feasible for most individual property owners ---; however, a PWS could justify the expense.**

23. Appendix 5A: Strategy J-60 appears to describe project components that have already been constructed. Please clarify what are the recommended components of this strategy in the final, adopted regional water plan. *[31 TAC §357.34(e)]*

    - **The strategy description for Oakmont Saddle Mountain WSC has been revised to specifically designate included strategy infrastructural components.**

24. Page 5-5, Table 5-1: The plan does not appear to consider conservation or drought management as a potentially feasible strategy for all identified water supply needs. Please include documentation that potentially feasible water management strategy types, as required by statute and rule, were considered to meet identified needs and, if not recommended, please document the reason why in the final, adopted regional water plan. *[31 TAC §357.34(f)]*

    - **Table 5-2 provides a listing of conservation strategies developed for all WUGs with needs. First paragraph of Chapter 5 Section 5.2.2 provides discussion pertaining to consideration of conservation and drought management plans.**

25. Page 6-3, Section 6.2: The plan contains incomplete information on impacts to agricultural resources. For example, impacts are stated as "$XXX". Please include a completed analysis in the final, adopted regional water plan. *[31 TAC §357.40(b)(1)]*

    - **Section 6.2 has been updated to reflect new information provided in the current Socioeconomic Report.**

26. Pages 7-29, Table 7-6: The plan does not include potential emergency responses for all County-Other water user groups identified (e.g., Flying L Ranch PUD). Please include this information in the final, adopted regional water plan. *[31 TAC §357.42(g)]*

    - **Table 7-6 has been updated to include emergency options for listed entities.**

27. Please indicate how the planning group considered relevant recommendations from the Drought Preparedness Council (a letter was provided to planning groups with relevant recommendations in November 2014) in the final, adopted regional water plan. *[31 TAC §357.42(h)]*

- **Drought Preparedness Council recommendations are recognized in Chapter 1 Section 1.1.1, discussed in more detail in Chapter 5 Section 5.2.1., and a link to the site is provided in Chapter 7 Section 7.1.**

28. Section 7.6.3: The plan contains region-specific data for use in a model drought contingency plan but does not appear to include region-specific model drought contingency plans. Please provide these model plans in the final, adopted regional water plan, for example in an Appendix or as an active link to an electronic document. *[31 TAC §357.42(j)]*

- **A paragraph and link are added to Chapter 7 Section 7.6.4.**

29. Please clarify in the final, adopted regional water plan how the plan development was guided by the principle that the designated water quality and related water uses as shown in the State Water Quality Management Plan shall be improved or maintained. *[31 TAC §358.3(19)]*

- **Paragraphs describing this guiding principal have been added in Chapter 1 Section 1.1.1 and Chapter 5 Section 5.2.1.**

30. Please clearly summarize which, if any, recommended water management strategies rely on or mutually exclude another recommended strategy. If such relationships exist, please account for how the strategy interactions impact the estimated water availability and yield assocciated with each impacted water management strategy in the final, adopted regional water plan. *[Contract Exhibit 'C', Section 3.4.2]*

- **Mutually associated strategies are described in a new last paragraph of Chapter 5 Section 5.2.1.**

31. Please submit all required electronic files with the final, adopted regional water plan. *[Contract Exhibit 'C', Section 12.2.1, Contract Exhibit 'D', Section 2.1]*

| **Level 2:** | **Comments and suggestions for consideration that may improve the readability and overall understanding of the regional water plan.** |
|---|---|

1. Pages 3-9: Please consider providing a complete description of the groundwater availability methodology employed for non-relevant aquifer groundwater sources in the plan.

   - **Additional groundwater availability methodology is provided in the last paragraph of Chapter 3 Section 3.1.1.**

2. Table 5-3: Recommended water management strategy J-30 has with notably high unit costs at $185,908/AF. Please confirm that calculated unit costs are correct in the final, adopted regional water plan.

   - **Strategy J-30 unit cost has been revised to $9,000 in Table 5-3.**

3. Pages 5-27: The plan refers to the City of Del Rio's 2009 Water Conservation Plan, however their most current plan was adopted April 8, 2014. Additionally, the link provided to Del Rio's conservation plan is not an active link. Please consider reflecting the contents of the most recent water conservation plan for Del Rio in the final, adopted regional water plan.

   - **Reference to City of Del Rio's Water Conservation Plan has been changed and the link has been updated.**

# APPENDIX 10C
# RESPONSE TO TPWD COMMENTS

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September 18, 2015

Mr. Jonathan Letz, Chairman
Plateau Water Planning Group (Region J)
700 Main Street, Suite 101
Kerrville, Texas 78028

Re: 2016 Plateau Region J Initially Prepared Plan

Dear Mr. Letz:

Thank you for seeking review and comment from the Texas Parks and Wildlife Department (TPWD) on the 2016 Initially Prepared Regional Water Plan (IPP) for the Plateau Region J Water Planning Area. As you know, water impacts every aspect of TPWD's mission to manage and conserve the natural and cultural resources of Texas. As the agency charged with primary responsibility for protecting the state's fish and wildlife resources, TPWD is positioned to provide technical assistance during the water planning process. Although TPWD has limited regulatory authority over the use of state waters, TPWD is committed to working with stakeholders and others to provide science-based information during the water planning process intended to avoid or minimize impacts to state fish and wildlife resources.

TPWD understands that regional water planning groups are guided by 31 TAC §357 when preparing regional water plans. These water planning rules spell out requirements related to natural resource and environmental protection. Accordingly, TPWD staff reviewed the IPP with a focus on the following questions:

- Does the IPP include a quantitative reporting of environmental factors including the effects on environmental water needs and habitat?
- Does the IPP include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the IPP discuss how these threats will be addressed?
- Does the IPP describe how it is consistent with long-term protection of natural resources?
- Does the IPP include water conservation as a water management strategy?
- Does the IPP include Drought Contingency Plans?
- Does the IPP recommend any stream segments be nominated as ecologically unique?
- If the IPP includes strategies identified in the 2010 regional water plan, does it address concerns raised by TPWD in connection with the 2010 Water Plan.

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800

www.tpwd.texas.gov

The population of the six county Plateau Water Planning Area is estimated to grow by 52 percent from 141,176 in 2020 to about 185,000 by 2070. Approximately 45 percent of the total population of the area is located in the two largest cities, Del Rio and Kerrville. Water needs are expected to grow from 39,802 acre-feet per year in 2020 to 44,937 acre-feet per year by 2070. Seventy-four percent of water use in the Region is for municipal and irrigation uses.

Recommended Water Management Strategies (WMS) for meeting future water needs include municipal water conservation, reuse, additional groundwater development including brackish groundwater, expansion of an existing aquifer storage and recovery (ASR) project and construction of a new ASR project, a new off-channel reservoir, and brush control/vegetation management. Deep well injection disposal of brine concentrate resulting from brackish groundwater desalination is one preferred approach to minimize impacts to fish and wildlife resources. Aquifer storage and recovery projects are generally preferred over surface reservoirs since habitat impacts can be minimized. TPWD supports the planning group's consideration of brush control/vegetation management as an additional means of conserving water if done in a manner that can also benefit wildlife habitat. As described in the IPP, TPWD's Kerr Wildlife Management Area has demonstrated how selective brush management coupled with good rangeland management can benefit endangered species and ranchers as well.

The Plateau Region J IPP includes thorough descriptions of natural resources and acknowledges the importance of protecting those resources. Environmental and recreational water needs are discussed in Sections 1.36 and 2.6 but not quantified. It would be appropriate to mention the Senate Bill 3 environmental flows process in this discussion. Table 5-4 provides a comparative analysis of environmental impacts related to each WMS. Quantitative reporting of environmental impacts is somewhat limited since recommended strategies rely largely on water conservation, reuse, and groundwater sources.

The IPP includes a good discussion of major springs and seeps that occur in the region. According to the IPP, groundwater availability was assessed with the goal of not significantly impacting spring flows that contribute to base flows in area rivers. Where possible, potential impacts to spring flows and spring ecosystems due to increased groundwater development should be quantified. As the plan and proposed strategies assess how increased groundwater withdrawals will impact the aquifer, base flow of streams, and spring flow, TPWD recommends the planning group also consider impacts on rare, subterranean species (e.g. blind catfish, salamanders, etc.) that rely completely on underground aquifer habitats. Little is known about these species and their aquifer habitats. As such, actions and proposed strategies in the plan should include assessments and studies of how those actions will impact these wildlife resources.

The Plateau Region J IPP discusses the use of groundwater to fill and maintain artificial lakes. The plan states that "although this use may exert stress on the local aquifer system, resulting impoundments do provide aesthetic value to the property and a water source for wildlife." TPWD cautions against the pumping of groundwater to maintain surface water bodies as this practice may rob water from an aquifer system that would otherwise store and slowly release this water in a temporally reliable fashion. Pumping groundwater to maintain surface water bodies may also negatively impact springflows that contribute to the ecological uniqueness of the Plateau region. Because groundwater is likely to be pumped at its highest intensity during drought (i.e. when aquifer levels are low), the effect of pumping groundwater to fill ponds may exacerbate the effects of drought and result in further groundwater level declines. Also, the wildlife benefits associated with the artificial habitats formed by filling impoundments with groundwater are limited. Many of these same benefits could be realized with the use of wildlife guzzlers or other forms of supplemental water that avoid evaporative losses associated with surface impoundments.

One or more new off-channel surface water storage facilities are recommended for eastern Kerr County. According to the IPP, Guadalupe River water would be captured during "excessive flow episodes" and that this strategy should have minimal environmental impact. Recent research shows that the volume and timing of periodic flood and pulse flow events are critical to a suite of ecological processes including riparian regeneration, fish spawning, and the redistribution of sediment within the river channel. Potential instream flow impacts should be described and quantified where possible.

TPWD commends the Plateau Region J Water Planning Group for its emphasis on municipal water conservation and reuse. According to the IPP, the City of Del Rio's Water Conservation Plan establishes a conservation goal of 176 gallons per capita per day, which is a 20 percent reduction from the 2007 rate. TPWD encourages Del Rio and other municipalities in the Region to adopt the Texas Water Conservation Task Force goal of 140 gallons per capita per day.

The Region J IPP does not include recommendations for designation of ecologically unique stream segments, stating "Although no specific ecologically unique river and stream segments' are recommended in this Plan, the PWPG is very explicit in acknowledging the importance of all springs and stream segments for their significance as wildlife habitat." If the PWPG chooses to recommend any of these stream segments in the future TPWD stands ready to provide any additional supporting information necessary to designate these segments as unique.

Thank you for your consideration of these comments. TPWD appreciates recognition in the IPP of our participation in the planning process. We look forward to continuing to work with the planning group to develop water supply strategies that not only meet the future water supply needs of the region but also preserve the ecological health of the region's aquatic resources. Please contact Ms. Cindy Loeffler at (512) 389-8715 if you have any questions or comments.

Sincerely,

Ross Melinchuk
Deputy Executive Director, Natural Resources

RM:CL

cc: Mr. Craig Bonds, Division Director, Inland Fisheries Division, TPWD
Mr. Clayton Wolf, Division Director, Wildlife Division, TPWD
Ms. Megan Bean, Inland Fisheries Division, TPWD

# RESPONSE TO TPWD COMMENTS

The Plateau Water Planning Group (PWPG) greatly appreciates the assistance that staff of the Texas Parks and Wildlife Department (TPWD) has provided throughout all of the planning periods. The current *IPP* comment letter is quite complimentary and contains a number of justifiable recommendations. It has been a goal of the PWPG to recognize the importance of the natural resources and ecological environments of this Region as they play a key role in the healthy economy of this Region. It is hoped that many of TPWD's concerns pertaining to maintaining healthy environmental habitats are addressed in the final *2016 Plan*. It is acknowledged that specific recommendations pertaining to quantifying environmental and recreational water needs, impacts on rare subterranean species, and instream flow impacts of proposed new off-channel surface water storage facilities still may need further development, and will strive to do so during the next planning period.

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11

# CHAPTER 11

# IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

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# 11 IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

As a result of new statutory requirements from SB660 (82nd Legislative Session) the planning rules (31 TAC §357.45(a)) require that each region report the level of implementation of previously recommended WMSs meeting water shortages. Chapter 11 contains an overview of the implemented water strategies detailed in the *2011 Plan* (Table 11-1). To best appreciate the continued improvements to the Plateau Region water planning process, this chapter also offers a comparison of key components in the *2011 Plateau Region Water Plan* to those in this current *2016 Plateau Region Water Plan.*

## 11.1 IMPLEMENTATION OF PREVIOUS REGIONAL WATER PLAN

Information needed to report on the implementation of the previous regional water plan was collected through a survey process. Table 11-1 provides a summary of the results of this survey. A total of seven WUGs were surveyed which included eighteen water projects.

**Table 11-1. 2011 Plateau Region Strategy Implementation Survey**

| Sponser | Recommended Water Management Strategy | Capital Costs | Infrastructure Type | At what level of implementation is the project? | If not implemented, why? | Initial Volume of Water Provided (acft/yr) | Funds Expended to Date ($) | Project Cost ($) | Year the Project is Online | Is this a phased project? | (Phased) Ultimate Volume (acft/yr) | (Phased) Ultimate Project Cost ($) | Year project reaches maximum capacity? | What is the project funding source(s)? | Included in the 2016 Plan? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bandera | Conservation: public information | $0 | No infrastructure | All phases fully implemented | N/A | 224 | | N/A | 2012 | No | 224 | N/A | N/A | Local | No |
| Bandera | Surface water acquisition, treatment and aquifer storage and recovery | $19,654,900 | Other | Not implemented | Financing | N/A | $0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | No |
| Brackettville | Conservation: system water audit and water loss audit | $0 | | | | | | | | | | | | | Yes |
| Camp Wood | Conservation: public information | $0 | No infrastructure | Currently operating | N/A | N/A | $1,500 | N/A | 2011 | No | N/A | N/A | N/A | Local | Yes |
| Camp Wood | Groundwater wells | $247,250 | Wells | Acquisition and design phase | N/A | 80 | $0 | $350,000 | N/A | No | 80 | $350,000 | 2017 | TDA Block Grant | Yes |
| County-Other Edwards | Additional groundwater wells | $50,600 | Wells | Acquisition and design phase | N/A | 25 | $0 | $240,000 | 2016 | No | 25 | $240,000.00 | 2016 | TDA Block Grant | Yes |
| County-Other Edwards | Conservation: public information | $0 | No infrastructure | All phases fully implemented | N/A | N/A | $500 | N/A | 2011 | No | N/A | N/A | N/A | N/A | No |
| County-Other Edwards | Replace pressure tank | $7,000 | Other | Not implemented | Not needed at this time | 0 | $0 | $0 | N/A | N/A | N/A | N/A | N/A | N/A | No |
| County-Other Kerr | Conservation: brush management | $3,937,790 | No infrastructure | All phases fully implemented | N/A | | $231,391 | N/A | 2011 | No | N/A | N/A | N/A | Local | Yes |
| County-Other Kerr | Conservation: public information | $0 | No infrastructure | All phases fully implemented | N/A | | $125,000 | N/A | 2011 | No | N/A | N/A | N/A | Local | Yes |
| County-Other Kerr | Surface water acquisition, treatment and aquifer storage and recovery | $17,005,100 | | | | | | | | | | | | | Yes |
| County-Other Kerr | Surface water storage | $7,050,000 | | | | | | | | | | | | | Yes |
| County-Other Real | Additional groundwater wells | $189,750 | Wells | Under construction | N/A | 120 | $111,971 | $500,000 | 2014 | No | 120 | $500,000.00 | 2014 | City of Leakey funds | Yes |
| County-Other Real | Conservation: system water audit and water loss audit | $0 | No Infrastructure | Currently operating | N/A | N/A | $0 | $0 | Currently operating | No | N/A | N/A | N/A | City of Leakey funds | Yes |
| Kerrville | Conservation: public information | $0 | | | | | | | | | | | | | No |
| Kerrville | Conservation: system water audit and water loss audit | $0 | | | | | | | | | | | | | Yes |
| Kerrville | Increased water treatment and aquifer storage and recovery capacity | $6,650,000 | | | | | | | | | | | | | Yes |
| Kerrville | Purchase water from UGRA | $0 | | | | | | | | | | | | | Yes |

## 11.2 COMPARISON TO PREVIOUS PLAN

The following section includes a brief summary that shows how the *2016 Plan* differs from the *2011 Plan*. Comparisons include:

1 Water demand projections;

2 Drought of record and the hydrologic and modeling assumptions on which plans are based;

3 Water availability at the source;

4 Existing water supplies of WUGs;

5 WUG and WWP needs;

6 Recommended and alternative water management strategies; and

7 Any other aspects of the plans that the PWPG chooses to compare.

### 11.2.1 Water Demand Projections

The following Table 11-2 provides a comparison between *2011* and *2016 Plan* water demand projections. The general decrease in water demand in the latest *Plan* is mostly the result of lower population projections based on the 2010 census.

**Table 11-2. Water Demand Projections Comparison (Acre-Feet per Year)**

| County | Plan | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bandera | 2011 | 3,671 | 4,725 | 5,774 | 6,341 | 6,528 | 6,900 | |
| | 2016 | | 3,413 | 3,717 | 3,872 | 3,928 | 3,972 | 3,998 |
| Edwards | 2011 | 1,249 | 1,254 | 1,229 | 1,205 | 1,188 | 1,166 | |
| | 2016 | | 1,230 | 1,211 | 1,193 | 1,184 | 1,173 | 1,166 |
| Kerr | 2011 | 9,814 | 10,377 | 10,552 | 10,503 | 10,751 | 10,857 | |
| | 2016 | | 9,063 | 9,154 | 9,171 | 9,242 | 9,343 | 9,433 |
| Kinney | 2011 | 15,228 | 14,661 | 14,122 | 13,613 | 13,121 | 12,641 | |
| | 2016 | | 8,406 | 8,397 | 8,384 | 8,380 | 8,378 | 8,378 |
| Real | 2011 | 1,173 | 1,157 | 1,119 | 1,083 | 1,079 | 1,075 | |
| | 2016 | | 913 | 890 | 870 | 855 | 843 | 835 |
| Val Verde | 2011 | 20,793 | 22,233 | 23,549 | 24,587 | 25,401 | 26,004 | |
| | 2016 | | 16,777 | 17,664 | 18,519 | 19,398 | 20,262 | 21,127 |
| Total | 2011 | 51,928 | 54,407 | 56,345 | 57,332 | 58,068 | 58,643 | |
| | 2016 | | 39,802 | 41,033 | 42,009 | 42,987 | 43,971 | 44,937 |

### 11.2.2 Drought of Record and Hydrologic and Modeling Assumptions

The drought of record consideration for water supply analysis for both the *2011* and *2016 Plans* is the drought of the 1950s. However, the *2016 Plan* does recognize that the current drought conditions, as particularly witnessed in the summer of 2011, is having a significant impact on local water supply sources. Surface water availability for both the *2011* and *2016 Plans* is based on Run 3 of the TCEQ Water Availability Models (WAMs) for the five river basins within the Plateau Region.

Groundwater availability in the *2011 Plan* was based on TWDB Groundwater Availability Model (GAMs) simulations as performed by the planning group hydrogeological consultants. Groundwater availability was defined by the planning group as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions.

In the *2016 Plan* groundwater availability is based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs) (per Texas Water Code 36.001). Aquifers recognized in this *2016 Plan* that are not included in the GMA-MAG process are termed "non-relevant" and "other aquifer". Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods.

### 11.2.3 Water Availability at the Source

As explained in the previous section, surface water source availability has not changed between the two *Plans*; however, groundwater availability has changed significantly due to the new GMA MAG requirements. In total, water supply from the source decreased from 195,103 acre-feet per year in the *2011 Plan* to 169, 608 acre-feet per year in the *2016 Plan*, with all the decrease occurring in the groundwater sources. The following Table 11-3 depicts these changes.

**Table 11-3. Source Supply Availability Comparison (Acre-Feet per Year)**

| County | Supply Source (Aquifer-River-Spring) | River Basin | 2011 Plan Source Availability | 2016 Plan Source Availability |
|---|---|---|---|---|
| Bandera | Edwards-Trinity (Plateau) | Guadalupe | 860 | 21 |
| | Edwards-Trinity (Plateau) | Nueces | 11,250 | 101 |
| | Edwards-Trinity (Plateau) | San Antonio | 5,200 | 561 |
| | Trinity | Guadalupe | - | 76 |
| | Trinity | Nueces | 5,969 | 903 |
| | Trinity | San Antonio | 12,589 | 6,305 |
| | Livestock Local Supply | San Antonio | 72 | 74 |
| | Upper Guadalupe River | Guadalupe | 3 | 3 |
| | Medina River | San Antonio | - | 0 |
| | Medina Lake/Reservoir | San Antonio | - | 0 |
| | Sabinal River | Nueces | 7 | 7 |
| | Hondo Creek | Nueces | 20 | 20 |
| | **County Total** | | **35,970** | **8,071** |
| Edwards | Edwards-Trinity (Plateau) | Colorado | 2,610 | 2,306 |
| | Edwards-Trinity (Plateau) | Nueces | 3,480 | 1,632 |
| | Edwards-Trinity (Plateau) | Rio Grande | 2,609 | 1,700 |
| | Nueces River Alluvium | Nueces | 1,787 | 1,787 |
| | Livestock Local Supply | Colorado | 61 | 13 |
| | Livestock Local Supply | Nueces | 62 | 47 |
| | Other Local Supply | Nueces | - | 11 |
| | Livestock Local Supply | Rio Grande | - | 13 |
| | Nueces River | Nueces | 138 | 138 |
| | West Nueces River | Nueces | 5 | 5 |
| | South Llano River | Colorado | 43 | 43 |
| | **County Total** | | **10,795** | **7,695** |
| Kerr | Edwards-Trinity (Plateau) | Colorado | 4,250 | 245 |
| | Edwards-Trinity (Plateau) | Guadalupe | 11,500 | 1,015 |
| | Edwards-Trinity (Plateau) | San Antonio | 330 | 3 |
| | Edwards-Trinity (Plateau) | Nueces | 330 | 5 |

**Table 11-3. (Continued) Source Supply Availability Comparison (Acre-Feet per Year)**

| County | Supply Source (Aquifer-River-Spring) | River Basin | 2011 Plan Source Availability | 2016 Plan Source Availability |
|---|---|---|---|---|
| Kerr | Trinity | Colorado | - | 318 |
| | Trinity | Guadalupe | 15,492 | 14,129 |
| | Trinity | San Antonio | 1,832 | 471 |
| | Trinity | Nueces | - | 0 |
| | Trinity ASR | Guadalupe | - | 390 |
| | Livestock Local Supply | Colorado | 20 | 46 |
| | Livestock Local Supply | Guadalupe | 73 | 393 |
| | Livestock Local Supply | San Antonio | 12 | 23 |
| | Upper Guadalupe River | Guadalupe | 1,221 | 1,221 |
| | **County Total** | | **35,000** | **18,259** |
| Kinney | Edwards-Trinity (Plateau) | Nueces | 1,432 | 12 |
| | Edwards-Trinity (Plateau) | Rio Grande | 21,000 | 70,326 |
| | Edwards (BFZ) | Nueces | 6,952 | 6,319 |
| | Edwards (BFZ) | Rio Grande | 1,800 | 2 |
| | Austin Chalk | Rio Grande | 4,982 | 4,928 |
| | Livestock Local Supply | Nueces | 45 | 42 |
| | Livestock Local Supply | Rio Grande | 90 | 42 |
| | Mud Creek | Rio Grande | 120 | 120 |
| | Pinto Creek | Rio Grande | 95 | 95 |
| | Los Moras Creek | Rio Grande | 669 | 669 |
| | Elm Creek | Rio Grande | 43 | 43 |
| | Rio Grande | Rio Grande | 176 | 176 |
| | **County Total** | | **37,323** | **82,774** |
| Real | Edwards-Trinity (Plateau) | Colorado | 200 | 278 |
| | Edwards-Trinity (Plateau) | Guadalupe | - | 3 |
| | Edwards-Trinity (Plateau) | Nueces | 5,537 | 7,196 |
| | Trinity | Nueces | 380 | 52 |
| | Frio River Alluvium | Nueces | 2,145 | 2,145 |
| | Nueces River Alluvium | Nueces | 1,787 | 1,787 |
| | Livestock Local Supply | Colorado | 24 | 3 |
| | Livestock Local Supply | Nueces | 25 | 50 |
| | Old Faithful Springs | Nueces | - | 0 |
| | Nueces River | Nueces | 648 | 648 |
| | Frio River | Nueces | 1,514 | 1,514 |
| | **County Total** | | **12,260** | **13,676** |
| Val Verde | Edwards-Trinity (Plateau) | Rio Grande | 49,607 | 24,988 |
| | Livestock Local Supply | Rio Grande | 153 | 27 |
| | Other Local Supply | Rio Grande | - | 149 |
| | Rio Grande | Rio Grande | 125 | 125 |
| | Cienegas Creek | Rio Grande | 794 | 794 |
| | San Felipe Creek | Rio Grande | 13,016 | 13,016 |
| | **County Total** | | **63,695** | **39,099** |

### 11.2.4 Existing Water Supplies of WUGs

Table 11-4 compares *2011 Plan* and *2016 Plan* water supplies available to cities and general water use categories based on the current infrastructure ability of each to obtain water supplies. These abilities primarily include existing infrastructure, water-rights limitations, and groundwater conservation district permit limitations.

**Table 11-4. Existing Water Supplies of WUGs Comparison (Acre-Feet per Year)**

| County | Water User Group | Source Basin | Source Name | 2011 Plan WUG Supplies | 2016 Plan WUG Supplies |
|---|---|---|---|---|---|
| Bandera | Bandera | San Antonio | Trinity | 1,210 | 660 |
| | County Other | Guadalupe | Edwards-Trinity (Plateau) | 31 | 20 |
| | | San Antonio | Edwards-Trinity (Plateau) | 803 | 411 |
| | | | Trinity | 9,870 | 1,960 |
| | | | Medina River | 0 | 0 |
| | | Nueces | Edwards-Trinity (Plateau) | 115 | 39 |
| | | | Trinity | 689 | 109 |
| | | | Sabinal River | 2 | 2 |
| | Mining | San Antonio | Trinity | 24 | - |
| | Irrigation | San Antonio | Trinity | 283 | 217 |
| | | | Medina River | 0 | 0 |
| | | Nueces | Trinity | 156 | 461 |
| | | | Hondo Creek | 20 | 25 |
| | | | Sabinal River | 5 | |
| | Livestock | Guadalupe | Edwards-Trinity (Plateau) | 6 | 1 |
| | | San Antonio | Trinity | 158 | 99 |
| | | | Edwards-Trinity (Plateau) | 32 | 52 |
| | | | Local Supply | 72 | 74 |
| | | Nueces | Trinity | 80 | 48 |
| | | | Edwards-Trinity (Plateau) | 15 | 24 |
| Edwards | Rocksprings | Colorado | Edwards-Trinity (Plateau) | 322 | 919 |
| | | Nueces | Edwards-Trinity (Plateau) | 180 | 0 |
| | County Other | Colorado | Edwards-Trinity (Plateau) | 121 | 83 |
| | | Nueces | Edwards-Trinity (Plateau) | 411 | 223 |
| | | | Other Aquifer (Nueces Alluvium) | 34 | 12 |
| | | Rio Grande | Edwards-Trinity (Plateau) | 72 | 44 |
| | Mining | Colorado | Edwards-Trinity (Plateau) | 89 | 23 |
| | | Nueces | Edwards-Trinity (Plateau) | - | 32 |
| | | | Local Supply | - | 11 |
| | | Rio Grande | Edwards-Trinity (Plateau) | - | 23 |
| | Irrigation | Colorado | Edwards-Trinity (Plateau) | 53 | 77 |
| | | | South Llano River | 43 | 43 |
| | | Nueces | Edwards-Trinity (Plateau) | 54 | 103 |
| | | | Nueces River | 138 | 143 |
| | | | West Nueces River | 5 | |
| | | Rio Grande | Edwards-Trinity (Plateau) | 53 | 77 |
| | Livestock | Colorado | Edwards-Trinity (Plateau) | 164 | 141 |
| | | | Local Supply | 61 | 5 |
| | | Nueces | Edwards-Trinity (Plateau) | 168 | 189 |
| | | | Local Supply | 62 | 47 |
| | | Rio Grande | Edwards-Trinity (Plateau) | 164 | 141 |
| Kerr | Kerrville | Guadalupe | Trinity | 2,890 | 885 |
| | | | Upper Guadalupe River | 150 | 150 |
| | | | ASR | - | 390 |
| | Ingram | Guadalupe | Trinity | 585 | 552 |
| | Loma Vista WS | Guadalupe | Trinity | - | 387 |
| | County Other | Colorado | Edwards-Trinity (Plateau) | 251 | 48 |
| | | Guadalupe | Edwards-Trinity (Plateau) | 5,547 | 457 |
| | | | Trinity | 6,504 | 4,716 |
| | | | Upper Guadalupe River | 15 | 15 |
| | | Nueces | Edwards-Trinity (Plateau) | - | 0 |
| | | San Antonio | Edwards-Trinity (Plateau) | 125 | 1 |
| | | | Trinity | 627 | 112 |

**Table 11-4. (Continued) Existing Water Supplies of WUGs Comparison (Acre-Feet per Year)**

| County | Water User Group | Source Basin | Source Name | 2011 Plan WUG Supplies | 2016 Plan WUG Supplies |
|---|---|---|---|---|---|
| Kerr | Manufacturing | Guadalupe | Trinity | 12 | 25 |
| | | | Edwards-Trinity (Plateau) | 30 | - |
| | | | Upper Guadalupe River | 9 | 9 |
| | Mining | Colorado | Edwards-Trinity (Plateau) | 13 | 2 |
| | | Guadalupe | Trinity | 159 | 5 |
| | | | Edwards-Trinity (Plateau) | 4 | 10 |
| | | | Upper Guadalupe River | 89 | 89 |
| | Irrigation | Colorado | Edwards-Trinity (Plateau) | - | 44 |
| | | Guadalupe | Trinity | 863 | 402 |
| | | | Upper Guadalupe River | 958 | 958 |
| | | San Antonio | Edwards-Trinity (Plateau) | - | 1 |
| | Livestock | Colorado | Edwards-Trinity (Plateau) | 105 | 43 |
| | | | Local Supply | 20 | 46 |
| | | Guadalupe | Trinity | 122 | 247 |
| | | | Edwards-Trinity (Plateau) | 160 | 133 |
| | | | Local Supply | 73 | 393 |
| | | San Antonio | Edwards-Trinity (Plateau) | 22 | 1 |
| | | | Local Supply | 12 | 23 |
| | | Nueces | Edwards-Trinity (Plateau) | 12 | 5 |
| Kinney | Brackettville | Rio Grande | Edwards (BFZ) | 645 | 645 |
| | | | Los Moras Creek | 2 | 0 |
| | Fort Clark Springs | Rio Grande | Edwards (BFZ) | 1,120 | 1,371 |
| | County Other | Nueces | Edwards (BFZ) | 41 | 29 |
| | | | Edwards-Trinity (Plateau) | 7 | 5 |
| | | Rio Grande | Edwards-Trinity (Plateau) | 24 | 132 |
| | | | Austin Chalk | 64 | 125 |
| | Irrigation | Nueces | Edwards (BFZ) | 4,382 | 2,694 |
| | | | Edwards-Trinity (Plateau) | 0 | - |
| | | Rio Grande | Edwards-Trinity (Plateau) | 20,813 | 3,367 |
| | | | Austin Chalk | 3,872 | 673 |
| | | | Mud Creek | 120 | 1,099 |
| | | | Pinto Creek | 95 | |
| | | | Los Moras Creek | 665 | |
| | | | Elm Creek | 43 | |
| | | | Rio Grande | 176 | |
| | Livestock | Nueces | Edwards (BFZ) | 130 | 162 |
| | | | Edwards-Trinity (Plateau) | 159 | 7 |
| | | | Local Supply | 45 | 42 |
| | | Rio Grande | Edwards-Trinity (Plateau) | 159 | 84 |
| | | | Other Aquifer (Austin Chalk) | 92 | 85 |
| | | | Local Supply | 90 | 42 |
| Real | Camp Wood | Nueces | Old Faithful Springs | 0 | 0 |
| | County Other | Colorado | Edwards-Trinity (Plateau) | 34 | 15 |
| | | Nueces | Edwards-Trinity (Plateau) | 491 | 357 |
| | | | Other Aquifer (Frio Alluvium) | 997 | |
| | | | Other Aquifer (Nueces Alluvium) | - | 736 |
| | | | Nueces River | 0 | 0 |
| | Mining | Colorado | Edwards-Trinity (Plateau) | 6 | - |
| | Irrigation | Colorado | Edwards-Trinity (Plateau) | - | 50 |
| | | Nueces | Edwards-Trinity (Plateau) | 349 | 153 |
| | | | Nueces River | 648 | 2,162 |
| | | | Frio River | 1,514 | |

**Table 11-4. (Continued) Existing Water Supplies of WUGs Comparison (Acre-Feet per Year)**

| County | Water User Group | Source Basin | Source Name | 2011 Plan WUG Supplies | 2016 Plan WUG Supplies |
|---|---|---|---|---|---|
| Real | Livestock | Nueces | Edwards-Trinity (Plateau) | 180 | 156 |
| | | | Local Supply | 25 | 50 |
| | | Colorado | Edwards-Trinity (Plateau) | 15 | 52 |
| | | | Local Supply | 24 | 3 |
| Val Verde | Del Rio | Rio Grande | San Felipe Springs | 7,461 | 11,416 |
| | | | Edwards-Trinity (Plateau) | 9,116 | 15,484 |
| | Laughlin AFB | Rio Grande | Edwards-Trinity (Plateau) (Purchased from Del Rio) | 2,178 | 2,299 |
| | | | Edwards-Trinity (Plateau) | 121 | |
| | County Other | Rio Grande | Edwards-Trinity (Plateau) (Purchased from Del Rio) | 1,631 | - |
| | | | Edwards-Trinity (Plateau) | 4,413 | 4,513 |
| | Mining | Rio Grande | Edwards-Trinity (Plateau) | 156 | 37 |
| | | | Local Supply | - | 149 |
| | Irrigation | Rio Grande | Edwards-Trinity (Plateau) | 363 | 276 |
| | | | Cienegas Creek | 794 | 2,519 |
| | | | San Felipe Springs | 5,555 | |
| | | | Rio Grande | 125 | |
| | Livestock | Rio Grande | Edwards-Trinity (Plateau) | 614 | 506 |
| | | | Local Supply | 153 | 27 |

### 11.2.5 WUG and WWP Needs

Water supply needs occur when an entity's (WUG's) projected water demand (Table 11-2) exceeds its supply availability (Table 11-4). Table 11-5 compares those entities in the *2011 Plan* that are projected to experience a water supply need at some decade in the next 50 years to those in the *2016 Plan*. The dramatic difference between WUG needs in the two *Plans* is primarily the result of the decreased supply source availability (Table 11-3) shown in the *2016 Plan*.

**Table 11-5. WUG and WWP Needs Comparison (Acre-Feet per Year)**

| 2011 Plan | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **County** | **WUG/WWP** | **Source Basin** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | |
| Kerr | Kerrville | Guadalupe | 1,322 | 1,706 | 1,878 | 1,897 | 2,112 | 2,222 | |
| Real | Camp Wood | Nueces | 172 | 172 | 166 | 160 | 163 | 167 | |
| **2016 Plan** | | | | | | | | | |
| **County** | **WUG/WWP** | **Source Basin** | | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Bandera | Irrigation | San Antonio | | 129 | 129 | 129 | 129 | 129 | 129 |
| | Livestock | Guadalupe | | 12 | 12 | 12 | 12 | 12 | 12 |
| | Livestock | San Antonio | | 1 | 1 | 1 | 1 | 1 | 1 |
| Edwards | Rocksprings | Nueces | | 98 | 96 | 94 | 94 | 94 | 94 |
| | Livestock | Nueces | | 16 | 16 | 16 | 16 | 16 | 16 |
| | Mining | Rio Grande | | 22 | 22 | 22 | 22 | 22 | 22 |
| Kerr | Kerrville | Guadalupe | | 3,194 | 3,263 | 3,281 | 3,334 | 3,396 | 3,450 |
| | Loma Vista WS | Guadalupe | | 30 | 37 | 38 | 44 | 51 | 57 |
| | County Other | Colorado | | 5 | 5 | 5 | 5 | 6 | 7 |
| | County Other | Nueces | | 1 | 1 | 1 | 1 | 1 | 1 |
| | Livestock | Colorado | | 106 | 106 | 106 | 106 | 106 | 106 |
| | Livestock | Nueces | | 6 | 6 | 6 | 6 | 6 | 6 |
| | Livestock | San Antonio | | 18 | 18 | 18 | 18 | 18 | 18 |
| | Irrigation | San Antonio | | 14 | 14 | 13 | 13 | 12 | 12 |
| | Mining | Colorado | | 12 | 13 | 17 | 17 | 19 | 21 |
| Kinney | Livestock | Rio Grande | | 22 | 22 | 22 | 22 | 22 | 22 |
| Real | Camp Wood | Nueces | | 134 | 131 | 128 | 127 | 126 | 126 |
| | Livestock | Nueces | | 33 | 33 | 33 | 33 | 33 | 33 |
| Val Verde | Mining | Rio Grande | | 4 | 63 | 73 | 37 | 6 | |

### 11.2.6 Recommended Water Management Strategies in the 2011 Plan

A total of 18 water management strategies (Table 11-6) for seven water user groups (WUGs) were recommended in the *2011 Plan*, with a total capital cost of $54,792,390. As a result of more WUGs projecting a water supply need (Table 11-5) in the *2016 Plan*, a total of 67 strategies (Table 11-7) for 27 WUGs were recommended with a total capital cost of $146,202,577.

**Table 11-6. 2011 Recommended Water Management Strategies**

| County | Water User Group | Strategy | Source | Strategy Supply (Acre-Feet/Year) 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | Total Capital Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| Bandera | City of Bandera | Surface water acquisition, treatment and ASR | Medina River | | 500 | 500 | 1,000 | 1,000 | 1,500 | $19,654,900 |
| | | Conservation: Public information | Conservation | 3 | 3 | 3 | 3 | 4 | 4 | $0 |
| Edwards | Community of Barksdale (Edwards County Other) | Additional groundwater wells | Nueces River Alluvium Aquifer | 17 | 17 | 17 | 17 | 17 | 17 | $50,600 |
| | | Replace pressure tank | Nueces River Alluvium Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | $7,000 |
| | | Conservation: Public information | Conservation | 2 | 2 | 2 | 2 | 2 | 2 | $0 |
| Kerr | City of Kerrville | Purchase water from UGRA | Guadalupe River | | | 3,840 | 3,840 | 3,840 | 5,450 | $0 |
| | | Increased water treatment and ASR capacity | Guadalupe River | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 | $6,650,000 |
| | | Conservation: System water audit and water loss audit | Conservation | 436 | 475 | 492 | 494 | 515 | 526 | $0 |
| | | Conservation: Public information | Conservation | 44 | 47 | 49 | 49 | 52 | 53 | $0 |
| Kerr | Upper Guadalupe River Authority (Kerr County Other) | Surface water acquisition, treatment and ASR | Guadalupe River | | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $17,005,100 |
| | | Surface water storage | Guadalupe River | | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,050,000 |
| | | Conservation: Brush management | Conservation | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | $3,937,790 |
| | | Conservation: Public information | Conservation | 14 | 15 | 15 | 15 | 16 | 16 | $0 |
| Kinney | City of Brackettville | Conservation: System water audit and water loss audit | Conservation | 58 | 58 | 58 | 58 | 58 | 58 | $0 |
| Real | City of Leakey (Real County Other) | Additional groundwater wells | Trinity Aquifer | 205 | 205 | 205 | 205 | 205 | 205 | $189,750 |
| | | Conservation: System water audit and water loss audit | Conservation | 20 | 20 | 20 | 20 | 20 | 20 | $0 |
| Real | City of Camp Wood | Groundwater wells | Edwards-Trinity (Plateau) Aquifer | 172 | 172 | 172 | 172 | 172 | 172 | $247,250 |
| | | Conservation: Public information | Conservation | 2 | 2 | 2 | 2 | 2 | 2 | $0 |

**Table 11-6. 2011 Recommended Water Management Strategies**

| County | Water User Group | Strategy | Source | Strategy Supply (Acre-Feet/Year) | | | | | | Total Capital Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | |
| Bandera | City of Bandera | Surface water acquisition, treatment and ASR | Medina River | | 500 | 500 | 1,000 | 1,000 | 1,500 | $19,654,900 |
| | | Conservation: Public information | Conservation | 3 | 3 | 3 | 3 | 4 | 4 | $0 |
| Edwards | Community of Barksdale (Edwards County Other) | Additional groundwater wells | Nueces River Alluvium Aquifer | 17 | 17 | 17 | 17 | 17 | 17 | $50,600 |
| | | Replace pressure tank | Nueces River Alluvium Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | $7,000 |
| | | Conservation: Public information | Conservation | 2 | 2 | 2 | 2 | 2 | 2 | $0 |
| Kerr | City of Kerrville | Purchase water from UGRA | Guadalupe River | | | 3,840 | 3,840 | 3,840 | 5,450 | $0 |
| | | Increased water treatment and ASR capacity | Guadalupe River | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 | $6,650,000 |
| | | Conservation: System water audit and water loss audit | Conservation | 436 | 475 | 492 | 494 | 515 | 526 | $0 |
| | | Conservation: Public information | Conservation | 44 | 47 | 49 | 49 | 52 | 53 | $0 |
| Kerr | Upper Guadalupe River Authority (Kerr County Other) | Surface water acquisition, treatment and ASR | Guadalupe River | | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $17,005,100 |
| | | Surface water storage | Guadalupe River | | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,050,000 |
| | | Conservation: Brush management | Conservation | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | $3,937,790 |
| | | Conservation: Public information | Conservation | 14 | 15 | 15 | 15 | 16 | 16 | $0 |
| Kinney | City of Brackettville | Conservation: System water audit and water loss audit | Conservation | 58 | 58 | 58 | 58 | 58 | 58 | $0 |
| Real | City of Leakey (Real County Other) | Additional groundwater wells | Trinity Aquifer | 205 | 205 | 205 | 205 | 205 | 205 | $189,750 |
| | | Conservation: System water audit and water loss audit | Conservation | 20 | 20 | 20 | 20 | 20 | 20 | $0 |
| Real | City of Camp Wood | Groundwater wells | Edwards-Trinity (Plateau) Aquifer | 172 | 172 | 172 | 172 | 172 | 172 | $247,250 |
| | | Conservation: Public information | Conservation | 2 | 2 | 2 | 2 | 2 | 2 | $0 |

**Table 11-7. 2016 Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Bandera | City of Bandera | San Antonio | Reuse treated wastewater effluent for irrigation use | J-1 | 310 | 310 | 310 | 310 | 310 | 310 | $450,000 |
| | | | Promote, design & install rainwater harvesting systems | J-2 | 1 | 1 | 1 | 1 | 1 | 1 | $56,000 |
| | | | Additional Lower Trinity well and lay necessary pipeline | J-4 | 323 | 323 | 323 | 323 | 323 | 323 | $2,284,000 |
| | | | Additional Middle Trinity wells within City water infrastructure | J-5 | 161 | 161 | 161 | 161 | 161 | 161 | $779,000 |
| | *Bandera County Other | | Water loss audit and main-line repair for Bandera County FWSD #1 | J-6 | 1 | 1 | 1 | 1 | 1 | 1 | $163,000 |
| | | | Water loss audit and main-line repair for Bandera River Ranch #1 | J-7 | 1 | 1 | 1 | 1 | 1 | 1 | $463,000 |
| | | | Water loss audit and main-line repair for Medina Water Supply Corporation | J-8 | 1 | 1 | 1 | 1 | 1 | 1 | $447,000 |
| | | | **Vegetative Management | J-9 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | Drought Management (BCRAGD) | J-68 | 467 | 519 | 546 | 556 | 563 | 568 | $0 |
| | | | Additional well for Pebble Beach Subdivision | J-10 | 161 | 161 | 161 | 161 | 161 | 161 | $3,717,000 |
| | | | Additional wells to provide emergency supply to VFD | J-11 | 189 | 189 | 189 | 189 | 189 | 189 | $2,824,000 |
| | | | Additional wells to help Medina Lake area | J-12 | 27 | 27 | 27 | 27 | 27 | 27 | $1,377,000 |
| | | Nueces | Drought Management (BCRAGD) | J-69 | 29 | 32 | 34 | 34 | 35 | 35 | $0 |
| | * Bandera County Irrigation | Nueces | Additional groundwater wells | J-13 | 130 | 130 | 130 | 130 | 130 | 130 | $244,000 |
| | * Bandera County Livestock | San Antonio | Additional groundwater well | J-14 | 20 | 20 | 20 | 20 | 20 | 20 | $103,000 |
| Edwards | * City of Rocksprings | Colorado | Water loss audit and main-line repair | J-15 | 1 | 1 | 1 | 1 | 1 | 1 | $129,000 |
| | | Nueces | Additional groundwater well | J-16 | 121 | 121 | 121 | 121 | 121 | 121 | $650,000 |
| | Edwards County Other | Nueces | Water loss audit and main-line repair for Barksdale WSC | J-17 | 1 | 1 | 1 | 1 | 1 | 1 | $203,000 |
| | | | Additional well in the Nueces River Alluvium Aquifer | J-18 | 54 | 54 | 54 | 54 | 54 | 54 | $114,000 |
| | | | **Vegetative Management | J-19 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |

**Table 11-7. (Continued) 2016 Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Edwards | * Edwards County Livestock | Nueces | Additional groundwater wells | J-20 | 20 | 20 | 20 | 20 | 20 | 20 | $105,000 |
| | * Edwards County Mining | Rio Grande | Additional groundwater wells | J-21 | 30 | 30 | 30 | 30 | 30 | 30 | $109,000 |
| Kerr | * City of Kerrville | Guadalupe | Increase wastewater reuse | J-22 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | 5,041 | $23,000,000 |
| | | | Water loss audit and main-line repair | J-23 | 147 | 147 | 147 | 147 | 147 | 147 | $9,339,000 |
| | | | Purchase water from UGRA | J-24 | | 0 | 0 | 0 | 0 | 0 | $4,103,791 |
| | | | Increased water treatment and ASR capacity | J-25 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 3360 | $11,543,000 |
| | * Loma Vista WSC | | Conservation: Public information | J-26 | 4 | 4 | 4 | 4 | 4 | 4 | $0 |
| | | | Additional groundwater well | J-27 | 57 | 57 | 57 | 57 | 57 | 57 | $728,000 |
| | * Kerr County Other | Guadalupe | Water loss audit and main-line repair for Center Point WWW | J-28 | 1 | 1 | 1 | 1 | 1 | 1 | $33,000 |
| | | | Water loss audit and main-line repair for Hills and Dales WWW | J-29 | 1 | 1 | 1 | 1 | 1 | 1 | $138,000 |
| | | | Water loss audit and main-line repair for Rustic Hills Water | J-30 | 1 | 1 | 1 | 1 | 1 | 1 | $99,000 |
| | | | Water loss audit and main-line repair for Verde Park Estates WWW | J-31 | 1 | 1 | 1 | 1 | 1 | 1 | $102,000 |
| | | | Conservation: Public information | J-32 | 9 | 9 | 9 | 10 | 9 | 8 | $0 |
| | | Colorado | Conservation: Public information - Water shortage met with J-32 | J-32A | 5 | 5 | 5 | 5 | 6 | 7 | $0 |
| | | Nueces | Conservation: Public information - Water shortage met with J-32 | J-32B | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | | Guadalupe | **Vegetative management - UGRA | J-33 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | UGRA Acquisition of Surface Water Rights [2](EKCRWSP) | J-34 | 1,029 | 1,029 | 1,029 | 1,029 | 1,029 | 1029 | $1,087,367 |
| | | | KCCC Acquisition of Surface Water Rights [2](EKCRWSP) | J-35 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | $6,342,000 |
| | | | Construction of an Off-Channel Surface Water Storage [2](EKCRWSP) | J-36 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | 1,121 | $7,534,303 |

**Table 11-7. (Continued) 2016 Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Kerr | *Kerr County-Other | Guadalupe | Construction of surface water treatment facilities and transmission lines [2](EKCRWSP) | J-37 | 149 | 149 | 149 | 149 | 149 | 149 | $25,581,000 |
| | | | Construction of ASR facility [2](EKCRWSP) | J-38 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | 1,124 | $1,258,000 |
| | | | Construction of Well field for dense, rural areas [2](EKCRWSP) | J-39 | 860 | 860 | 860 | 860 | 860 | 860 | $4,357,000 |
| | | | Construction of Desalination plant [2](EKCRWSP) | J-40 | 860 | 860 | 860 | 860 | 860 | 860 | $14,539,000 |
| | | | Construction of an Ellenburger Aquifer water supply well [2](EKCRWSP) | J-41 | 108 | 108 | 108 | 108 | 108 | 108 | $567,000 |
| | *Kerr County Irrigation | San Antonio | Additional groundwater well | J-42 | 20 | 20 | 20 | 20 | 20 | 20 | $78,000 |
| | * Kerr County Livestock | Colorado | Additional groundwater wells | J-43 | 108 | 108 | 108 | 108 | 108 | 108 | $667,000 |
| | * Kerr County Livestock | Guadalupe | Additional groundwater wells | J-44 | 20 | 20 | 20 | 20 | 20 | 20 | $190,000 |
| | * Kerr County Livestock | San Antonio | Additional groundwater well | J-45 | 20 | 20 | 20 | 20 | 20 | 20 | $65,000 |
| | * Kerr County Mining | Guadalupe | Additional groundwater well | J-46 | 30 | 30 | 30 | 30 | 30 | 30 | $132,000 |
| Kinney | City of Brackettville | Rio Grande | Water loss audit and main-line repair | J-47 | 58 | 58 | 58 | 58 | 58 | 58 | $1,116 |
| | | | Increase supply to Spoford with new water line | J-48 | 3 | 3 | 3 | 3 | 3 | 3 | $751,000 |
| | | | Increase storage facility | J-49 | 3 | 3 | 3 | 3 | 3 | 3 | $288,000 |
| | Fort Clark Springs MUD | | Increase storage facility | J-50 | 620 | 620 | 620 | 620 | 620 | 620 | $1,033,000 |
| | Kinney County Other | | **Vegetative Management | J-51 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | * Kinney County Livestock | | Additional groundwater wells | J-52 | 22 | 22 | 22 | 22 | 22 | 22 | $55,000 |

**Table 11-7. (Continued) 2016 Recommended Water Management Strategy Roll-Up Summary**

| County | Water User Group | Strategy Source Basin | Water Management Strategy | 2016 Strategy ID | Strategy Supply (Acre-Feet Per Year) | | | | | | Total Capital Cost (Table 5-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | |
| Real | * City of Camp Wood | Nueces | Conservation: Public information | J-53 | 1 | 1 | 1 | 1 | 1 | 1 | $0 |
| | | | Additional groundwater wells | J-54 | 172 | 172 | 172 | 172 | 172 | 172 | $1,887,000 |
| | City of Leakey (Real County Other) | | Water loss audit and main-line repair | J-55 | 1 | 1 | 1 | 1 | 1 | 1 | $52,000 |
| | | | Additional groundwater well | J-56 | 91 | 91 | 91 | 91 | 91 | 91 | $156,000 |
| | | | Develop interconnections between wells within the City | J-57 | 81 | 81 | 81 | 81 | 81 | 81 | $200,000 |
| | Real County Other | | Water loss audit and main-line repair for Real WSC | J-58 | 2 | 2 | 2 | 2 | 2 | 2 | $199,000 |
| | | | **Vegetative Management | J-59 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | | | Additional well for Oakmont Saddle WSC | J-60 | 54 | 54 | 54 | 54 | 54 | 54 | $420,000 |
| | * Real County Livestock | | Additional groundwater wells | J-61 | 40 | 40 | 40 | 40 | 40 | 40 | $74,000 |
| Val Verde | City of Del Rio | Rio Grande | Water loss audit and main-line repair | J-62 | 119 | 119 | 119 | 119 | 119 | 119 | $8,673,000 |
| | | | Drill & equip new well, connect to distribution system | J-63 | 850 | 850 | 850 | 850 | 850 | 850 | $2,937,000 |
| | | | Water treatment plant expansion | J-64 | | 943 | 943 | 943 | 943 | 943 | $1,841,000 |
| | | | Develop a wastewater reuse program | J-65 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | 3,092 | $1,700,000 |
| | Val Verde County Other | | **Vegetative Management | J-66 | 0 | 0 | 0 | 0 | 0 | 0 | $0 |
| | * Val Verde County Mining | | Additional groundwater well | J-67 | 80 | 80 | 80 | 80 | 80 | 80 | $235,000 |
| | | | | **Totals** | **27,414** | **28,412** | **28,441** | **28,452** | **28,460** | **28,465** | **146,202,577** |

*WUGs with projected water supply needs (deficits).