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# Raiders of the Lost Aquifer? Or, the Beginning of the End to Fifty Years of Conflict over the Texas Edwards Aquifer

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## I. THE EDWARDS AQUIFER: HYDROLOGY, LAW, AND ECOLOGY

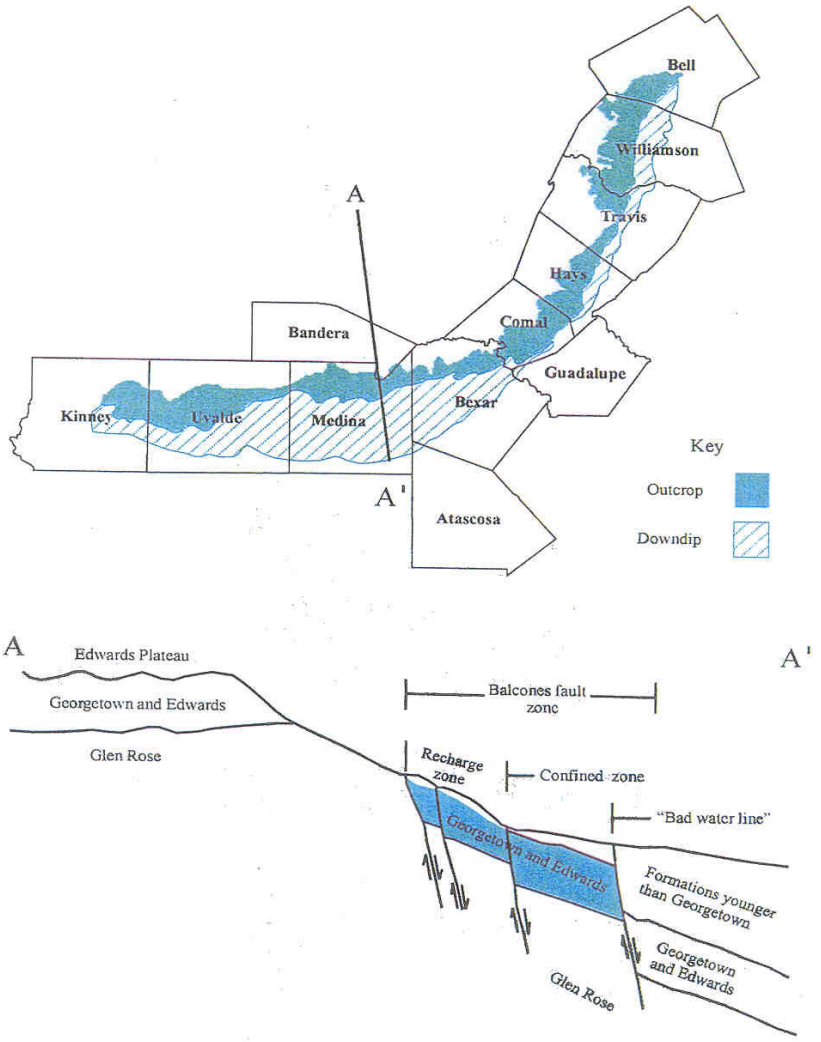
### *A. Hydrology*

The Edwards (Balcones Fault Zone) Aquifer (Figure 1) is a major Texas groundwater formation.[1] The aquifer is essentially the sole source of water for almost two million persons, including the residents of the City of San Antonio and the surrounding regions.[2] Because of the aquifer's substantial contribution to the flow of regional rivers and the unique forms of life endemic to the springs from the aquifer, its use as a water source has been the focus of intense regional competition and occasionally open conflict in local, state and federal courts, as well as the Texas Legislature.

1. *See generally* http://www.edwardsaquifer.net (cataloging a large collection of information about the Edwards Aquifer including current news, history and selected publications); http://www.edwardsaquifer.org (cataloging information including notices of Edwards Aquifer Authority (EAA) meetings and rules); http://tx.usgs.gov/aquifer/edwards.html (posting hydrologic information about the Edwards Aquifer region); http://rio.twdb.state.tx.us (detailing the State Water Plan and much additional water resource management and planning information); http://www.gbra.org (cataloging information about the Guadalupe River and the Guadalupe-Blanco River Authority).

2. The importance of the Edwards Aquifer as a water supply was recognized by the federal government in 1975 when the U.S. Environmental Protection Agency (USEPA) declared it the nation's first "sole source aquifer" under the Safe Drinking Water Act of 1974, 42 U.S.C. §§ 300f-300j (1994). The quality and quantity of water supplied throughout the history of the region has been so high that San Antonio has relied on the aquifer as its only source of water. Interview with Mike Thuss, President and CEO of the San Antonio Water System (1999). The infrastructure necessary to deliver treated surface water to supply the city in the event of a prolonged drought or to accommodate future growth is only now being built. *Id.* The use of water by San Antonio's largest water purveyor, the San Antonio Water System (SAWS), was inefficient in the past, but has become more efficient in recent years. *Id.* SAWS reports that their per capita water consumption had been reduced from 225 gallons per capita per day (gpcd) in 1982 to 143 gpcd in 2001, with an eventual goal of 140 gpcd. Susan Butler, Presenting LCRA-SAWS Water Project Overview, San Antonio Water System: Planning Our Future for the Next Fifty Years 4 (May 23, 2002). Until the Endangered Species Act litigation there was little incentive for groundwater pumpers, to spend money to plug leaks.

Figure 1.
Edwards Aquifer



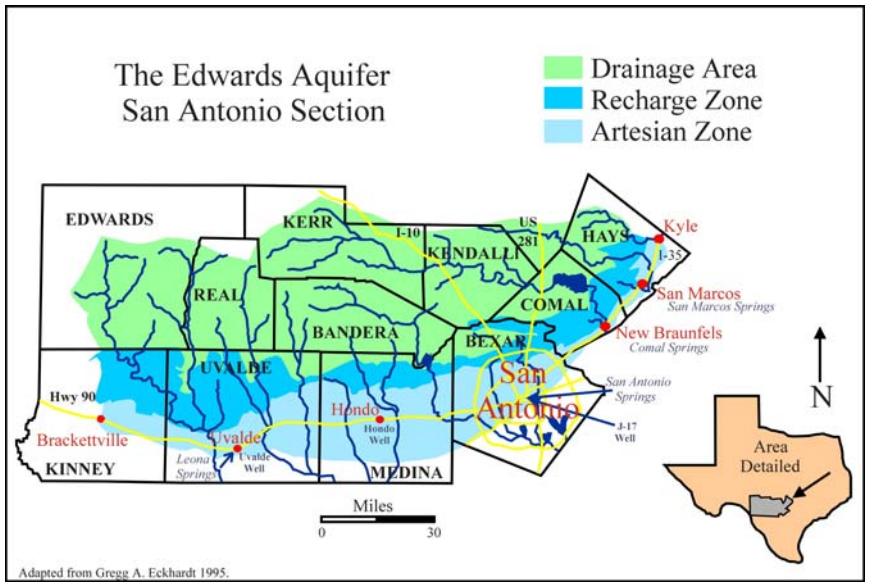

(Ashworth and Hopkins 1995, 14)

The aquifer stretches from Brackettville in Kinney County, east to San Antonio in Bexar County, and northeast through Austin in Travis County to Mills County northwest of Salado.[3] It consists of three segments: the northern segment, the Barton Springs segment, and the San Antonio

3. http://www.edwardsaquifer.net.

segment.[4] The San Antonio segment stretches about 200 miles from Brackettville, east to San Antonio, and northeast to Kyle, Texas.[5] This segment of the aquifer is one of the most permeable and productive carbonate aquifers in the United States.[6] In total, the complexly faulted karst groundwater formation encompasses a contributing zone of some 4400 square miles, a recharge zone of 1500 square miles, and a confined zone of 2100 square miles, totaling some 8000 square miles.[7]

Figure 2.
Edwards (Balcones Fault Zone) Aquifer




The Edwards Aquifer is a common pool resource undergoing a transition to a regulated resource at a time when the aquifer is unable to satisfy all demands for domestic, municipal, industrial, commercial, agricultural, recreational, and environmental uses. Prior to regulation,

4. *Id.*
5. *Id.*
6. U.S. GEOLOGICAL SURVEY, MEMORANDUM, 1 (1997) (on file with author). The aquifer is very transmissive due to the highly permeable and porous Edwards limestone. Most of the aquifer's permeability results from secondary porosity through joints, fractures, vugs, and solution channels that are interconnected; W.B. KLEMT ET AL., TEX. DEP'T OF WATER RES., GROUND-WATER RESOURCES AND MODEL APPLICATIONS FOR THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE SAN ANTONIO REGION, TEXAS 36 (1979).
7. EDWARDS AQUIFER AUTH., THE EDWARDS AQUIFER: A TEXAS TREASURE, 2 (undated).

overlying land ownership was the sole legal requirement for participation in the common pool resource that is the Edwards Aquifer.[8]

A simple analogy of the complex Edwards Aquifer likens it to a bucket with different sized holes that represent the springs at several levels from top to bottom. If the bucket is full of water, the water flows out from all the holes at variable velocities depending upon the water level in the bucket and the size and elevation of the holes. As the water level declines, flow from each hole decreases until the lower edge of each downward hole is reached, and then flow ceases. San Antonio, Comal, and San Marcos Springs are examples of the holes in the bucket and are also the sources of rivers of the same name, all of which eventually flow into, and provide much of the base flow for, the Guadalupe River.[9]

Comal and San Marcos Springs are among the largest springs in the United States.[10] Withdrawals from the Edwards have increased from approximately 100,000 acre-feet (acft) in 1934, to a peak of 542,400 acft during the drought year of 1989.[11] As withdrawals from the Edwards Aquifer multiplied, the possibility that Comal and San Marcos Springs could become intermittent, or cease to flow altogether, increased.[12]

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8. Garrett Hardin's proposed solution to the exploitation of common pool resources is a regime of coercion mutually agreed upon—i.e., some form of institutional control:

> Picture a pasture open to all. . . . Each herdsman will try to keep as many cattle as possible on the commons. . . . More or less consciously, he asks, 'What is the utility to *me* of adding one more animal to my herd? . . .' The rational herdsman concludes that the only sensible course for him to pursue is to add another animal. . . . And another and another . . . . This is the conclusion reached by each and every herdsman sharing a commons. . . . Each man is locked into a system that compels him to increase his herd without limit. . . . Freedom in a commons brings ruin to all.

Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1244 (1968).

9. Todd H. Votteler, *The Little Fish That Roared: The Endangered Species Act, State Groundwater Law, and Private Rights Collide over the Texas Edwards Aquifer*, 29 ENVTL. L. 845, 847-48 (1998), *available at* http://www.edwardsaquifer.net/votteler.html [hereinafter *Little Fish That Roared*].

10. Other historical sources have indicated that Comal and San Marcos Springs were the largest in the southwest. GUNNAR BRUNE, TEX. WATER DEV. BD., MAJOR AND HISTORICAL SPRINGS OF TEXAS, 39, 45 (1975). However, because other springs across the United States have declined, Comal and San Marcos Springs may have risen in rank. Comal Springs actually consists of some eighteen or more spring openings. GUNNAR BRUNE, SPRINGS OF TEXAS, 1, 131 (1981). San Marcos Springs consists of some 200 outlets that originate from three large fissures, and many small openings, at the bottom of Spring Lake. *Id.* at 223.

11. U.S. GEOLOGICAL SURVEY, RECHARGE TO AND DISCHARGE FROM THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 2000 3 (2001).

12. Somewhere south of the Edwards Aquifer downdip, a "bad water line" separates the area of usable groundwater from the area where wells produce highly mineralized water. The bad water line exists in close proximity to Comal and San Marcos Springs. The possibility of saltwater encroachment into freshwater wells has been a concern since the drought of record. There is disagreement among knowledgeable persons as to the risk of this line migrating into the freshwater zone as a result of excessive aquifer withdrawals and inadequate recharge. Research

Waters discharging from these springs comprise a significant, but variable, portion of the surface water available downstream in the Guadalupe River.[13] Combined, these springs have contributed an annual average of 325,800 acft of water into the Guadalupe River.[14] During droughts the discharge from Comal and San Marcos Springs diminishes in total volume, but increases in terms of its percentage contribution to instream flows in the Guadalupe River and to freshwater inflows to the river's estuary and the San Antonio Bay; as Figures 4 and 5 illustrate, the springs regularly provide the majority of flow in the Guadalupe River, as well as the freshwater inflows to San Antonio Bay, during the frequent droughts that occur in the region. Water from the aquifer also supports the economies of agriculture-based counties west of the city, Comal and Hays counties to the east, and counties in the Guadalupe River Basin all the way to the Texas Gulf Coast.[15] Permits issued by the state to surface water rights holders in the Guadalupe River Basin are based, in part, on flows from the aquifer. Many permits for Guadalupe River water were issued before withdrawals from the aquifer reached significant levels.

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is currently underway to examine this risk. Todd H. Votteler, Water from a Stone: The Limits of the Sustainable Development of the Texas Edwards Aquifer 186-188 (2000) (unpublished Ph.D. dissertation, Southwest Texas State University) (on file with author) [hereinafter Water From a Stone].

13. *See infra* Figure 4.

14. Based upon U.S. Geological Survey data on Comal and San Marcos Springs discharge, the author has calculated that the mean daily discharge from Comal Springs from December 19, 1927 to June 3, 1998, was 283 cfs. This includes 144 days of zero discharge during the drought of record. The author calculated the mean daily discharge from San Marcos Springs from May 26, 1956 to September 29, 1998, was 167 cfs. The combined mean discharge was 450 cfs, which produces some 325,800 acft annually. This calculation compares favorably with the USGS estimate of annual discharge from Comal and San Marcos Springs in 2000, a year with low rainfall and therefore low recharge and heavy pumping (86% of all Edwards Aquifer springs discharge) of 291,200 acft. *See* U.S. GEOLOGICAL SURVEY, RECHARGE TO AND DISCHARGE FROM THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS, 2000, 4 (2001) [hereinafter Recharge/Discharge]. Discharge from all Edwards Aquifer Springs from 1934 through 2000 averaged 366,200 acft, and the median discharge was 375,500 acft. *Id.*

15. Edwards Aquifer springs were an important resource for early inhabitants of the region. San Antonio, New Braunfels, San Marcos and Uvalde formed around Edwards Aquifer springs long before wells were drilled into the aquifer. The use of artesian wells from the aquifer dates back to 1884, when the first irrigation well was completed in Bexar County. TEX. BD. OF WATER ENG'S, A PLAN FOR MEETING THE 1980 WATER REQUIREMENTS OF TEXAS 14, (John J. Vandertulip ed., 1961). The withdrawal of groundwater began in earnest during the 1950s. Laura Ann Wimberley, Reluctant Conservationists, Water Scarcity and Regional Interdependence: Central Texas and the 'Great Drought,' presented at the Southwest Social Science Association (1997) (unpublished manuscript, on file with author). Until the record drought in that decade, the aquifer was so prolific, and the demand so small, that pumping from wells appears to have made little difference with regard to spring discharge. Today, many of the springs, such as San Antonio Springs, rarely flow unless a flood fills the aquifer.

Figure 3.
Nueces, San Antonio and Guadalupe Rivers

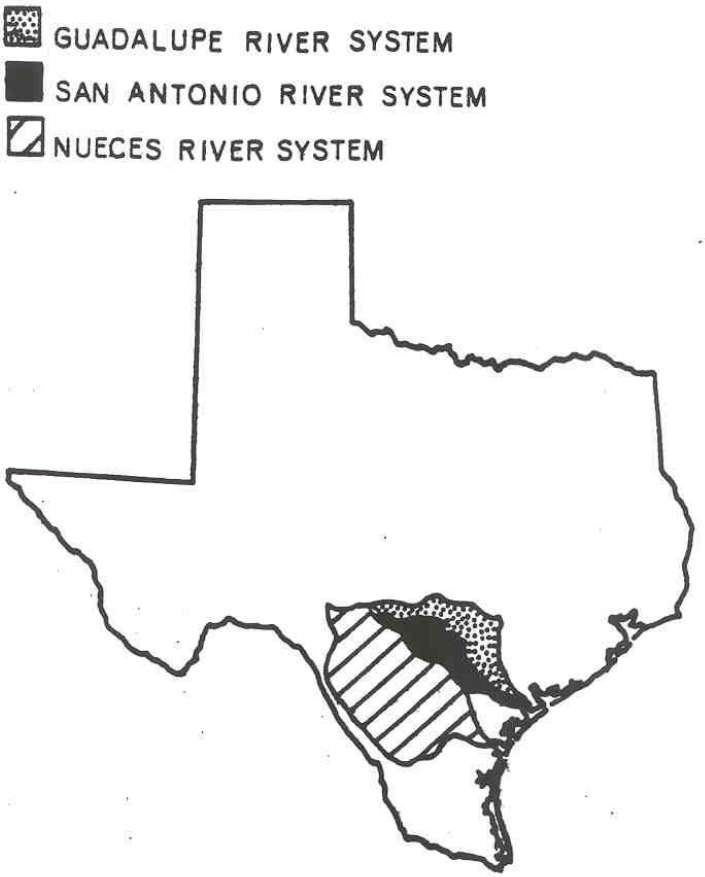
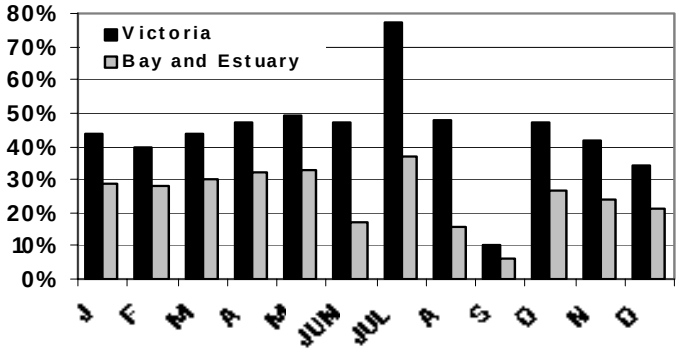


Table 1. Summary of Edwards (Balcones Fault Zone) Aquifer Hydrology[16]

| | |
|---|---|
| An acre-foot (acft) | 325,851 gallons of water |
| Average annual recharge (1934-2000) | 679,000 acft |
| Median annual recharge (1934-2000) | 556,100 acft |
| Record lowest recharge (1956) | 43,700 acft |
| Record highest recharge (1992) | 2,486,000 acft |
| Discharge of all Edwards Aquifer Springs (1934-2000) | Average 366,200 acft<br>Median 375,500 acft |
| Annual discharge from Comal and San Marcos Springs in 2000 (86% of all Edwards Aquifer springs discharge) | 291,200 acft |
| Average annual discharge of Comal and San Marcos Springs to the Guadalupe River (1927-1998) | 325,800 acft |

Figure 4.

**Comparison of the Contribution of Combined Comal and San Marcos Springs Discharge to the Flow at Victoria, Texas, and to the Bay and Estuary Inflows* During the 1996 Drought****

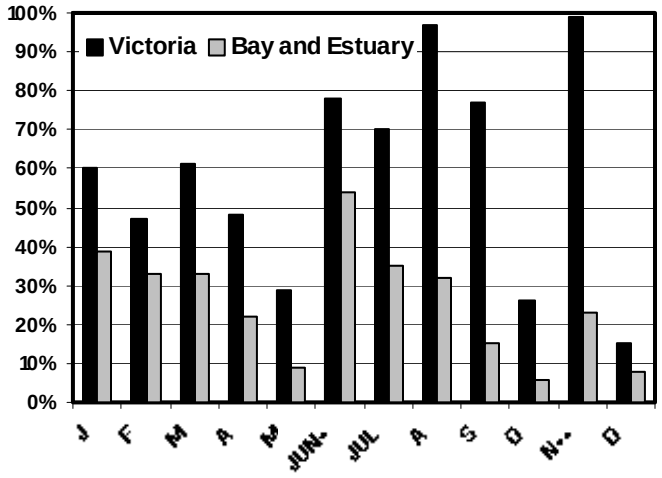



*In addition to Guadalupe River discharge, total bay and estuary inflows consist of San Antonio River discharge and inflows from ungaged coastal basins.
**Data sources are the USGS and TWDB. Channel losses were applied to the USGS spring discharge data based upon values from the TNRCC Water Availability Model Project.
Prepared by Kathy Rutledge.

16. *See* Recharge/Discharge, *supra* note 14, at 2-4. Critical period year calculation by author.

Figure 5.

**Comparison of the Contribution of Combined Comal and San Marcos Springs Discharge to the Flow at Victoria, Texas, and to the Bay and Estuary Inflows* During the 1956 Drought****




* In addition to Guadalupe River discharge, total bay and estuary inflows consist of San Antonio River discharge and inflows from ungaged coastal basins.
** Data sources are the USGS and TWDB. Channel losses were applied to the USGS spring discharge data based upon values from the TNRCC Water Availability Model Project.
\+ Comal Springs ceased to flow in June and resumed flowing in November.
++ Estimation uncertain because channel losses exceeded average.
Prepared by Kathy Rutledge.

The total volume of circulating water in the Edwards Aquifer is not known with great certainty, but has been estimated at forty-five million acre feet.[17] However, much of this water is at depths that make its use currently uneconomical.[18] Aquifer levels are dependent upon highly variable annual rainfall, recharge, and the rate of groundwater withdrawals.[19] Much of the aquifer recharge occurs as the result of brief but intense storms that supply water to the mostly perennial overlying streams.[20] Average annual rainfall across the region varies from twenty-two to thirty-six inches, with twenty-two to twenty-nine inches falling over the key recharge counties of Kinney, Uvalde and Medina.[21] This

17. U.S. GEOLOGICAL SURVEY, GROUND-WATER STORAGE IN THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS 1 (1996), *available at* http://tx.usgs.gov/reports/dist/dist-1996-01/dist-1996-01.pdf.
18. *Id.*
19. *Id.*
20. KLEMT ET AL., *supra* note 6, at 23.
21. Rick Illgner, The Edwards Aquifer: Political Prisoner, paper presented at the 89th Annual Meeting of the Association of American Geographers 1, 2 (1993) (unpublished manuscript, on file with author).

recharge occurs where three major rivers, the Nueces, the San Antonio, and Guadalupe, cross the aquifer recharge zone.[22]

The majority of the water enters the aquifer west of San Antonio as runoff from storms that drain into the streams and rivers of the Nueces River Basin that flow generally south across the recharge zone where they come into direct contact with the porous Edwards limestone outcrop.[23] The aquifer then generally flows south and southeast within higher hydraulic gradients and lower permeabilities to the confined zone with low hydraulic gradients and high permeabilities.[24] As the water flows eastward within the confined zone, wells intercept a significant portion of the aquifer's annual recharge.[25] The presence of faults north and northeast of Hondo, Texas, tends to redirect water flow to the Southwest before it begins its easterly trip to the springs.[26] The flow of water is also redirected through the Knippa Gap Northwest of Uvalde, Texas, an ill-defined geologic feature that restricts, to an unknown degree, the flow of water from the western parts of the aquifer to the east.[27]

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22. TODD ENGINEERS, EDWARDS AQUIFER OPTIMIZATION OVERVIEW 9 (1999) (unpublished manuscript, on file with author).

23. *See* KLEMT ET AL., *supra* note 6, at 23.

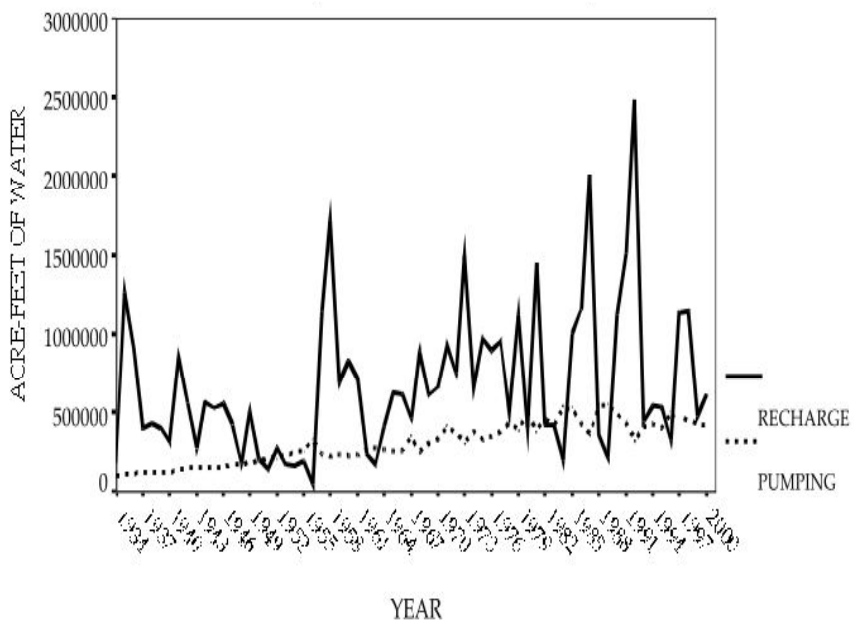
24. *Id.* Because the Edwards Aquifer is primarily recharged west of San Antonio and the water reemerges east of San Antonio at Comal and San Marcos Springs, the aquifer has been characterized as an enormous natural trans-basin diversion. Roger Nevola, Regulation of the Edwards Aquifer-Conjunctive Management of Surface Water and Groundwater, paper presented at the Texas Water Conservation Association, Mid-Year Technical Conference 11-12 (1989) (unpublished manuscript, on file with author).

25. KLEMT ET AL., *supra* note 6, at 23.

26. R.W. Maclay & L.F. Land, U.S. Geological Survey, Water-Supply paper 2336, Simulation of Flow in the Edwards Aquifer, San Antonio Region, Texas and Refinements of Storage and Flow Concepts 48 (1988). Faults include the Haby Crossing and the Medina Lake fault.

27. This feature influences the movement of water through the aquifer much as a spillway does for a surface reservoir. TODD ENGINEERS, *supra* note 22, at 16. Under normal conditions, cross-formational flow from the Shallower Trinity Aquifer provides 64,000 acft to the Edwards Aquifer. ROBERT E. MACE ET AL., TEX. WATER DEV. BD., GROUNDWATER AVAILABILITY OF THE TRINITY AQUIFER, HILL COUNTRY AREA, TEXAS: NUMERICAL SIMULATIONS THROUGH 2050, at 85, 103 (Sept. 2000). For this reason the management of the Trinity Aquifer influences the hydrology of the Edwards Aquifer as well as the Guadalupe River.

Figure 6.
Total Annual Recharge vs.
Total Annual Withdrawals, 1934-2000




In water supply planning, the question is not how much water can be supplied from a particular source during periods of average rainfall; rather, the question is, how much water can be supplied during historical droughts? Significant droughts and floods occur frequently in the Edwards Aquifer region.[28] The resulting wide variations in recharge make water supply planning very difficult in the Edwards region.[29]

Major multiyear droughts affecting the Great Plains (including the Edwards region) have occurred once or twice a century for the last 400 years.[30] In Texas, the critical drought period used for planning and management purposes is called the drought of record, meaning generally the worst drought that has occurred in a region since detailed records

28. B.D. Jones, U.S. Geological Survey, Water-Supply Paper 2375, National Water Summary 1988-89 Hydrological Events and Floods and Droughts 513 (1991).

29. *See supra* Table 1. In subhumid to semiarid regions, such as the Edwards, with a dry climate, runoff tends to be more variable than in regions that receive more rainfall. *See* LUNA B. LEOPOLD, A VIEW OF THE RIVER 96 (1994).

30. Connie Woodhouse & Jonathan Overpeck, *2000 Years of Drought Variability in the Central United States*, 79 BULL. AM. METEOROLOGICAL SOC'Y 2693, 2698 (1998).

have been kept. For Texas and the Edwards Aquifer, the drought of record is that which occurred from 1950 to 1957.[31] Comal Springs ceased to flow for 144 days in 1956, and the Bexar County groundwater index well for the Edwards Aquifer, J-17, declined to a record low 612.5 feet (ft) above mean sea level (msl) on August 17, 1956.[32] On average, a similar drought can be expected to occur once in every 50 to 100 years.[33]

Regions underlain by karst aquifers, particularly those such as the Edwards that provide nearly all of an area's water supply, are distinctly vulnerable to droughts, because they can experience noticeable effects even from droughts of short duration.[34] The detrimental effects accompanying a drought of record would probably be far greater today, because of the growth in population and the size of the economy.[35] Also, the greater efficiency of water use renders the region more vulnerable. For example, the impacts of water shortages during a drought can be more severe for efficient municipal water systems that have little waste to eliminate during emergencies.[36]

The challenge represented by droughts to those who depend on Edwards water is made even greater in the absence of readily available water supply alternatives. Most of the storage in Texas surface water reservoirs is permitted on a firm yield basis, with the firm yield volume being the maximum quantity of water reliably available during a repeat of the drought of record.[37] While the drought of record is the event which water supply planning strategies are designed to withstand, at least ideally, droughts worse than the drought of record have almost certainly occurred in the past and may await somewhere over the horizon.

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31. TEX. WATER DEV. BD., WATER FOR TEXAS: A CONSENSUS-BASED UPDATE TO THE STATE WATER PLAN, technical app. GP-6-2, 2-36 (1997). By the end of 1956, about 94% of Texas' 254 counties were classified as disaster areas for lack of precipitation. Recharge to the aquifer was below average for each of the fourteen years from 1942 to 1956, with an annual average recharge of 300,600 compared to 679,000 acre-feet for the period of record, 1934-2000. *See* Water from a Stone, *supra* note 12, at 73.

32. Water from a Stone, *supra* note 12, at 209. Glenn Longley, The Relationship Between Long Term Climate Change and Edwards Aquifer Levels, with an Emphasis on Droughts and Spring Flows, paper presented at the 24th Water for Texas Conference, Austin, Texas 113 (1995). During the drought of record, industries that depended on the flow from Comal and San Marcos Springs and flood runoff into the Guadalupe River continued to operate only through implementation of emergency measures such as recirculating water systems. ROBERT L. LOWRY, TEX. BD. OF WATER ENG'S, BULLETIN 5914: A STUDY OF DROUGHTS IN TEXAS, 34 (1959).

33. Jones, *supra* note 28, at 518; TEX. WATER DEV. BD., *supra* note 31, at GP-6-2, 2-36.

34. TEX. WATER DEV. BD., *supra* note 31, at GP-6-2.

35. Droughts have driven the development of Texas water management policies, programs and law. Accordingly, major water legislation and litigation have followed droughts.

36. NATURAL RES. LAW CTR., UNIV. OF CO., RESTORING THE WATERS 41 (1997).

37. Water Demand/Drought Management Technical Advisory Committee of the Consensus State Water Plan, Potential Impacts of Drought in Texas, paper delivered at the Planning for the Next Drought: A National Drought Mitigation Center Workshop 4 (1998).

### *B. Surface and Groundwater Regulation in Texas*

Historically, there was no limit to groundwater withdrawals from the Edwards Aquifer.[38] Groundwater in Texas has been governed by the English common law concept known as "the rule of capture," the right of capture, the law of absolute ownership, as well as other names.[39] In accordance with this rule, underground water can be withdrawn by an owner of the overlying land, even from beneath adjoining owners' land, unless a state statute specifies otherwise.[40] In addition, remedies in tort law are unavailable to an adjoining landowner whose available groundwater is adversely affected by someone else's pumping unless there is waste.[41] By contrast, surface water in Texas is governed by the appropriative water rights doctrine, also known as prior appropriation, which is common in most western states.[42] Under this doctrine, surface water is held in trust by the state for the benefit of all the people, subject to a state-granted right to use.[43] Those who are "first in time" are "first in right" to take or divert water from a surface watercourse or reservoir and apply it to a beneficial use.[44] Surface water rights are subject to another rule that maintains that a water right holder must "use it or lose it," meaning that unused water rights are subject to cancellation.[45]

As coexisting legal frameworks, prior appropriation and the rule of capture encourage incompatible behaviors by water users, depending upon the source. They contribute to the deleterious effects of droughts by treating surface and groundwater as separate legal entities. The separation ignores the fundamental hydrologic connection between them and provides no incentives for their efficient conjunctive use.[46] This legal and hydrological dichotomy is a complicating factor for those with the responsibility for managing water in Texas, particularly for the Edwards Aquifer and the Nueces, San Antonio, and Guadalupe Rivers because of the degree of interaction between these systems.

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38. RONALD A. KAISER, TEX. WATER RES. INST., HANDBOOK OF TEXAS WATER LAW: PROBLEMS AND NEEDS 32 (1987).

39. *See* Houston & T.C. Ry. Co. v. East, 81 S.W. 279 (Tex. 1904).

40. KAISER, *supra* note 38, at 32.

41. *Id.*

42. *See id.* at 18.

43. *Id.* at 19-20.

44. *Id.* at 22.

45. *See id.* In reality, the involuntary cancellation of water rights is not enforced in Texas.

46. The 1968 *Texas Water Plan* describes the disconnection between ground and surface law: "The situation is paradoxical when one realizes the actual interrelationship of ground and surface water development for future State needs and the necessity for adequate ground water supplies to meet future municipal and domestic requirements in certain areas." TEX. WATER DEV. BD., THE TEXAS WATER PLAN, II-29 (1968).

In 1949, the Texas Legislature chose local groundwater districts, with limited powers to prescribe spacing of wells and production limits, as the preferred method for managing groundwater under the rule of capture in areas where problems were emerging.[47] By the beginning of 2002, forty-eight local groundwater districts, covering much of the state, had been created and confirmed by local elections and are actually functioning to regulate withdrawals to some degree.[48]

Over the years, the Legislature has made two unusual exceptions to the rule of capture to address two different problems arising from overdrafting of aquifers. In 1975, the Legislature created the Harris-Galveston Coastal Subsidence District to limit pumping from the Gulf Coast Aquifer because pumping had caused land to subside in the area by as much as ten feet.[49] The second exception is the creation of the Edwards Aquifer Authority (EAA) in 1993 to limit withdrawals to protect endangered species and guarantee minimum flows of groundwater from Comal and San Marcos Springs into the Guadalupe River.[50]

### *C. Ecology*

While the water needs of the growing population of the Edwards region were once the sole determinant of the allocation of groundwater, a concern for the aquifer's unique ecology is now an important competing consideration. The Edwards Aquifer is considered one of the most diverse aquifer ecosystems in the world.[51] The U.S. Fish and Wildlife Service (USFWS) within the Department of the Interior considers the

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47. KAISER, *supra* note 38, at 72.

48. E-mail from Harvey Everheart, President, Texas Alliance of Groundwater Districts, to author (Jan. 8, 2002) (on file with author). Texas has chosen single county groundwater districts as the preferred method for managing aquifers that can extend from one end of the state to the other.

49. RICK CALLAWAY, HARRIS-GALVESTON COASTAL SUBSIDENCE DISTRICT: A REPORT ON ITS CREATION, POWERS, LIMITATIONS OF POWERS AND PROGRESS 1 (1986). The District was created, "to provide for the regulation of the withdrawal of groundwater within the boundaries of the District for the purpose of ending subsidence which contributes to or precipitates flooding, inundation or overflow of any area within the District, including without limitation rising water resulting from storms or hurricanes." *Id.* at 2. The constitutionality of the District was upheld in *Beckendorff v. Harris-Galveston Coastal Subsidence District*, 558 S.W.2d 75 (Tex. Civ. App. 1977).

50. Edwards Aquifer Authority Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355.

51. Glenn Longley, *The Edwards Aquifer: Earth's Most Diverse Groundwater Ecosystem?*, 11 INT'L J. OF SPELEOLOGY 123, 127 (1981). Within the aquifer, species exist that are found nowhere else and of which little is known. Blind catfish (species), such as the widemouth blindcat, are occasionally pumped from the aquifer from wells almost 2,134 feet deep. GLENN LONGLEY & HENRY KARNEI, U.S. FISH AND WILDLIFE SERVICE, STATUS OF SATAN EUROYSTOMUS HUBBS AND BAILEY, THE WIDEMOUTH BLINDCAT 6 (1978).

Comal and San Marcos Springs ecosystems to contain one of the greatest known diversities of organisms of any aquatic ecosystem in the Southwest.[52] This is in part because the constant temperature and flow of the high quality waters of the aquifer create unique ecosystems that support the development of species that are restricted geographically and do not occur elsewhere.[53] Comal and San Marcos Springs are the remaining major natural discharge points from the Edwards Aquifer, as well as habitat for one threatened and seven endangered species listed by the USFWS.[54] All these species are aquatic and inhabit ecosystems dependent on the Edwards Aquifer.[55] The USFWS recovery priority for these species indicates that each faces a high degree of threat and a low potential for recovery, and the survival of each species is in conflict with development projects or other forms of economic activity.[56]

During dry periods, when withdrawals from the aquifer increase, and flow from the springs diminishes to critical levels, aquatic habitat is impacted, causing "takes" of species listed under the Federal Endangered Species Act (ESA); and the flow of surface water downstream in the Guadalupe River decreases.[57] Extremely low flow, or no flow, from these springs places the species in "jeopardy." Under the ESA, the take of a threatened or endangered species by any person subject to the

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52. SAN MARCOS/COMAL RECOVERY TEAM, U.S. FISH AND WILDLIFE SERV., SAN MARCOS AND COMAL SPRINGS AND ASSOCIATED AQUATIC ECOSYSTEMS (REVISED) RECOVERY PLAN 121, 6 (1996) [hereinafter RECOVERY PLAN].

53. *Id.*

54. The San Marcos salamander (*Eurycea nana*) is listed as threatened. *Id.* The San Marcos gambusia (*Gambusia georgei*), Texas wild-rice (*Zizania texana*), fountain darter (*Estheostoma fonticola*), Texas blind salamander (*Typhlomolge rathbuni*), Comal Springs riffle beetle (*Heterelmis comalensis*), Comal Springs dryopid beetle (*Stygoparnus comalensis*), and Peck's cave amphipod (*Stygobromus pecki*) are listed as endangered. *Id.* All but the subterranean Texas blind salamander occur in spring-fed systems. *See id.* at 7. Critical habitat has been designated only at San Marcos Springs, and is designated for all listed species, except the Texas blind salamander and the Comal Springs riffle beetle. In addition to the threatened and endangered species, there are other rare and endemic species dependent on the Edwards Aquifer classified by the USFWS as candidates for listing. Historically, San Marcos gambusia populations were sparse. San Marcos/Comal Springs Recovery Team, *supra* note 52, at 28. Originally listed in 1980, no individuals were collected during sampling in at least 15 attempts between 1982 and 1995, raising the possibility that the gambusia is extinct. *Id.* The fountain darter and Comal Springs riffle beetle are the only species listed at both Comal Springs and San Marcos Springs.

55. *See id.* at 6.

56. *Id.* at 27.

57. Take means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Endangered Species Act, 16 U.S.C. § 1532 (19) (2001). A "take" is an event that may affect as few as one individual of the species. "Jeopardy" is not defined in the Act.

jurisdiction of the United States, constitutes a violation of the Act.[58] Withdrawals from the Edwards Aquifer for municipal, industrial, agricultural, recreational, and other uses contribute to the reduction of spring discharge at Comal and San Marcos Springs, which in turn can cause takes of the listed species.[59]

In 1993, during the *Sierra Club v. Babbitt* litigation over the protection of endangered species, the USFWS provided the United States District Court in Midland, Texas, with its "best professional judgment" of the flow/discharge rates at which take and jeopardy occur for the species of concern at Comal and San Marcos Springs.[60] These thresholds are characterized by the USFWS as conservative, and a statement was added to the flow determinations that the judgments may change to reflect more accurately the best available scientific and commercial information as that information becomes accessible.[61]

A flow rate of 200 cfs at Comal Springs, below which "take" occurs, and 100 cfs at San Marcos Springs, below which jeopardy occurs, are the presumed tripwires for an ESA enforcement action.[62] A review of United States Geological Survey (USGS) spring discharge data confirms that Comal Springs typically declines below the critical 200 cfs level before San Marcos Springs declines below the critical 100 cfs

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58. The definition of person includes private citizens, agencies, and any other individual or group. *See id.*

59. Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353, 6 (W.D. Tex. Feb. 1, 1993). [Ed. Note: Though the case was filed initially as *Sierra Club v. Lujan*, the subsequent proceedings are commonly referred to as *Sierra Club v. Babbitt* reflecting the changes in Department of Interior Secretaries.]

60. Notice of Filing of Springflow Determinations Regarding 'Take' of Endangered and Threatened Species, submitted by Charles R. Shockley on behalf of U.S. Department of Justice, Environmental and Natural Resources Division following Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353 (W.D. Tex. Feb. 1, 1993) (on file with author) [hereinafter Take Notice]; Notice of Filing of Springflow Determinations Regarding Survival and Recovery and Critical Habitat of Endangered and Threatened Species, submitted by Charles R. Shockley on behalf of U.S. Department of Justice, Environmental and Natural Resources Division following Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353 (W.D. Tex. Feb. 1, 1993) (on file with author) [hereinafter Survival Notice].

61. The USFWS provided the following qualifying language when determining the take levels:

> In reviewing available information and interviewing various experts, the Service found more data available for basing flow level determinations for some of the listed species than for others. In addition, there are significant gaps in knowledge upon which to base minimum flow level findings for all of the species. Because this evaluation was conducted with much less data than are normally available, this document renders the Service's best professional judgment on the levels where "take" occurs. If sufficient data are not available, the Service acts conservatively to be certain that irrevocable harm to listed species is unlikely to occur from the action(s) being evaluated.

*Id.* at 1.

62. *See* Take Notice and Survival Notice, *supra* note 60.

level.[63] For this reason, the endangered fountain darter at Comal Springs is typically the first species to be affected by declining spring discharge, and therefore the population of the darter serves as an indicator of stress to the Edwards Aquifer system.[64] Recall the earlier bucket analogy. Any water in the aquifer above the elevation of the San Marcos Springs, 573 ft msl, is only in temporary storage since the San Marcos Springs are the lowest surface outlet for the aquifer.[65] Since the sustained flow of 200 cfs from the Comal Springs is critical for protecting the fountain darter, the elevation of those springs, 623 ft msl, plus a flow of 200 cfs, become the significant benchmarks for protecting the endangered species.[66] While Comal Springs ceased to flow for 144 days in 1956, there is no record that San Marcos Springs has ceased to flow during the last 10,000 years.[67]

When the springs are diminished to the point where fountain darters are being "taken," flows from the aquifer to downstream ecosystems and users in the Guadalupe River are also diminished. In addition, the Guadalupe River provides freshwater inflows to San Antonio Bay, winter home of the majority of migratory endangered whooping cranes (*Grus americana*).[68]

## II. *SIERRA CLUB V. BABBITT*: PUMPING LIMITS MANDATED

The landmark legal case concerning the Edwards Aquifer has been *Sierra Club v. Babbitt*.[69] The Edwards Aquifer litigation under the provisions of the Endangered Species Act was motivated by two desires of the plaintiffs: (1) to protect the unique species found in the Comal and San Marcos Springs ecosystems and (2) to assure a continued minimum

63. *See* U.S. GEOLOGICAL SURVEY, *supra* note 14, tab. 2.

64. The original population of fountain darters was extirpated from the Comal Springs ecosystem when the springs ceased to flow in 1956. Fountain darters from San Marcos Springs were reintroduced into Comal Springs in 1975 and 1976; however, the darters at Comal Springs are not classified as an experimental population. T.L. ARSUFFI ET AL., ECOLOGY OF THE INTRODUCED GIANT RAMS-HORN SNAIL, MARISA CONUARIETIS, IN THE COMAL RIVER ECOSYSTEM 4 (1990).

65. Water from a Stone, *supra* note 12, at 229.

66. *Id.*

67. Three points have been cited to support this conclusion: (1) no known record exists indicating flow has ever ceased; (2) the development of great biological diversity and unique endemic plants and animals; (3) and the archeological record of continuous human habitation going back at least as early as 9200 BC. GLENN LONGLEY, SAN MARCOS RIVER MANAGEMENT PLAN, REPORT PHASE II (1991) (on file with author).

68. *See* Determination of Critical Habitat for the Whooping Crane, 43 Fed. Reg. 20938, 20942 (Mar. 9, 1978); *see also* http://species.fws.gov/bio_whoo.html.

69. For more details on *Sierra Club v. Babbitt*, as well as other Edwards Aquifer cases, see *Little Fish That Roared*, *supra* note 9.

flow of surface water in the Guadalupe River downstream of the springs.[70]

In 1991, the Sierra Club filed a suit in the United States District Court in Midland, Texas, alleging that the Secretary of the Interior and the USFWS had allowed takings of endangered species by not ensuring a water level in the Edwards Aquifer adequate to sustain the flow of Comal and San Marcos Springs to protect the endangered species it had named.[71] In *Sierra Club*, the Sierra Club, joined by the Guadalupe-Blanco River Authority among others, requested that the defendant be enjoined to restrict withdrawals from the Edwards Aquifer under certain conditions and develop and implement recovery plans for named endangered and threatened species found in the aquifer and at Comal and San Marcos Springs.[72]

A nonjury trial was held in the United States District Court, Western District of Texas, in November 1992.[73] On February 1, 1993, the presiding Judge, Lucius D. Bunton III, ruled in favor of the plaintiffs and required the USFWS to determine the minimum spring discharge requirements to avoid take and jeopardy of the listed species in both springs:

> I entered my judgment in January 1993 and essentially found that the overpumping from the Edwards Aquifer could indeed endanger the species that I had previously found were endangered in the Comal and San Marcos Springs. In the finding I expressly stated that the solution should be by the

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70. The second motivation is an example of a transboundary water issue known as sequential power dispute. Olen P. Matthews, *Judicial Resolution of Transboundary Water Conflicts*, 30 WATER RES. BULL. 375 (1994). Sequential power conflicts can occur when water flows from one jurisdiction to another. *Id.* Typically, a dispute ensues as the result of concerns on behalf of the receiving jurisdiction. *See id.* at 376-78. In the Edwards Aquifer region, as surface water enters the aquifer recharge zone it leaves the appropriative water rights jurisdiction of the Nueces, San Antonio, or Guadalupe-Blanco River Authorities and the state. It becomes groundwater by percolating into the Edwards limestone. Prior to creation of the EAA the groundwater was governed solely by the rule of capture, and was therefore unregulated. When the groundwater discharges from Comal and San Marcos Springs it again becomes surface water, subject to the jurisdiction of Guadalupe-Blanco River Authority and the state. On its journey, the water, until 1996, passed from regulated, to essentially unregulated, and then back to regulated jurisdictions. Former GBRA general manager John Specht has stated that the GBRA's motivation in *Sierra Club v. Babbitt* was to protect the water resources of the Guadalupe River Basin, as contrasted with the Sierra Club's interest in protecting the threatened and endangered species. Interview with John Specht, Former General Manager of the Guadalupe-Blanco River Authority (1999). Specht believed action had to be taken before another crisis similar to the drought of record. His goal was to assure that, during a repeat of the drought of record, while Comal Springs might cease to flow for a short period of time, San Marcos Springs would continue to flow, assuring some surface flow downstream in the Guadalupe. *Id.*

71. Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353, at *30 (W.D. Tex. Feb. 1, 1993).

72. *See generally id.*

73. *Id.* at *1.

> state rather than the federal government, and I would give the state an opportunity to address the matter in the coming session of the Texas Legislature.
>
> The Legislature passed an act, but after the session was over, the legislation was submitted to the Attorney General of the United States, and it found that the act violated the Voting Rights Act. The Legislature didn't meet again for two years. In the early '90s this delay did not make a lot of difference because it was raining on the aquifer, and the yards and farms on the aquifer were not using as much water as in times of drought.
>
> In April 1994 the Sierra Club (because the land was getting dry) filed a motion to expand the lawsuit and wanted me to declare an emergency and take control of the aquifer. Needless to say, this really grabbed the attention of the people of San Antonio.[74]

Bunton ruled that, if the Texas Legislature did not adopt a management plan to limit withdrawals from the aquifer by the end of its then-current session, the plaintiffs could return to the court and seek additional relief.[75] The Sierra Club indicated that, if it had to return to the District Court 1993, it would seek regulation of the aquifer by having it placed under federal judicial control through the USFWS.[76]

The issues raised in *Sierra Club* were resolved, at least temporarily, on February 26, 1996, after the USFWS published the *San Marcos and Comal Springs and Associated Aquatic Ecosystems (Revised) Recovery Plan* (Recovery Plan) for the threatened and endangered species at Comal and San Marcos Springs.[77] The Recovery Plan acknowledges that the key issue to survival of the listed species is the conservation of the aquatic ecosystems at Comal and San Marcos Springs dependent on their flow, as well as the aquifer itself.[78]

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74. LUCIUS D. BUNTON III, A BIT OF BUNTON: MEMOIRS BY LUCIUS D. BUNTON III, at 310, 311 (1999).

75. Sierra Club, 1993 WL 151353, at *34.

76. Telephone Interview with Stuart Henry, Attorney for the Sierra Club (July 3, 2002).

77. U.S FISH AND WILDLIFE SERVICE, SAN MARCOS/COMAL RECOVERY TEAM, SAN MARCOS AND COMAL SPRINGS AND ASSOCIATED AQUATIC ECOSYSTEMS (REVISED) RECOVERY PLAN (1996).

78. Sierra Club, 1993 WL 151353, at *51. The Recovery Plan lists first among the actions needed to protect the listed species: "1. Assure sufficient water levels in the Edwards aquifer and flows in Comal and San Marcos Springs to maintain habitat for all life stages of the five listed species [three more species were added afterwards] and integrity of the ecosystem upon which they depend." *Id.* at Executive Summary.

## III. EDWARDS AQUIFER AUTHORITY

### *A. The Texas Legislature Creates the Edwards Aquifer Authority*

> *The next session of the Texas Legislature offers the last chance for adoption of an adequate state plan before the 'blunt axes' of Federal intervention have to be dropped.*[79]

Senate Bill 1477, or the Edwards Aquifer Authority Enabling Act, was adopted by the Legislature on May 30, 1993, one day before the deadline for threatened federal action.[80] The Act created a conservation and reclamation district, named the Edwards Aquifer Authority (EAA or the Authority).[81] The EAA was charged with regulating groundwater withdrawals pursuant to the Conservation Amendment in the Texas Constitution, Article XVI, § 59, replacing the rule of capture in five counties and portions of three others, with a permit system.[82] The Authority replaced the Edwards Underground Water District (EUWD), which at that time covered only three counties overlying the aquifer.[83] Under the Act annual withdrawals are eventually to be limited to 450,000 acft before December 31, 2007, and to 400,000 acft thereafter, unless drought conditions require more severe restrictions.[84] By December 31, 2012, "the authority [EAA] . . . shall . . . ensure that . . . the continuous minimum springflows of the Comal Springs and the San Marcos Springs are maintained to protect endangered and threatened species to the extent

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79. *Id.* at 29; Finding 196, Amended Findings of Fact and Conclusions of Law, Sierra Club v. Lujan (May 26, 1993).

80. *See* EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355.

81. *Id.* As alluded to earlier, after the Legislature adjourned, an objection to the make-up of the governing board of the EAA under the federal Voting Rights Act of 1965, 42 U.S.C. 1971-1973 (1994), prevented the Authority's activation. In fourteen states with a past history of discrimination against minority voters, any change affecting voters or elections in political subdivisions must be submitted to the U.S. Department of Justice (USDOJ) for preclearance. The Mexican American Legal Defense and Education Fund (MALDEF) opposed preclearance of the procedure for choosing EAA board members. On November 19, 1993, USDOJ's Civil Rights Division agreed with MALDEF and objected to the new law "insofar as it replaces the previously elected governing body [of the Edwards Underground Water District] with an appointed board [for the EAA]." HOUSE RESEARCH ORG., TEX. HOUSE OF REPRESENTATIVES, REGULATING THE EDWARDS AQUIFER: A STATUS REPORT, 2 (1994). The USDOJ was concerned that Hispanic voters in the former Edwards Underground Water District would not have the same opportunity to be represented on the appointed EAA board.

82. EAA Enabling Act, ch. 626, § 1.14.

83. The Edwards Underground Water District (EUWD) was created by the Texas Legislature in 1959 after the drought of record ended in 1957. *See* HOUSE RESEARCH ORG., *supra* note 81, at 15. Attempts to create the EUWD had failed in the Legislature during the 1955 and 1957 sessions.

84. EAA Enabling Act, ch. 626, §§ 1.14(b)-(c).

required by federal law."[85] The EAA is specifically charged by Senate Bill 1477 with protecting threatened and endangered species.[86]

As a result of the judgment in *Sierra Club v. Babbitt* the Federal District Court contributed to the end of the rule of capture in the Edwards Aquifer by encouraging the Legislature to create a system to regulate pumping. The EAA was established to supervise the transition from a pure rule of capture system to a hybrid permit system.[87] The exercise of individual permits are still not subject to remedies under tort law.[88] If individual well owners were to have the ability to sue each other for damages when levels of the aquifer declined below well intakes, it could potentially undermine the authority of the EAA to regulate the aquifer on a holistic basis.

The EAA has four primary tasks.[89] The first is to adopt a plan for restricting withdrawals during periods when the aquifer level and spring discharge rates are approaching levels adversely affecting endangered species, i.e., a critical period management plan (CPMP).[90] The second is to issue permits for groundwater pumping based on historical use.[91] The third is to limit total pumping from the aquifer through a series of staged reductions.[92] The fourth is to manage the aquifer through the development and implementation of groundwater management plan and the assessment of pumping fees to finance the operation of the Authority.[93] Though the EAA has additional responsibilities, these four are the primary responsibilities assigned by the Texas Legislature to resolve the transboundary water disputes associated with the aquifer. The EAA was originally intended to assume these responsibilities on September 1, 1993.[94] A series of legal challenges delayed the EAA's operation until a decision by the Texas Supreme Court regarding the constitutionality of its Enabling Act on June 28, 1996.[95] As of June 2002, three of the four primary tasks delegated by the Legislature had not been completed.

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85. *Id.* § 1.14(h).
86. *Id.* §§ 1.14(a)-(b).
87. Amicus Edwards Authority Brief on the Merits, 5, Sipriano v. Great Spring Waters of Am., Inc., 1 S.W.3d 75 (Tex. 1999) (No. 98-0247).
88. *Id.*
89. *See* EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355.
90. *Id.* § 1.26(a).
91. *Id.* § 1.16.
92. *Id.* § 1.14(b)-(c).
93. *Id.* §§ 1.25-1.29.
94. *Id.* § 4.02.
95. *See* Barshop v. Medina County Underground Water Conservation Dist., 925 S.W.2d 618 (Tex. 1996).

In addition to the EAA, Senate Bil1 1477 created the South Central Texas Water Advisory Committee (SCTWAC), to "[a]dvise the EAA Board of Directors on downstream water rights and issues" among other duties.[96] In its most recent review of the EAA, the SCTWAC made observations concerning three of the four responsibilities of the EAA:

- Delays in the enforcement of the statutory limit on withdrawals;
- Overestimation of available aquifer water for planning purposes; and
- Inadequacy of trigger levels for the implementation of drought management rules, and inadequacy or reduction measures at low aquifer levels.[97]

These concerns will be addressed below in reverse order.

### *B. Critical Period Management Plan*

The EAA was charged by the Texas Legislature to adopt permanent rules called the Critical Period Management Plan (CPMP) by September 1, 1995, on the second anniversary of what was anticipated to be the birth date of the EAA.[98] The CPMP is the set of rules that prescribe how withdrawals from the aquifer will be restricted before spring discharge rates reach critical levels at Comal and San Marcos Springs resulting in take or jeopardy of the listed species and violations of the Endangered Species Act.[99] Since the challenge to the constitutionality of Senate Bill 1477 delayed the formation of the EAA, the deadline for the adoption of the CPMP was moved to June 28, 1998.[100] As of June, 2002, the EAA

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96. NAISMITH ENG'G, S. CENT. TEX. WATER ADVISORY COMM., REPORT OF THE EFFECTIVENESS OF THE EDWARDS AQUIFER AUTHORITY, 1 (2000).

97. *Id.* at 7.

98. EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355, § 1.25.

99. *Id.* § 1.26.

100. The original deadline in Senate Bill 1477 for adopting CPMP was two years after the original September 1, 1993 activation date of the EAA: "(a) Consistent with Section 1.14 of this article, the authority shall develop, by September 1, 1995, and implement a comprehensive water management plan that includes conservation, future supply, and demand management plans." The delay in the activation in the EAA postponed the date for the demand management plans until two years after the Texas Supreme Court's decision on June 28, 1996. Barshop v. Medina County Underground Water Conservation Dist., 925 S.W.2d 618 (Tex. 1996). In 2000, the EAA adopted a measure to trigger Stage III pumping reductions, a ban on lawn watering, when Comal Springs dropped below 150 cfs. Edwards Aquifer Authority, measure adopted at the regular meeting of the Board of Directors, August 23, 2000. However, when Comal Springs actually reached 150 cfs in September 2000, EAA Board Chairman Michael Beldon explained before the San Antonio City Council that the ban was a mistake. Jerry Needham, *Sprinkler Ban Called Mistake; EAA Admits Measure Premature; Council Rejects Enforcement*, SAN ANTONIO EXPRESS-NEWS, Sept. 15, 2000, at 1A. Recently, the EAA has proposed the incorporation of spring discharge rates throughout the CPMP in conjunction with the use of groundwater index wells to

had yet to adopt CPMP rules, missing the revised deadline by nearly four years. Instead, as a short-term substitute, the Stage III Emergency Drought Management Plan Rules of 2000 were adopted by EAA on May 1, 2000.[101]

Historically, drought management plans developed in the San Antonio area were triggered by an "index well" (J-17) at Randolph Air Force base rather than spring flows at Comal and San Marcos. Therefore, the EAA has relied primarily on the levels of three regional groundwater wells (see Figure 2) to initiate restrictions on groundwater withdrawals. The levels of the three regional groundwater wells were selected by the EAA to serve as proxies to anticipate when discharge rates for actual spring flow approach critical levels.[102]

An examination of the trigger levels used in various drought management plans and the levels for the J-17 index well in San Antonio demonstrates that groundwater withdrawals from the aquifer, in many cases, would not have been restricted prior to the onset of take and jeopardy flow levels at Comal Springs. Table 2 summarizes the range of flows at Comal Springs that correlate to the index well trigger levels.[103] Remember, take of the fountain darter can begin at 200 cfs at Comal Springs and jeopardy begins at 150 cfs according to the USFWS.[104]

Table 2. Range of Flows at Comal Springs Corresponding to Key Trigger Levels[105]

| Index Well | Stage | Trigger Level (ft. above mean sea level) | Comal Springs (cubic ft. per second) |
|---|---|---|---|
| J-17 | I | 650 | 180-250 |
| J-17 | II | 640 | 115-200 |
| J-17 | III | 630 | 55-120 |

initiate water conservation measures. Edwards Aquifer Authority, Comprehensive Water Management Plan Implementation Rules, Proposed Rules—Chapter 715.212, 214, 216 and 218, May 15, 2002 (on file with author).

101. Edwards Aquifer Authority, Stage II Emergency Drought Management Plan Rules (May 1, 2000).

102. *See* Water from a Stone, *supra* note 12, at 247.

103. Table 2 shows that Comal Springs discharges have historically ranged from 180 cfs to 250 cfs when J-17 is at 650 ft msl, the trigger for Stage I conservation measures. For Stage II, take or jeopardy levels have occurred in the past when J-17 was at 640 ft msl. For Stage III, Comal Springs experiences jeopardy flows when J-17 is at 630 ft msl. For all three stages using the Hondo index well, take, and for Stages II and III most likely jeopardy, would have occurred at Comal Springs. For Comal Springs and the Uvalde well, it is difficult to find a range of corresponding flows for any of the Stages, although when the Uvalde Well is at 875 ft msl or less, take and jeopardy would already have occurred in the past at Comal Springs. Water from a Stone, *supra* note 12, at 216.

104. *See* Take Notice and Survival Notice, *supra* note 60.

105. Water from a Stone, *supra* note 12, at 219.

| Index Well | Stage | Trigger Level (ft. above mean sea level) | Comal Springs (cubic ft. per second) |
|---|---|---|---|
| Hondo | I | 670 | 80-160 |
| Hondo | II | 660 | 50-125 |
| Hondo | III | 655 | 50-70 |
| Uvalde | I | 845 | UTD |
| Uvalde | II | 840 | UTD |
| Uvalde | III | 835 | UTD |

UTD = Unable to determine

In Table 3, the historical CPMP trigger levels are compared with historical low flow periods at Comal Springs to demonstrate which stages of the plan would have been triggered for each zone of the aquifer during past periods when Comal Springs was below take and jeopardy. It shows that, if the EAA CPMP trigger levels had been in effect during every year when flows have been less than 200 cfs, the pumping restrictions would have been triggered in Uvalde County during a portion of the drought of record from 1952 through 1957, but not in any subsequent years when critical flows occurred at Comal Springs.

Table 3. A Comparison of the EAA's Historical Trigger Levels and Critical Flows at Comal Springs[106]

The (x) denotes each stage of the CPMP that would have been initiated historically using the trigger levels in years when Comal Springs was below 200 cfs or 150 cfs.

| Stage/ Trigger Level | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1971 | 1980 | 1983 | 1984 | 1985 | 1989 | 1990 | 1991 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stage I, J-17 ≤ 650 > 640 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Stage II, J-17, ≤ 640 > 630 | | X | X | X | X | X | X | | X | X | | | X | X | | | X | | X | X | | X | |
| Stage III, J-17 ≤ 630 | | | | X | X | X | X | | | | | | X | X | | | X | | X | X | | X | |
| Stage I, Hondo, ≤ 670 > 660 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | X | X | | X | |
| Stage II, Hondo, ≤ 660 > 655 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | X | | X | |

106. *Id.* at 225.

| Stage/ Trigger Level | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1971 | 1980 | 1983 | 1984 | 1985 | 1989 | 1990 | 1991 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stage III, Hondo ≤ 655 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | | X | | | |
| Stage I, Uvalde, ≤ 845 > 835 | | X | X | X | X | X | X | | | | | | | | | | | | | | | | |
| Stage II, Uvalde, ≤ 840 > 835 | | X | X | X | X | X | X | | | | | | | | | | | | | | | | |
| Stage III, Uvalde, ≤ 835 | | | X | X | X | X | X | | | | | | | | | | | | | | | | |

Note: J-17 triggers water conservation measures in Bexar, Caldwell, Comal, Hays and Guadalupe Counties; the Hondo well triggers measures in Hondo and Atascosa Counties; and the Uvalde well triggers measures in Uvalde County.

The results of a similar analysis prepared for San Marcos Springs during the historical period demonstrate that the use of the trigger levels would be unlikely to initiate conservation measures in most cases.[107] Remember, Jeopardy can begin at 100 cfs at San Marcos Springs according to the USFWS.[108] For each of the groundwater index wells, take and jeopardy conditions would have occurred in some years prior to the initiation of each stage of pumping restrictions using the groundwater well trigger levels.[109] Table 5 demonstrates which stages of the restrictions would have been triggered for each zone of the aquifer during past critical flow periods at San Marcos Springs.

Table 4. Range of Flows at San Marcos Springs Corresponding to Key Trigger Levels[110]

| Index Well | Stage | Trigger Level (ft. above mean sea level) | San Marcos Springs (cubic ft. per second) |
|---|---|---|---|
| J-17 | I | 650 | 85-230 |
| J-17 | II | 640 | 80-210 |
| J-17 | III | 630 | 75-150 |
| Hondo | I | 670 | 80-125 |
| Hondo | II | 660 | 90-120 |
| Hondo | III | 655 | UTD |
| Uvalde | I | 845 | UTD |
| Uvalde | II | 840 | UTD |
| Uvalde | III | 835 | UTD |

107. *See infra* Tables 4 and 5.
108. *See* Take Notice and Survival Notice, *supra* note 60.
109. Water from a Stone, *supra* note 12, at 234.
110. *Id.* at 238.

UTD = Unable to determine

Table 5. A Comparison of the EAA's Historical Trigger Levels and Critical Flows at San Marcos Springs[111]

The (x) denotes the CPMP stages that would have been initiated historically using the trigger levels in years when San Marcos Springs was below 100 cfs.*

| Stage / Trigger Level | 1956 | 1957 | 1963 | 1964 | 1965 | 1967 | 1978 | 1971 | 1984 | 1989 | 1990 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stage I, J-17 ≤ 650 > 640 | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Stage II, J-17, ≤ 640 > 630 | X | X | X | X | | X | | X | X | X | X | X | |
| Stage III, J-17, ≤ 630 | X | X | | | | X | | X | X | X | X | X | |
| Stage I, Hondo, ≤ 670 > 660 | NA | NA | NA | NA | NA | NA | NA | NA | NA | X | X | X | |
| Stage II, Hondo, ≤ 660 > 655 | NA | NA | NA | NA | NA | NA | NA | NA | NA | | X | X | |
| Stage III, Hondo, ≤ 655 | NA | NA | NA | NA | NA | NA | NA | NA | NA | | X | | |
| Stage I, Uvalde, ≤ 845 > 840 | X | X | | | | | | | | | | | |
| Stage II, Uvalde, ≤ 840 > 835 | X | X | | | | | | | | | | | |
| Stage III, Uvalde, ≤ 835 | X | X | | | | | | | | | | | |

*Springflow data for San Marcos Springs available from the USGS beginning 1956.
NA = Hondo Well level measurements available beginning in 1986.
Note: J-17 triggers water conservation measures in Bexar, Caldwell, Comal, Hays, and Guadalupe Counties; the Hondo well triggers measures in Hondo and Atascosa Counties; and the Uvalde well triggers measures in Uvalde County.

There should be particular concern about the trigger level used for Stage I of the restrictions in Uvalde County. Using 845 ft msl to trigger Stage I there would have allowed pumping from the aquifer to occur unabated when Comal or San Marcos Springs were historically below take and jeopardy flows.[112] The exception occurs during the final years of the drought of record.[113] It appears that the most recent year in which the Uvalde well was at or below 845 ft msl was 1958, despite eighteen additional years since flows below take occurred at Comal Springs.[114] The summer 2000 Withdrawal Suspension Program (WSP) announced on February 11, 2000, also relied on 845 feet msl at the Uvalde well to initiate that program.[115]

111. *Id.* at 245.
112. *Id.* at 225, 245.
113. *Id.*
114. The two additional years are 1998 and 2000, which are outside the dataset for the original table.
115. Greg Ellis, Announcement and Frequently Asked Questions: Withdrawal Suspension Program (2002) (on file with author).

Tables 3 and 5 indicate that the burden for reduced pumping under the critical period restrictions would have fallen disproportionately upon Edwards Aquifer users in Bexar, Caldwell, Comal, Hays, and Guadalupe counties, and to a lesser extent in Medina and Atascosa counties. As a result pumping reductions would come primarily from municipal water users in San Antonio and other cities instead of agricultural water users.[116] Article 1, § 1.26(4) of Senate Bill 1477 requires that nondiscretionary industrial and crop irrigation water use be reduced to a greater extent than municipal, domestic, and livestock use.[117] The restrictions apparently do not satisfy this provision because, during most historical periods when Comal and San Marcos Springs were below critical levels, restrictions would not have been triggered in Uvalde County using the water levels proposed for the Uvalde index well.[118]

Any future CPMP should use Comal Springs discharge levels to trigger adequate conservation measures for agricultural as well as municipal, industrial, and other water uses, to avoid take and jeopardy flows at the springs and assure minimal water for water users downstream on the Guadalupe River. In some years San Marcos Springs discharge should be used if it approaches critical levels first. Another solution (and one in the EAA's proposed habitat conservation plan) is a combination of spring flows and well levels with an "either-or" trigger. In the event of a repeat of the historical record of Edwards Aquifer conditions, the groundwater index well trigger levels that have previously been proposed to initiate conservation measures in the EAA's CPMP will eventually fail to achieve the desired result of protecting minimum discharges from Comal and San Marcos Springs and downstream flows in the Guadalupe River.

To avoid take and jeopardy conditions, the focus for management plans should be the actual flow at Comal and San Marcos Springs as direct measures of aquifer conditions as opposed to using ineffective indirect indicators. Using the index well levels in many instances would not trigger reductions prior to critical spring discharges being reached. The former U.S. Fish and Wildlife Service Supervisor, David Frederick, recommended to the EAA that "[t]rigger levels should be based on springflow rates at Comal (and possibly San Marcos), rather than index well levels."[119] As the analysis presented demonstrates, variations in spring discharges corresponding to the index wells' water levels clearly

116. Water from a Stone, *supra* note 12, at 227.

117. EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2305, 1.26(4).

118. Water from a Stone, *supra* note 12, at 246.

119. Letter from David Frederick, USFWS Supervisor, to Greg Ellis, General Manager of the Edwards Aquifer Authority (1998) (on file with author).

illustrate the problems with using well levels as proxies for springflow to initiate conservation measures.[120] Even though the overall correlation in some instances is very high, for example between the annual means of Comal Springs and J-17, substantial variations exist, which increase as Comal Springs flow declines.[121] It is when the discharge rate is declining that the relationship between the springs and the water level in the index wells becomes critical for triggering conservation measures. Because of the wide range of spring discharges corresponding to specific index well levels, simply raising the index well trigger levels is not an adequate solution. Raising the index well trigger levels would significantly increase the number of instances when the restrictions would be initiated while spring discharge is safely above the take and jeopardy levels and reductions are unnecessary. Below is an alternative set of water use restrictions that could provide a more effective CPMP (Table 6).

120. Water from a Stone, *supra* note 12, at 246-47.
121. *Id.* at 277.

Table 6. Recommended Agricultural, Municipal, Industrial, and Commercial Water Use Restrictions: Trigger Levels and Water Use Reductions[122]

| Comal Springs Discharge Rate | San Marcos Springs Discharge Rate | Reduction Stage (1)(2) | Irrigation-Authorized Monthly Pumping(3) | Municipal, Industrial, & Commercial-Maximum Allowable Pumping Percentages(3) |
|---|---|---|---|---|
| 301 cfs & above | 151 cfs & above | Vigilance* | 100% | 100% |
| 300-251 cfs | 150-141 cfs | I. Caution | 95% | 95% |
| 250-201 cfs | 140-121 cfs | II. Alert | 90% | 90% |
| 200**-151 cfs | 120-101 cfs | III. Critical Period | 80% | 80% |
| 150***-101 cfs | 100***-51 cfs | IV. Jeopardy | 70% | 70% |
| 100-0 cfs | 50-0 cfs | V. Emergency**** (Possible Cessation of Spring Discharge) | 60% | 60% |

NOTES:
* Year around conservation measures required when Comal Springs is 301-350 cfs or San Marcos Springs is 151-200 cfs. These measures are described in the Edwards Aquifer Authority's Groundwater Conservation Plan.
** The discharge rate at which USFWS has determined that takes of endangered species can begin.
*** The discharge rate at which USFWS has determined that endangered species may be in jeopardy.
**** Additional measures may be necessary as the situation dictates.
(1) When the discharge from Comal and San Marcos Springs do not indicate the same reduction stage, the lower of the two stages shall be in effect.
(2) Reductions shall be initiated based on average discharge rates for both Comal and San Marcos Springs over five consecutive days. Reductions shall cease when the discharge rates for both Comal and San Marcos Springs have been above the Stage I trigger level for five consecutive days.
(3) Total percentage reductions are estimated based upon total permitted pumping of 540,000 acre-feet with a minimum reduction of total pumping to 340,000 acre-feet during Stage V. The limit of 340,000 acre-feet was specified as a placeholder in the Region L Plan and incorporated into the State Water Plan. Senate Bill 1477 requires pumping limits of 450,000 acre-feet prior to 2008; limits of 400,000 acre-feet after 2008; and unspecified limits of 400,000 acre-feet after 2012. Pumping percentages should be modified based upon changes in the amount of total permitted pumping such that total reductions do not exceed 340,000 acre-feet, or alternatively a limit contained in a regional Section 10(a) permit for the Edwards Aquifer under the federal Endangered Species Act.

122. Recommendations of Todd Votteler, Guadalupe-Blanco River Authority (June 2002).

### *C. Take and Jeopardy Early Warning Indicators of Years Containing Critical Periods*

In addition to an effective CPMP, a system for initiating conservation measures early, in advance of years in which a critical period is likely to occur, is necessary to manage the Edwards Aquifer given the current absence of available supplemental sources of water. Because of the tendency for critical spring discharges to occur after irrigation has been completed for the year, a program has been developed that pays farmers not to irrigate in years where it appears critical spring flows might occur.[123] The Withdrawal Suspension Program (WSP), or Irrigation Suspension Program, is intended to achieve water use reductions in agricultural irrigation, the second largest category of Edwards Aquifer water use.[124] The WSP, like the CPMP, should be triggered based upon spring discharge rates.

In the absence of information on future aquifer levels and spring discharge, predictions of future conditions can be based in part on the expected precipitation for a particular month.[125] Based upon the pattern of historical recharge and withdrawals, a lower rate of spring discharge in June is of greater concern than the same rate of low flows in August.[126] The potential for rapid declines in spring discharge is greater as the hottest and generally drier period of the year approaches, along with peak pumping for the year.[127] If the discharge rate is declining during April, May, and June, it could signal an increasing potential for critical discharges later in the year because April, May, and June comprise the high rainfall period that typically sustains the aquifer through the hot and relatively dry month of August, when recharge is low and total

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123. In 1992, the Texas Water Commission proposed a program of water use curtailment originally known as the dry-year option:

> The essence of the Commission's recommended curtailment plan is that non-agricultural users, and downstream surface water users, would make temporary purchases of agricultural groundwater rights, to be left in place for the purpose of aquifer level and springflow maintenance during periods of low recharge. The benefit of the program is that it will allow immediate and substantial reductions in groundwater withdrawals, only when necessary, at a cost that is well below the estimated cost for other water supply options. Most important, the dry-year option will lessen the magnitude of demand curtailment required by non-agricultural users and thereby protect the bulk of the region's population and economy.

TEX. WATER COMM'N, AVOIDING DISASTER: AN INTERIM PLAN TO MANAGE THE EDWARDS AQUIFER 12, 13 (1992) (on file with author).

124. *Id.*

125. *See* Water from a Stone, *supra* note 12, at 264.

126. *Id.*

127. *Id.* at 265.

withdrawals are the highest.[128] After June, the influence of rainfall associated with frontal weather systems diminishes across the region, and more variable and less predictable tropical systems become a major source of recharge to the aquifer.[129]

An examination of discharge data shows that, during most fall seasons, discharge at Comal and San Marcos Springs increases once withdrawals from the Edwards Aquifer decline after peak summer demand and fall rains begin.[130] As the fall progresses, the likelihood that substantial rainfall will replenish the aquifer diminishes as the traditional months of high rainfall pass and the relatively dry winter months in this region commence.[131]

This observation suggests that the discharge from the springs in the fall could be an important indicator of future spring discharge conditions. The period used here to suggest when to initiate the WSP begins in 1958 after the drought of record. Prior to 1956 pumping from the aquifer had yet to reach 300,000 acft annually.[132] Comal Springs flow was chosen for the analysis because Comal Springs is at a higher elevation than San Marcos Springs and, in most years, declines below critical levels before similar declines at San Marcos Springs.[133]

Since 1957, Comal Springs has declined below 200 cfs in a majority of the years when discharge was less than 300 cfs throughout the fall of the previous year.[134] Jeopardy occurred in at least one-third of the following years under the same conditions.[135] Table 7, The Take and Jeopardy Early Warning Indicator Flows, provides the cumulative frequency of the percentage of years in which take or jeopardy occurred when flow at Comal Springs was below a specified level in October, November, and December. The percentages were calculated for October, November, and December because a program to reduce irrigation, such as the WSP, must be prepared before initiation of preparation for an irrigated crop in the upcoming calendar year.

128. *Id.*
129. Jones, *supra* note 28, at 514.
130. Water from a Stone, *supra* note 12, at 265.
131. *Id.*
132. Recharge/Discharge, *supra* note 14, at 3.
133. Water from a Stone, *supra* note 12, at 265.
134. *Id.* at 266.
135. *Id.*

Table 7. Take and Jeopardy Early Warning Indicator Flows[136]

(Frequency)

| | Comal Springs ≥400 cfs | | Comal Springs 350-399 cfs | | Comal Springs 300-349 cfs | | Comal Springs 250-299 cfs | | Comal Springs 200-249 cfs | | Comal Springs 0-199 cfs* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years: 1958-1999 | The next year: Take | Jeopardy | The next year: Take | Jeopardy | The next year: Take | Jeopardy | The next year: Take | Jeopardy | The next year: Take | Jeopardy | The next year: Take | Jeopardy |
| On Oct. 31 | 0% | 0% | 0% | 0% | 9% | 0% | 40% | 10% | 71% | 57% | 100% | 33% |
| On Nov. 30 | 0% | 0% | 0% | 0% | 17% | 0% | 60% | 30% | 83% | 50% | 100% | 50% |
| On Dec. 31 | 0% | 0% | 10% | 0% | 17% | 0% | 71% | 43% | 100% | 67% | 100% | 33% |

* The category 0-99 cfs was not included in Table 40 because there were no springflow measurements less than 100 cfs on the target dates during the period 1958-1999.
\# In each year that jeopardy flows occurred, take flows also occurred.

Keying the initiation of measures to the November 30 date was preferable to October 31 because of additional opportunity for rainfall to recharge the aquifer. The Comal Springs discharge rate on the last day of November is the preferred date to base initiation of measures for reducing pumping in the upcoming year, because of the time needed to organize such a program. The program could be cancelled if sufficient recharge were to occur during December. In addition, after November the likelihood of large amounts of recharge decrease as the hurricane season ends, and average total rainfall for the period from December through March is less than seven inches.[137] The last day of December provides a fail-safe deadline to cancel the implementation of pumping reduction programs should the necessary recharge materialize in the interim.

Using these criteria, the performance of the suggested Take and Jeopardy Early Warning Indicators has been examined. Initiating an irrigation WSP when the Comal Springs discharge rate was 300 cfs or less on November 30, would have resulted in an accurate prediction of critical springflows in each of the years since this method of prediction was first presented in 1995.

136. *Id.* at 269.
137. *Id.* at 315.

Comal Springs reached take (200 cfs) during each of the years its flow was below 300 cfs on December 31 of the prior year:[138]

| Discharge Rate on November 30, 1995 | Discharge Rate on December 31, 1995 | Minimum discharge rate in 1996 |
|---|---|---|
| 263 cfs | 272 cfs | 83 cfs |

| Discharge Rate on November 30, 1996 | Discharge Rate on December 31, 1996 | Minimum discharge rate in 1997 |
|---|---|---|
| 185 cfs | 196 cfs | 193 cfs |

| Discharge Rate on November 30, 1997 | Discharge Rate on December 31, 1997 | Minimum discharge rate in 1998 |
|---|---|---|
| 289 cfs | 296 cfs | 168 cfs |

| Discharge Rate on November 30, 1999 | Discharge Rate on December 31, 1999 | Minimum discharge rate in 2000 |
|---|---|---|
| 301 cfs | 289 cfs | 140 cfs |

Comal Springs remained above take (200 cfs) during each of the years it was above 300 cfs on December 31 of the prior year:

| Discharge Rate on November 30, 1998 | Discharge Rate on December 31, 1998 | Minimum discharge rate in 1999 |
|---|---|---|
| 429 cfs | 419 cfs | 276 cfs |

| Discharge Rate on November 30, 2000 | Discharge Rate on December 31, 2000 | Minimum discharge rate in 2001 |
|---|---|---|
| 345 cfs | 345 cfs | 243 cfs |

Comal Springs remained above take (200 cfs) during each of the years flow was above 300 cfs on December 31 of the prior year:

A report was filed with the U.S. District Court for each of the years listed above, based in part on this system.[139] Thus far, the reports have accurately predicted the presence or absence of a critical period in each

138. *See* http://www. edwardsaquifer.org (reporting Comal Springs historical discharge rates for 1995 through 2002).

139. Letter from Joe G. Moore, Jr., Court Monitor to Judge Lucius D. Bunton III, November 1, 1995; Letter from Todd H. Votteler, Special Master to Judge Lucius D. Bunton III, December 3, 1996; Letter from Todd H. Votteler, Special Master to Judge Lucius D. Bunton III, December, 1997; Letter from Todd H. Votteler, Special Master to Judge Lucius D. Bunton III, December 4, 1998; Letter from Todd H. Votteler, Special Master to Judge Lucius D. Bunton III, November 30, 1999; Letter from Todd H. Votteler, Special Master to Judge Lucius D. Bunton III and Judge Sam Sparks, December 11, 2000; and Letter from Todd H. Votteler, Special Master to Judge Sam Sparks, December 10, 2001.

of the years that followed years in which Comal Springs flows equaled 300 cfs or less by November 30.[140] As for 2002, on November 30, 2001, Comal Springs was 394 cfs and on December 31, 2001, Comal Springs was 382 cfs. Therefore Comal Springs is predicted to remain above 200 cfs throughout 2002.[141]

Taking smaller steps to reduce pumping earlier, before a potential low flow year, can reduce the need for more severe measures later, if dry conditions and high pumping persist. However, if drought measures are initiated when unnecessary, public confidence in drought-related water conservation efforts will suffer. Based on Table 7, and given the vulnerability of the aquifer to short-term droughts and the lack of supplemental supplies, when Comal Springs is less than 300 (cfs) on November 30 (or San Marcos Springs is less than 100 cfs) an announcement should be made that the WSP will be initiated in January of the following year. With Comal Springs discharging at this rate, take has historically occurred during 60% of the years that followed, and jeopardy has occurred in 30% of those years (1958-1999).[142] If the flow rises above 300 cfs (for a sustained period) by December 31, the WSP preparations could be terminated. While this conservative trigger level might occasionally initiate the WSP for years in which aquifer levels and spring flows recovered early the following year, in the absence of supplemental sources to those who depend on the Edwards Aquifer, conservation measures will need to be initiated early to avoid violations of the ESA.

### *D. Pumping Limits*

The EAA is authorized to achieve the required limits on withdrawals through issued permits or by purchasing and retiring

140. The Take and Suggested Jeopardy Early Warning Indictors were first developed by the author for the U.S. District Court in 1995 and were then refined in subsequent years. While the reports on predicted future spring discharge rates provided accurate predictions of future conditions at Comal Springs in every year, there has been one anomalous event. In late 1996 a report was issued that predicted the take level would be breached at Comal Springs in 1997. Comal Springs did breach the take level early in 1997, however, late heavy rainfall raised the level of the Edwards Aquifer, and thus spring flow; during the following spring and a revised report was issued in June 1997 indicating that the aquifer was in recovery. A third report was issued in July indicating that take flows were again imminent, based on a series of spring discharge measurements issued by the USGS that contained an error rate of some 42%. The suggested Take and Jeopardy Early Warning Indicators are dependent on timely and accurate USGS spring discharge reports. The EAA, USGS, and GBRA have made additional efforts in subsequent years to improve the accuracy of reported spring discharge measurements.

141. Letter from Todd H. Votteler, Special Master, to Judge Sam Sparks (Dec. 10, 2001) (on file with author).

142. Water from a Stone, *supra* note 12, at 316.

permitted withdrawal rights.[143] When the pumping cap goes from 450,000 acft to 400,000 acft, downstream users in the Guadalupe River Basin will contribute to the money needed to purchase the 50,000 acft reduction (Table 8).[144] Domestic and livestock pumping was excluded from the 450,000 and 400,000 acft caps.[145] The EAA Enabling Act has been interpreted to mean that agricultural irrigators are guaranteed 2 acft of water per acre of irrigated cropland. The export of groundwater across county lines was limited.[146]

Once the 400,000 acft cap is achieved beginning in 2008, with a 15% reduction in pumping applied for an entire year during Stage III of the EAA's draft 2000 CPMP, only 340,000 acft of groundwater can be withdrawn from the aquifer.[147]

The Texas Water Development Board's GWSIM IV Model runs predict that only when pumping from the Edwards Aquifer is limited to 175,000 acft annually is jeopardy (150 cfs) prevented in all cases at Comal Springs using the historical data.[148] However, the same model runs with the same data indicate that jeopardy (100 cfs) would be violated at San Marcos Springs.[149]

The EAA has proposed to issue 818 regular permits totaling 532,275 acft.[150] Once this process has concluded, the EAA is likely to issue permits totaling 540,000 acft of annual pumping from the Aquifer, some 90,000 acft above the limit specified in SB 1477.[151] The EAA has indicated that instead of reducing permitted withdrawals to 450,000 acft before 2008, and 400,000 acft after 2008, the Authority may seek to raise authorized pumping limits to 500,000 acft or more annually, possibly by seeking an amendment to SB 1477.[152] This action may be based on a program of projects designed to "optimize" the functioning of the aquifer through projects such as recharge dams that could provide additional recharge when rainfall is available.[153]

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143. EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355 §§ 1.16, 1.22a.

144. *Id.* § 1.29(d).

145. S. 1477, 73d Leg., Reg. Sess. (Tex. 1993).

146. EAA Enabling Act § 1.28(b).

147. NAISMITH ENG'G, *supra* note 96, at 5.

148. HICKS & CO., EDWARDS AQUIFER AUTH., INITIAL DRAFT (INCOMPLETE) ENVIRONMENTAL IMPACT STATEMENT AND HABITAT CONSERVATION PLAN, app. B, Table 19 (2001).

149. *Id.*

150. Edwards Aquifer Authority, Technical Media Briefing on Proposed Groundwater Permits 2, 4 (Nov. 13, 2000) (on file with author).

151. Greg Ellis, EAA General Manager, Remarks at Meeting of SCTRWPG, San Antonio, Texas (Feb. 7, 2002).

152. *Id.*

153. Todd Engineers, Draft: Edwards Aquifer Authority Optimization Overview 1 (1999) (on file with author).

A recent Texas Supreme Court interpretation of the Edwards Aquifer Act in a related matter found that:

> The Act entitles an existing user to a permit allowing the user to withdraw an amount of water equal to the user's maximum beneficial use of water without waste during any one calendar year of the historical period, unless the aggregate total of such use throughout the aquifer exceeds the 450,000 acre-foot cap. *Id.* § 1.16(e). *If this occurs, the Legislature has directed that the Authority proportionately adjust the amount of water authorized for withdrawal under the permits to meet the cap. Id.* This downward adjustment is limited in two circumstances, the first of which is relevant here: (1) an existing irrigation user must receive a permit of not less than two acft a year for each acre of land the user actually irrigated in any one calendar year during the historical period; and (2) an existing user who operated a well for three or more years during the historical period must receive a permit for at least the average amount of water withdrawn annually during the historical period. *Id.* Subject to certain restrictions, permitted water rights may also be sold or leased. *Id.* §§ 1.22, 1.34. [emphasis added].[154]

The EAA could be faced with proportionally reducing the 540,000 acre-feet in permits once the contested case process is concluded in 2003. It would appear that all of the proportional reductions could come from the approximately 290,000 acre-feet allocated for municipal and industrial users.[155] This is because the Texas Supreme Court has stated that the 250,000 acre-feet in irrigation permits would be exempt from the reductions.[156]

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154. Bragg v. Edwards Aquifer Auth., 71 S.W.3d 729, 731 (Tex. 2002). Senate Bill 1477 art. 1, § 1.21, allows for permit retirement and reads as follows:

> (a) The authority shall prepare and implement a plan for reducing, by January 1, 2008, the maximum annual volume of water authorized to be withdrawn from the aquifer under regular permits to 400,000 acre-feet a year or the adjusted amount determined under Subsection (d) of Section 1.14 of this article.
>
> (b) The plan must be enforceable and must include water conservation and reuse measures, measures to retire water rights, and other water management measures designed to achieve the reduction levels or appropriate management of the resource.
>
> (c) If, on or after January 1, 2008, the overall volume of water authorized to be withdrawn from the aquifer under regular permits is greater than 400,000 acre-feet a year or greater than the adjusted amount determined under Subsection (d) of Section 1.14 of this article, the maximum authorized withdrawal of each regular permit shall be immediately reduced by an equal percentage as is necessary to reduce overall maximum demand to 400,000 acre-feet a year or the adjusted amount, as appropriate. The amount reduced may be restored, in whole or in part, as other appropriate measures are implemented that maintain overall demand at or below the appropriate amount.

155. Author's calculation. *See infra* Table 8.

156. *Bragg*, 71 S.W.3d at 731.

Table 8. Edwards Aquifer Water Use Statistics and Projections[157]

| | |
|---|---|
| Record High Withdrawals (1989) | 542,400 acft |
| Total groundwater pumped in 2000 | 415,000 acft |
| Total amount of aquifer withdrawals from permit applications | 852,800 acft |
| Total amount allowed under Senate Bill 1477 before 2008 | 450,000 acft |
| Total amount allowed under Senate Bill 1477 beginning in 2008 | 400,000 acft |
| Total amount allowed after 2012 will be the amount ensuring continuous minimum flow of Comal and San Marcos Springs for endangered species as prescribed by USFWS | See below |
| Amount TWDB's model, and the USFWS, indicates can be pumped during a repeat of the drought of record without causing jeopardy at Comal and San Marcos Springs | 175,000 acft |
| Interim pumping limit adopted by SCTWPG in Region L Plan | 340,000 acft |
| Total amount of permitted groundwater proposed by EAA | 532,000 acft |
| Amount EAA estimates will be issued after contested case process ends | 540,000 acft |
| Estimated breakdown of the total groundwater permits likely to be issued by the EAA | *540,000 acft total*<br>~250,000 acft irrigated agricultural<br>~260,000 acft municipal<br>~30,000 acft industrial |

### *E. Habitat Conservation Plan*

Prior to 1982, nonfederal parties faced penalties under the Endangered Species Act when their otherwise legal activities resulted in the take of a species.[158] In that year, Congress amended the ESA to allow the "taking" of federally listed species when the taking is the inadvertent result of a legal activity by obtaining an incidental take permit (ITP) under Section 10(a) of the Act.[159] With regard to the Edwards Aquifer, an ITP would allow withdrawals that may cause the take of listed species at Comal or San Marcos Springs to continue until the jeopardy spring discharge levels are reached.[160] To secure a permit, protective measures are devised to prevent lowering the aquifer, which would cause spring

157. Statistics compiled and calculated by author; *see* EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355; Water from a Stone, *supra* note 12; *Bragg*, 71 S.W.3d at 729.

158. Endangered Species Act of 1973, 16 U.S.C. § 1539(a)(1)(B) (1997).

159. *Id.*

160. Joe G. Moore, Jr. & Todd H. Votteler, Draft Habitat Conservation Plan for the Edwards Aquifer (Balcones Fault Zone—San Antonio Region), prepared for the Honorable Lucius D. Burton III (June 23, 1995) (on file with author) [hereinafter Draft Plan].

flows to decline and, in turn, cause jeopardy for the species of concern. The purpose is to prevent extinction of the endangered species.

Development of a habitat conservation plan (HCP) is required for an ITP.[161] A regional Edwards Aquifer HCP must be a water conservation and supply plan for the sustainable development of the region, and will be used to secure a multiyear permit authorizing incidental takes by those entities and individuals who sign the application.[162] Theoretically, holders of the ITP would be protected from an ESA enforcement action when Comal Springs drops below 200 cfs and until the 150 cfs jeopardy level is reached.[163] The difference between these flows, 50 cfs, would allow additional withdrawals from the Edwards of approximately 36,200 acft annually in critical years.[164]

The EAA is currently engaged in the development of an HCP to obtain an ITP.[165] As part of this effort the EAA has contracted for studies to answer two major questions: (1) what would the regional economic impacts be of various Edwards Aquifer pumping limits, and (2) is the current regime of take and jeopardy spring discharge rates specified by the USFWS optimal for the continued survival of the listed species.[166]

The preliminary results of an impact study of Edwards Aquifer pumping limits conducted by researchers at Texas A&M has concluded:

> "A limit of 340,000 acft per year creates minimal to moderate impacts on most economic variables and regions.
>
> —Notable Exception is Irrigated Acreage in the Central and Eastern Regions.
>
> —Overall, this study supports EAA-HCP implementation because economic impacts are moderate for all but the most extreme pumping limit.

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161. 16 U.S.C. § 1539(a)(2)(A).

162. During *Sierra Club v. Babbitt*, a draft regional HCP for the Edwards Aquifer was developed between October 1994 and June 1995 for the U.S. District Court. The primary themes of the 330-page draft HCP were the conservation and reuse of existing water supplies, and the introduction of additional ground and surface water to the region to reduce withdrawals from the aquifer. A sufficient number of supply alternatives, totaling 250,000 to 350,000 acft annually, were proposed in the HCP to protect the endangered species and assure downstream minimum flows in the Guadalupe River during droughts. No new reservoirs were included. The 2001 Region L Water Plan, although substantially more detailed, included most of the elements found in the U.S. District Court's draft HCP, which was also prepared by a panel representing water purveyors and interests.

163. *See* Draft Plan, *supra* note 160.

164. Water from a Stone, *supra* note 12, at 134.

165. Status of the Edwards Aquifer Habitat Conservation Plan, Presented by the Hicks Company at the Edwards Aquifer Authority Board Workshop (June 15, 2002).

166. Lonnie Jones et al., Economic Impacts of Edwards Aquifer Pumping Restriction Alternatives, Presentation at Texas A&M University (Aug. 2001) (on file with author); Edmund Oborny, Jr., Edwards Aquifer Authority Variable Flows Study Project Update (Oct. 9, 2001) (on file with author).

> —Implementation of the HCP pumping limits down to and including 340,000 ac.ft./yr could be accomplished without major disruption of the regional economy."[167]

These conclusions are significant because they appear to refute the belief that reduced pumping from the Edwards Aquifer would cripple the economy of the Edwards Aquifer region. Most irrigation occurs in the western region of the aquifer, while irrigation in the eastern and central regions has been declining steadily in recent years.[168] The figures 340,000 acft and 175,000 acft were used in this study because 340,000 acft is the limit on pumping adopted in the Region L Water Plan (discussed below) and 175,000 acft is the limit necessary to prevent jeopardy flows at the springs during a repeat of the drought of record.[169] The preliminary results of this study found that an annual pumping limit of 175,000 acft produced "[h]igh negative impacts on all economic variables in all regions of the HCP planning area."[170]

A second study, by the consulting firm BIO-WEST, Inc., is investigating the possibility of adopting a regime of variable spring discharge rates at Comal and San Marcos Springs.[171] This study is still underway, but thus far indicates that a variable regime of minimum spring discharge rates is preferable for protecting the listed species at the springs instead of fixed spring discharge rates.[172] Although the results of research by a team at Utah State University has been reported by the *San Antonio Express-News* to undermine the previous springflow determinations, the USFWS has stated that the results from the Utah State University study are preliminary and do not consider all of the relevant factors necessary for determining the required flows necessary for the survival of the listed species.[173] However, other researchers, including some under contract to the EAA, have recently concluded that the take level established for the endangered fountain darter at Comal

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167. Jones et al., *supra* note 166, at 20, 23.

168. Joe G. Moore, Jr., Emergency Withdrawal Reduction Plan for the Edwards Aquifer, Prepared for the Honorable Lucius D. Burton III, at 30-33 (Aug. 1, 1994) (on file with author); South Central Texas Regional Water Planning Group, South Central Texas Regional Water Plan, Vol. I, § 2.6, at 2-21 (Jan. 2001) [hereinafter Regional Water Plan].

169. Regional Water Plan, *supra* note 168, § 3, at 5; TEX. WATER DEV. BD., WATER FOR TEXAS—TODAY AND TOMORROW: RECOMMENDATIONS FOR THE 1992 UPDATE TO THE TEXAS WATER PLAN 94 (1992). This source recommends an 165,000 acft pumping limit for the Edwards Aquifer to ensure a minimum of 100 cfs of discharge from Comal Springs and 50 cfs at San Marcos Springs during a repeat of the drought of record.

170. Jones et al., *supra* note 166, at 24.

171. Oborny, *supra* note 166, at 1.

172. *Id.*

173. Jerry Needham, *Study Throws Water on Aquifer Limits*, SAN ANTONIO EXPRESS-NEWS, May 24, 2000, at 1A.

Springs may be too low to prevent harm, and should actually be raised: "Consequently, spring flows below 300 cfs appear to have serious negative impacts on the abundance of *E. fonticola* in the Comal Springs system."[174] Researchers at the Texas Parks and Wildlife Department (TPWD) have recently reached similar conclusions for the endangered Texas wild-rice in the San Marcos Springs ecosystem: "At flows less than 140 $ft^3/s$ [cfs], critical depths for *Z. texana* are violated (Appendix IV: Figure 8) and the potential for recreational impact increases."[175]

## IV. THE BLUEPRINT FOR A NEW CENTURY

### *A. Senate Bill 1*

Senate Bill 1, passed by the Texas Legislature in 1997, heralded a new era in state water planning in Texas.[176] Regional plans were to be developed from the bottom up by citizen groups, as opposed to the top down by state agencies, as had been the case in the series of previous plans never fully implemented.[177] Under Senate Bill 1 the Water Development Board carved the state into sixteen water planning regions, based on a compromise between political boundaries and surface and groundwater hydrologic boundaries.[178] The water planning region local to the Edwards Aquifer, the South Central Texas Regional Water Planning Group or Region L, covers portions of the Nueces, San Antonio, and Guadalupe River watersheds. In 2000, the population within Region L was estimated at 2,132,188, and it is projected to increase to 4,527,361 by the year 2050.[179]

Consensus environmental criteria developed by the Texas Parks and Wildlife Department, Texas Water Development Board and Texas Natural Resource Conservation Commission were used to evaluate all options considered in the Region L Plan.[180]

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174. Clark Hubbs, *Environmental Correlates to the Abundance of Spring-Adapted Versus Stream-Adapted Fishes*, 53 TEXAS J. SCI. 299, 321 (2001).

175. KENNETH SAUNDERS ET AL., TEXAS PARKS AND WILDLIFE DEP'T, AN EVALUATION OF SPRINGS FLOWS TO SUPPORT THE UPPER SAN MARCOS RIVER SPRING ECOSYSTEM, HAYS COUNTY, TEXAS, 28 RIVER STUDIES REPORT NO. 1628 (2001), *available at* http://www.tpwd.state.tx.us/texaswater/river_studies.

176. Martin Hubert, *Senate Bill 1: The First Big and Bold Step Toward Meeting Texas' Future Water Needs*, 30 TEX. TECH. L. REV. 53, 57 (1999).

177. *Id.* at 70. The first Texas Water Plan was published by the Texas Board of Water Engineers (later renamed the Texas Water Development Board) in 1961 and the last in 1997.

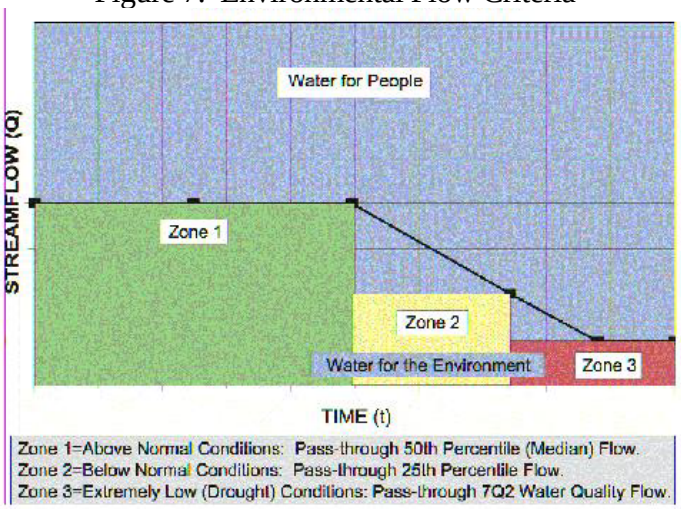
178. TEX. WATER DEV. BD., WATER FOR TEXAS—2002, at 22 (2002) [hereinafter WATER FOR TEXAS—2002].

179. *Id.* at 26.

180. *Id.* at 59-60:

> State and regional water planning requires use of consensus criteria to assess the environmental flow needs of all new water development strategies when site-specific

Figure 7. Environmental Flow Criteria




Source: Texas Water Development Board, 2001.

The Region L Plan is a consensus plan developed by a panel of regional residents representing a wide range of interests.[181] No major new reservoirs are in the plan that could cause significant adverse

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field studies are not available or feasible during regional planning efforts. The criteria were developed through extensive collaboration among scientists and engineers from the State's natural resource agencies (TWDB, TPWD and TNRCC), as well as academics, consultants, and informed citizens. The criteria are composed of multistage rules for environmentally safe operation of impoundments and diversions during above-normal streamflow conditions, below-normal conditions, and drought conditions [Figure 7]. The criteria provide balance by sharing the adverse impacts of drought so that neither human nor environmental needs prevail over the other. However, it should be recognized that State and Federal permitting processes may require different environmental flow constraints based on the results of intensive field studies or other permitting considerations.

There are two distinct methods for determining environmental flow needs: statistical "desk-top" techniques and intensive field studies. The first method is used in water planning, particularly when several alternative water management strategies are being evaluated for meeting a water supply need. This method uses a statistical analysis of existing hydrologic records for a potential water development site. The second method involves a field study and modeling assessment of the actual flow needed for environmental maintenance. The second method is generally recognized as more accurate than the statistical method and is generally required during the State and Federal permitting process.

Because many streams in Texas are fully or almost fully appropriated, opportunities are limited for making new water appropriations for the environment or for new water development projects that alone would provide flows sufficient to maintain a healthy ecosystem. In most cases, water rights issued before 1985 for development of water supply projects have no environmental requirements.

*Id.*

181. *Id.* at 21-24

impacts to freshwater inflows to coastal bays and estuaries are included in the plan.[182] The Region L Plan has been consolidated with the plans of the other fifteen regions to create the new State Water Plan, which has been adopted by the Texas Water Development Board (TWDB).[183] A maximum of 340,000 acft of withdrawals from the Edwards Aquifer was agreed upon by the region as the interim limit in the Region L Plan.[184]

### *B. The Lower Guadalupe Supply Project*

On May 10, 2001, the Guadalupe-Blanco River Authority (GBRA), San Antonio Water System (SAWS), and San Antonio River Authority (SARA) signed a historic first agreement to bring large amounts of surface water to San Antonio.[185] The Lower Guadalupe Supply Project, known as option SCTN-16c in the Region L Plan, is a water management strategy that diverts surface water from the short segment of the Guadalupe River downstream of the confluence of the Guadalupe and San Antonio Rivers near Tivoli, Texas, to be distributed by the San Antonio River Authority (SARA) and the San Antonio Water System (SAWS).[186] Lower Guadalupe Supply Project provides approximately 20% of the new water supplies needed to meet future needs within the 20 and 1/2 counties contained in Region L.[187] In October 2000 the SAWS Board and San Antonio City Council approved a water supply fee.[188] This fee will be used to finance new sources of water as well as water

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182. Regional Water Plan, *supra* note 168.

183. Water for Texas—2002, *supra* note 178.

184. The Region L Plan contains the following discussion of the future Edwards Aquifer pumping limit:

> For planning purposes, an estimate of 340,000 acft/yr of available supply during a drought of record from the Edwards Aquifer was agreed upon by the South Central Texas Regional Water Planning Group and the staff of the Texas Water Development Board. This quantity was adopted as a placeholder number until the EAA completes and acquires approval from the U.S. Fish and Wildlife Service for a Habitat Conservation Plan (HCP). TWDB staff, in a letter to Greg Ellis, dated November 16, 1999, agreed to accept water availability from the Edwards Aquifer as 340,000 acft/yr after 2012 in the Regional Water Plan, if it includes actions to be taken to ensure that the required level of protection of the endangered species at San Marcos and Comal Springs will be maintained drought a drought of record.

*See* Regional Water Plan, *supra* note 168, § 3.5, at 1.

185. Guadalupe-Blanco River Authority News, GBRA Moves to Secure Water Supply to Region, Nov. 28, 2001, at 2 [hereinafter GBRA News]; Water Supply and Delivery Agreement Among Guadalupe-Blanco River Authority, San Antonio Water System and San Antonio River Authority (May 10, 2001) (on file with author).

186. Regional Water Plan, *supra* note 168, § 5.2.3.

187. *Id.* § 5, tab. 5.1-1, at 5-5 to 5-6.

188. Susan Butler, Presenting LCRA—SAWS Water Project Overview, San Antonio Water System: Planning Our Future for the Next Fifty Years 4 (May 23, 2002).

conservation for the City.[189] The fee, which is being added to the residential water and wastewater service, "(S)till keeps San Antonio as one of the lowest of any major city in Texas."[190] The surface water is scheduled to reach San Antonio beginning in 2010, relieving pressure on the Edwards Aquifer and protecting springflow levels, instream flows, and bay and estuary inflows for San Antonio Bay.[191] Under the terms of the fifty-year Water Supply and Delivery Agreement, the diversion will also serve communities along the pipeline route in the SARA four-county district.[192]

The Lower Guadalupe Supply Project has three components: (1) an amendment of GBRA's existing Lower Guadalupe water rights to deliver water on a temporary, interim basis, (2) an application to divert unappropriated flows from the Guadalupe River and deliver water on a longer term basis with special conditions for the benefit of the bay and estuary, and (3) the use of groundwater as a supplemental source.[193]

The surface water would be primarily available in accordance with currently existing water rights.[194] A total of 70,000 acft of surface water will be diverted initially with an additional 24,500 acft supplied from the Gulf Coast Aquifer primarily from Goliad and Refugio Counties.[195] The groundwater supply would be managed by two recently created districts, the Refugio Groundwater Conservation District and Goliad County Groundwater Conservation District.[196] This arrangement also has the advantage of slowly reducing the amount of delivered surface water to avoid a conflict at the end of the 50-year contract. A contract between GBRA, SAWS, and SARA reduces the amount of surface water diverted from the Guadalupe River as in-basin river-user demand increases.[197] As

189. *Id.*

190. *Id.*

191. *Id.* In 1991, and 1994, the citizens of San Antonio voted in two separate elections to abandon the Applewhite Reservoir project already under development south of the City on the Medina River. The Applewhite Reservoir was not the first surface water San Antonio had rejected. In 1976, the San Antonio City Council disapproved a contract for the purchase of 30,000 acft of surface water from Canyon Reservoir to be supplied by GBRA. In the 1950s and 1960s the GBRA and San Antonio fought over control of the Canyon Reservoir project, with GBRA the winner in the Texas Supreme Court. Prior to the 1950s the City refused participation in the U.S. Army Corps of Engineers Goliad Reservoir project on the San Antonio River. Before WWII the San Antonio city fathers declined an offer to buy up the water rights in the San Antonio River watershed from Medina Lake. *Id.*

192. Water Supply and Delivery Agreement, *supra* note 185, § 2.1.

193. Regional Water Plan, *supra* note 168, § 5.2.3.

194. Water Supply and Delivery Agreement, *supra* note 185, § 5.2.3.

195. *Id.*

196. W.E. West, Jr., Comments at Meeting Between Goliad County Groundwater Conservation District, Guadalupe-Blanco River Authority, Crossroads Groundwater Conservation District and Refugio Groundwater Conservation District in Victoria, Texas, June 18, 2002.

197. Water Supply and Delivery Agreement, *supra* note 185, tab. 1.

the Guadalupe River water diverted to San Antonio is reduced over the life of the fifty-year contract, other water resources are planned to be brought on line and delivered via the pipeline such as desalinated seawater.[198] Additional amounts of surface water can be purchased on an interruptible basis, when available, and when not needed in the Guadalupe River system.[199] This will give San Antonio a large surface water supply in the short-run, reducing the city's reliance on the Edwards Aquifer, while allowing the region to develop a long-term water supply including sources such as desalination. The project also protects GBRA's water rights from cancellation under the "use it or lose it" theory.[200] This Project maintains these rights for eventual use within the GBRA's jurisdiction as the demand develops.

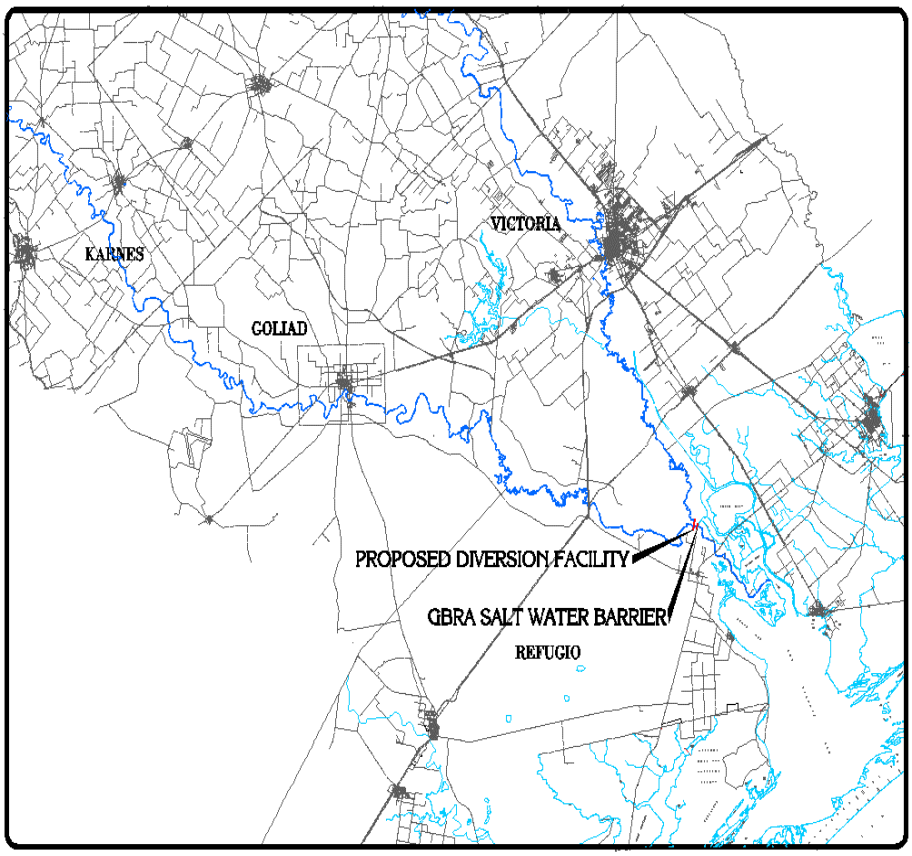
On November 28, 2001, the GBRA Board of Directors authorized the filing of applications with the Texas Natural Resource Conservation Commission (TNRCC) to initiate the project.[201] The agreement provides for an initial reservation period of one to seven years, during which time SAWS and SARA will pay an approximate annual fee of approximately $12 per acre-foot of water.[202] Once water delivery begins, the cost will increase to $60 per acre-foot in addition to an annual inflation factor based on the Consumer Price Index.[203] The cost of the treated water, delivered 130 miles uphill through a pipeline to San Antonio, will be approximately $829 per acre-foot, which includes treatment costs at the point of use.[204]

GBRA will build, own and operate the diversion pump station at Tivoli, Texas (Figure 7).[205] SAWS and SARA will construct the pipeline, as well as treatment and storage facilities.[206] The pumping facilities to be located on the Lower Guadalupe River will be owned and operated by GBRA.[207] GBRA will be responsible for oversizing the pipeline to deliver additional amounts of water from other sources.[208] These projects could use the same pipeline that will be developed by GBRA, SARA,

198. Regional Water Plan, *supra* note 168, § 5, tab. 5.1-1.
199. Water Supply and Delivery Agreement, *supra* note 185, § 2.4.
200. GBRA News, *supra* note 185, at 2.
201. *Id.* at 1.
202. Todd H. Votteler, *Guest Commentary: Guadalupe River Diversion Could Signal an End to Regional Water Conflict*, 16 WATER STRATEGIST 12 (2001).
203. *Id.*
204. *Id.*
205. Water Supply and Delivery Agreement, *supra* note 185, § 4.6.
206. *Id.* § 5.2(a).
207. *Id.* § 4.6(a)
208. *Id.* § 5.1(a).

and SAWS for the Lower Guadalupe Supply Project, while supplying additional water to San Antonio.[209]

Figure 8. The Lower Guadalupe Supply Project Diversion Point




The first GBRA application was filed with TNRCC on April 4, 2002, and requested amendments to six existing water rights permits owned by GBRA downstream of the confluence of the San Antonio and

209. Regional Water Plan, *supra* note 168, § 5, tab. 5.1-1. A joint project between the LCRA and SAWS would develop up to 330,000 acre-feet of water through construction of off-channel reservoirs, groundwater supplies and conservation. Quentin Martin, LCRA—SAWS Water Project Overview, Presentation at San Antonio Water System and Resources Program 3 (May 23, 2000). The program would be funded entirely by SAWS, but SAWS would receive only 150,000 acre-feet of water, while as much as 160,000 acre-feet of the total would be reserved for irrigation (primarily for rice) in the basin of origin. *Id.*

Guadalupe Rivers.[210] These amendments would allow water from these rights to be used within GBRA's ten-county statutory district as well as outside the Authority's jurisdiction. In the first set of proposed amendments, water associated with existing water rights will serve municipal, industrial, and irrigation customers within GBRA's service area.[211]

The second application requests a new permit for the diversion of unappropriated flows.[212] In this application, GBRA will request authorization to divert the unappropriated water from the Guadalupe River upstream of the GBRA Salt Water Barrier.[213] That water could be used to meet future demands within the Middle and Lower Guadalupe River. It also provides for the sustainable use of the region's water resources, while protecting instream flows and bay and estuary freshwater inflows.

GBRA's second application to TNRCC for rights to unappropriated water in the Guadalupe River is also addressed in the Water Supply and Delivery Agreement among GBRA, SAWS, and SARA.[214] This application will contain protections for bay and estuary flows that could establish a new standard for the state.[215]

The exact amount of water to be requested in the permit application has not been determined. There are disagreements as to how much water is actually available. The amount of the permit will be decided by a combination of an analysis using the Texas National Resource Conservation Commission's Water Availability Model and an analysis of the ecological needs of the Guadalupe Estuary and San Antonio Bay.[216] The new regional water plan contains the only option that actually increases bay and estuary flows above current levels, once all of the elements of the plan are implemented.[217]

By diverting the water at the coast, instream flows in the Guadalupe River are protected. Eventually, with all the elements of this project in place, more baseflow will actually be available during the critical summer months, and will help maintain instream and freshwater flows

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210. Supplement to Applications of Guadalupe-Blanco River Authority for Amendment of Certificates of Adjudication Nos. 18-5173, 18-5174, 18-5175, 18-5176, 18-5177, and 18-5178, filed by Roger P. Nevola on Apr. 8, 2002 (on file with author).

211. GBRA News, *supra* note 185, at 3.

212. *Id.* at 1.

213. *Id.* The Salt Water Barrier prevents the encroachment of salt water up the Guadalupe River during low flow periods.

214. Water Supply and Delivery Agreement, *supra* note 185, § 2.5(b).

215. GBRA News, *supra* note 185, at 3.

216. *Id.*

217. W.E. West, Jr., Testimony Before the Texas Legislature's Joint Interim Committee on Water Resources (Feb. 27, 2002).

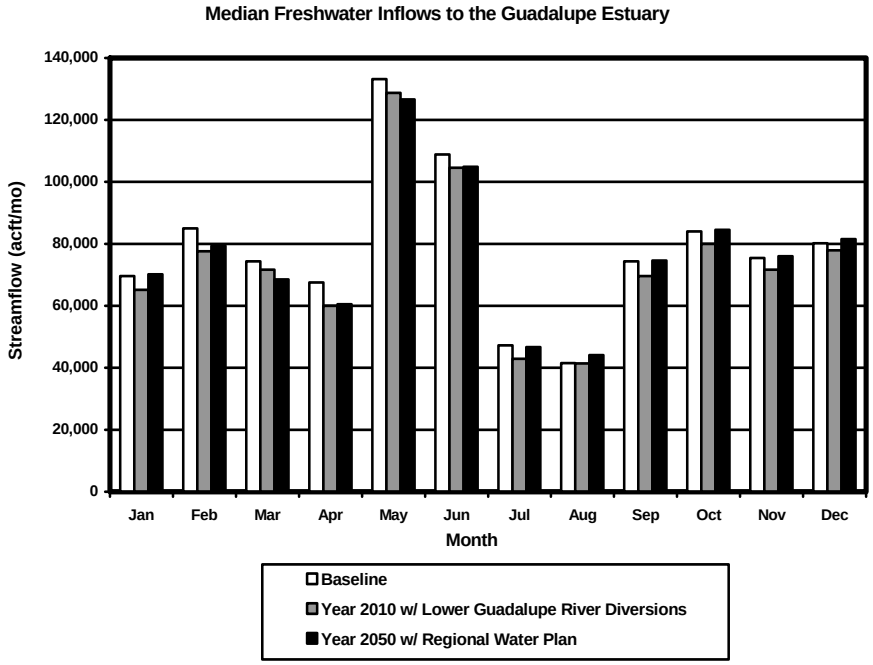
for bay and estuary, especially during low rainfall and drought conditions.[218]

218. HDR Engineering has identified additional factors that may provide more positive benefits from the Regional L Plan than are generally known:

> —Every simulated water management strategy in the Region L Plan assumed that surface water rights were fully diverted in every year. In years when water rights are not fully diverted, the water supply associated with the surface water management strategies should increase and the unit cost should decrease. Additionally, instream flows and/or freshwater inflows to estuaries and bays could be greater than what is found in the Region L Plan;
>
> —Every simulated water management strategy in the Region L Plan assumed the discharge of treated wastewater at rates consistent with current conditions, however, no return flows from diversions for irrigation purposes were assumed. If the discharge of treated wastewater increases as water use increases in the future, or that irrigation return flows occur at all, the water supply associated with the surface water management strategies should increase and the unit cost should decrease; and
>
> —The evaluation of the water management strategies and the assessments of cumulative impacts of implementation of the Region L Plan were based upon a fixed annual withdrawals from the Edwards Aquifer of 400,000 acft/yr subject to draft EAA Critical Period Management rules, which are not as restrictive as the rules proposed in 2002. If springflow is ultimately protected, the water supply associated with the surface water management strategies downstream of the springs should increase and the unit cost should decrease. An additional positive benefit would be increased instream flows and/or freshwater inflows to estuaries and bays, greater than those found in the Region L Plan.

Memorandum from Sam Vaugh, HDR Engineering, Inc. to Dr. Todd Votteler concerning the South Central Texas Regional Water Plan (June 14, 2002) (on file with author).

Figure 9. The South Central Texas Regional Water Plan Increases Total Freshwater Inflows, Particularly During the Critical Month of August




The Executive Summary of the Region L Plan states:

> —Phased implementation of the Regional Water Plan (including timely utilization of Management Supplies) results in increased instream flows in the Guadalupe and San Antonio Rivers and increased freshwater inflows to the Guadalupe Estuary, particularly during the drier months and more extended drought periods.[219]

Despite the fact that the San Antonio River merges with the larger Guadalupe, and therefore in the same basin, there is a possibility that the project could be declared an interbasin transfer by the TNRCC.[220] The rivers have been considered as separate basins for management purposes, which could result in the Lower Guadalupe Supply Project being classified as an interbasin transfer.[221] TWDB commented that "the plan

219. *See* Regional Water Plan, *supra* note 168.

220. Letter from Tommy Knowles, Deputy Executive Administrator, TWDB, to Evelyn Bonavita and Greg Roth 3 (Mar. 28, 2001) (on file with author).

221. *Id.*

is in error in its representation of the Lower Guadalupe River Diversions as a non [interbasin transfer]."[222] In the new State Water Plan, the Lower Guadalupe Supply Project was presented as both an interbasin transfer and not an interbasin transfer.[223] The decision as to whether the project is an interbasin transfer will be made either by the TNRCC (or Texas Commission on Environmental Quality as it will soon be known) during permit review or by an act of the Texas Legislature. If the TNRCC considers the Lower Guadalupe Supply Project an interbasin transfer, an interbasin transfer permit would be required from TNRCC and would reduce the reliability of the surface water rights proposed for use in the Lower Guadalupe Supply Project (which includes groundwater from the Gulf Coast Aquifer as well as surface water):

> Such classification would significantly reduce the dependable supply from the 94,500 acft/yr shown in the Adopted Regional Water Plan due to adjustment of priority and application of Consensus Environmental Criteria for diversions under the portion of the GBRA/UCC water rights (CA# 18-5178) to be used in Bexar County.[224]

Such a designation would make the senior water rights identified for the project junior for the purposes of their use in San Antonio. This is because in 1997, the Senate Bill 1 water planning statute modified the Texas Water Code making the waters rights associated with interbasin transfers junior in priority to all other water rights in the basin of origin, significantly reducing the reliability of these reclassified rights during droughts.[225] For this reason it may be necessary for the Texas Legislature to acknowledge the uniqueness of this situation and clearly resolve the question in 2003.

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222. *Id.*

223. *See* Regional Water Plan, *supra* note 168, Attachment D, Discussion of Lower Guadalupe River Diversions (SCTN-16).

224. *Id.* at 3.

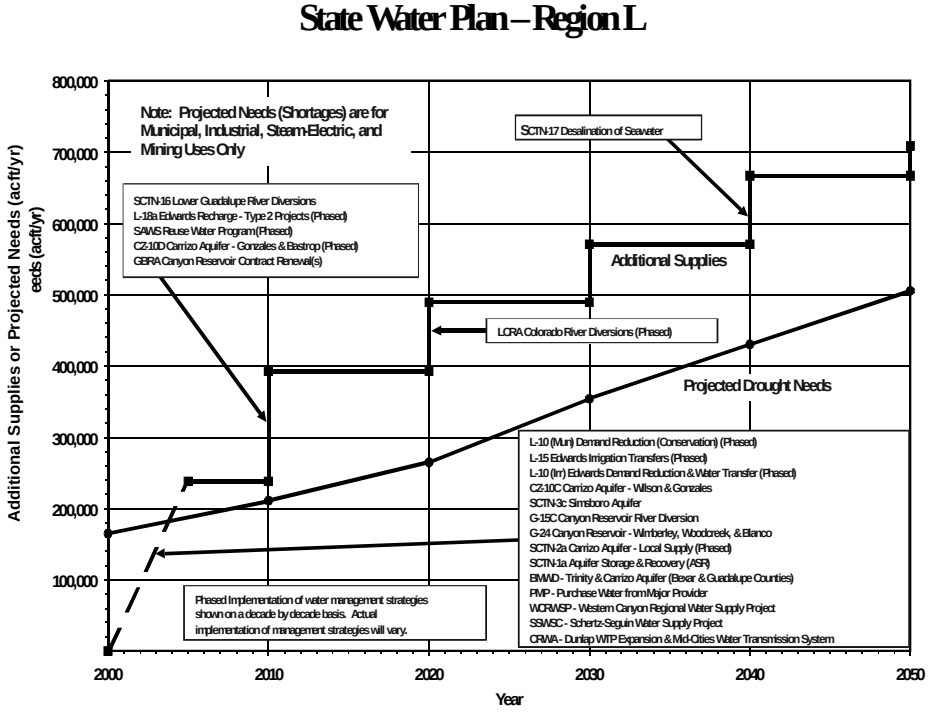
225. TEXAS WATER CODE ANN. § 11.085 (Vernon Supp. 2002):

> (s) Any proposed transfer of all or a portion of a water right under this section is junior in priority to water rights granted before the time application for transfer is accepted for filing.
>
> (t) Any proposed transfer of all or a portion of a water right under this section from a river basin in which two or more river authorities or water districts created under Section 59, Article XVI, Texas Constitution, have written agreements or permits that provide for the coordinated operation of their respective reservoirs to maximize the amount of water for beneficial use within their respective water services areas shall be junior in priority to water rights granted before the time application for transfer is accepted for filing.

### *C. Providing Freshwater Inflows to the Guadalupe Estuary and San Antonio Bay*

A key question in the development of any regional water plan is the potential impact on the environment. With the Lower Guadalupe Water Supply Project water is diverted near the coast, which should avoid significant issues concerning instream flows along most of the length of the river.

Figure 10.




What remains, primarily, are issues concerning freshwater inflows to the Guadalupe Estuary and San Antonio Bay. A methodology for estimating the necessary level of freshwater inflows to Texas estuaries was published in 1994.[226] The primary method for estimating required freshwater inflows for the ecological needs of Texas estuaries and bays was developed by TPWD and TWDB under the State Bays and Estuaries

226. TEX. PARKS & WILDLIFE DEP'T AND TEX. WATER DEV. BD., FRESHWATER INFLOWS TO TEXAS BAYS AND ESTUARIES: ECOLOGICAL RELATIONSHIPS AND METHODS FOR DETERMINATION OF NEEDS (William L. Longley ed., 1994).

Research Program.[227] The analysis of the estimated requirements for estuaries and bays attempts to determine the amount of freshwater inflow necessary to provide for certain target species, such as blue crab, oyster, red drum, black drum, spotted seatrout, and brown shrimp used in the analysis for the Guadalupe Estuary and San Antonio Bay.[228]

At the heart of the methodology are three components: (1) a statistical regression of commercial species harvesting versus inflow and other variables, (2) the Estuarine Mathematical Programming or Optimization Model (TXEMP), and (3) the two dimensional, finite element hydrodynamic circulation model (TXBLEND).[229] TXEMP produces a range of solutions that simultaneously predict seasonal (monthly) inflows, and the corresponding estuarine fishery harvests, which satisfy the model input constraints.[230] The monthly flow targets are also included. Output from TXEMP serves as input to TXBLEND, which simulates patterns of salinity distribution and water circulation within the bay.[231]

These simulations rely on computer optimization and hydrodynamic modeling as basic predictive techniques that produce theoretical estimates of a minimum freshwater inflow (termed the MinQ flow), maximum harvest freshwater inflow (termed MaxH flow) and maximum annual inflow (termed MaxQ) for each Texas estuary.[232] Flows below MinQ for extended periods of time were considered to be potentially harmful.[233] Using this technique, TPWD has estimated the amount of water necessary to annually produce the maximum fisheries

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227. Tex. Parks & Wildlife Dep't and Tex. Water Dev. Bd., Freshwater Inflow Recommendation for the Guadalupe Estuary of Texas, Coastal Studies Technical Report No. 98-1, at 3 (Dec. 1998) [hereinafter Inflow Recommendation].

228. *Id.* In 2000, the author began discussions about the need to determine what impacts, if any, the proposed Guadalupe River diversion might have to the endangered whooping crane flock that winters at Aransas National Wildlife Refuge located on San Antonio Bay. On November 15, 2001, a meeting was held with Professor Douglas Slack of the Texas A&M University Department of Wildlife and Fisheries Sciences at the GBRA office in Seguin, Texas. As a result of this meeting a proposal was prepared by Professor Slack with the goal to "use empirically generated and available data to evaluate the relationship between freshwater inflows into San Antonio Bay and the health of the endangered whooping crane population at [Aransas National Wildlife Refuge] ANWR." Douglas Slack, Stephen Davis, & William Grant, Linking Freshwater Inflows and Marsh Community Dynamics in San Antonio Bay to Whooping Crane Populations, Research Proposal to GBRA 4 (May 30, 2002).

229. George Ward, in association with Espey, Padden Consultants, Inc., Brown & Root, Inc. and Freese & Nichols, Inc., Technical Basis for Establishing Freshwater Inflow Requirements for Galveston Bay, Prepared for the Trinity River Authority, Tarrant Regional Water District and the City of Houston 13 (Nov. 1999).

230. Inflow Recommendation, *supra* note 227, at 2.

231. *Id.*

232. *Id.* at 1.

233. *Id.* at 9.

harvest (MaxH) for the Guadalupe Estuary, at a total of 1.15 million acre-feet annually, with varying amounts needed on a monthly basis.[234] The TPWD report on freshwater inflows for the Guadalupe Estuary and San Antonio Bay concludes:

> *TPWD staff recommends MaxH (1.15 million ac-ft per yr) inflows as the lowest target value to fulfill the biological needs of the Guadalupe Estuary System on a seasonal basis. TPWD prefers this conservative value of MaxH since it was shown to produce conditions closer to many of the salinity preferences of the target species and wetlands examined in this analysis.*[235]

In 2000, the TPWD estimates produced by this effort were used as the basis of the San Marcos River Foundation's (SMRF's) application for unappropriated water in the Guadalupe River.[236] In total, some 1.3 million acre-feet of water rights were requested by SMRF for "beneficial, nonconsumptive, instream use" within the Guadalupe River Basin.[237] This amount is equal to 424 billion gallons of water. The SMRF application is supported by the TPWD, who supports conveying the water right to Texas Water Trust to be reserved for environmental purposes.[238] SMRF's claim was based on amendment to its current water right on the San Marcos River, which is 5 acre-feet.[239] Based on the

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234. *Id.* at 3, 8.

235. *Id.* at 8 (emphasis in original).

236. Dianne Wassenich, Application for Amendment to a Water Right, filed with the Texas Natural Resource Conservation Commission, July 10, 2000, at 1.

237. Tex. Natural Resource Conservation Comm'n, Notice of Water Right Application, Application No. 5724, July 3, 2001, at 2.

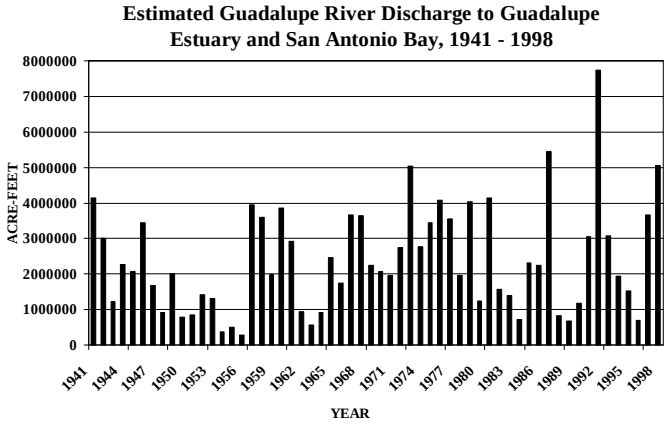
238. Letter from Colette Baron, Texas Parks & Wildlife Dep't, to Todd Chenoweth, Texas Natural Resources Conservation Commission 1 (June 15, 2001).

239. Wassenich, *supra* note 236, at 1. Other permit applications operating under the same theory as the SMRF permit application, dedicating all remaining unappropriated flows in a river for beneficial, nonconsumptive, instream uses could make all new permitted water uses in that river basin effectively junior to the unspecified category, under Section 11.023 of the Texas Water Code for "any other beneficial use."

> § 11.023. Purposes for Which Water May be Appropriated
> (a) State water may be appropriated, stored, or diverted for:
> (1) domestic and municipal uses, including water for sustaining human life and the life of domestic animals;
> (2) industrial uses, meaning processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, including the development of power by means other than hydroelectric;
> (3) irrigation;
> (4) mining and recovery of minerals;
> (5) hydroelectric power;
> (6) navigation;
> (7) recreation and pleasure;
> (8) stock raising;
> (9) public parks; and

Water Availability Model (WAM) utilized by TNRCC, the median annual freshwater inflow into the Guadalupe Estuary with all existing water rights fully utilized, including the 70,000 acre-feet proposed in the Lower Guadalupe Water Supply project, is currently 1.57 million acre-feet according to TPWD.[240] If TPWD's estimated MinQ requirements of 1.03 million acre-feet are reserved for the Guadalupe Estuary, some 540,000 acre-feet of water remains for new appropriations within the Guadalupe River.[241] If MaxH (1.15 million acre-feet) is reserved on an annual basis, some 420,000 acre-feet of water remains for new appropriations from the Guadalupe River based on TPWD's estimates.

Figure 11.




The SMRF application could be contrary to Senate Bill 1 and the Texas Water Code. Section 11.134(b)(3)(E) of the code requires that the TNRCC shall grant an application only if the proposed appropriation

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(10) game preserves.

(b) State water also may be appropriated, stored, or diverted for any other beneficial use.

Act of June 16, 1977, 65th Leg., Reg. Sess., ch. 870, § 1, 1977 TEX. GEN. LAWS 2217 (codified as amended at TEX. WATER CODE ANN. §11.023 (Vernon Supp. 2000)).

In practice, the category of "any other beneficial use" could preempt all other new uses such as municipal, industrial and agricultural because it is almost a certainty that with a 'non-use' application for all remaining flows, every other application that would follow for any other use could be excluded depending on the amount requested in the application and estimated amount of available unappropriated flows. In addition, while the Texas Water Code provides that water may be "appropriated, stored, or diverted," there appears to be no provision for "reserving" water as is the intent of SMRF'S application. *Id.*

240. Tex. Parks & Wildlife Dep't, Texas Parks & Wildlife Water Issues Meeting, Handout of Overheads, Mar. 21-22, 2002, at 16 (on file with author).

241. *Id.*

"addresses a water supply need in a manner that is consistent with the state water plan and an approved regional water plan for any area in which the proposed appropriation is located."[242]

The economic impact of granting this permit could be substantial as would be the environmental impact. Without the ability to use the remaining unappropriated run of the river flows above what is required for instream, bay and estuary needs, the construction of additional main channel reservoirs becomes the only viable option for large amounts of additional surface water supplies. A SMRF permit, and similar permits on other Texas rivers, could preclude the development of relatively low environmental impact run-of-river diversion projects, as opposed to reservoir projects. Once conservation is maximized, substantial projected water supply needs might then have to be met through development of large reservoirs, less renewable groundwater resources, and/or expensive seawater desalination facilities.

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242. Texas Water Code § 11.134, Action of Applications, provides the rules for how the Commission must act on applications:

> (a) After the hearing, the commission shall make a written decision granting or denying the application. The application may be granted or denied in whole or in part.
> (b) The commission shall grant the application only if:
> (1) the application conforms to the requirements prescribed by this chapter and is accompanied by the prescribed fee;
> (2) unappropriated water is available in the source of supply;
> (3) the proposed appropriation:
> (A) is intended for a beneficial use;
> (B) does not impair existing water rights or vested riparian rights;
> (C) is not detrimental to the public welfare;
> (D) considers the effects of any hydrological connection between surface water and groundwater; and
> (E) addresses a water supply need in a manner that is consistent with the state water plan and an approved regional water plan for any area in which the proposed appropriation is located, unless the commission determines that conditions warrant waiver of this requirement; [emphasis added] and
> (4) the applicant has provided evidence that reasonable diligence will be used to avoid waste and achieve water conservation as defined by Subdivision (8)(B), Section 11.002, of this code.
> (c) Beginning September 1, 2001, the commission may not issue a water right for municipal purposes in a region that does not have an approved regional water plan in accordance with Section 16.053(i) of this code unless the commission determines that conditions warrant waiver of this requirement.

TEX. WATER CODE ANN. § 11.134 (Vernon Supp. 2000). SMRF's permit application to the TNRCC is being contested by the Canyon Regional Water Authority, City of Kerrville, GBRA, Headwaters Groundwater Conservation District, Kerr County, SAWS, Texas Water Conservation Association, and Upper Guadalupe River Authority. GBRA News, *supra* note 185, at 3.

Figure 12.

**Guadalupe Estuary: The Numbers Based on TNRCC's Water Availability Models**

***1.1 Million Acre Feet*** **per Year to sustain Existing Health and Productivity**

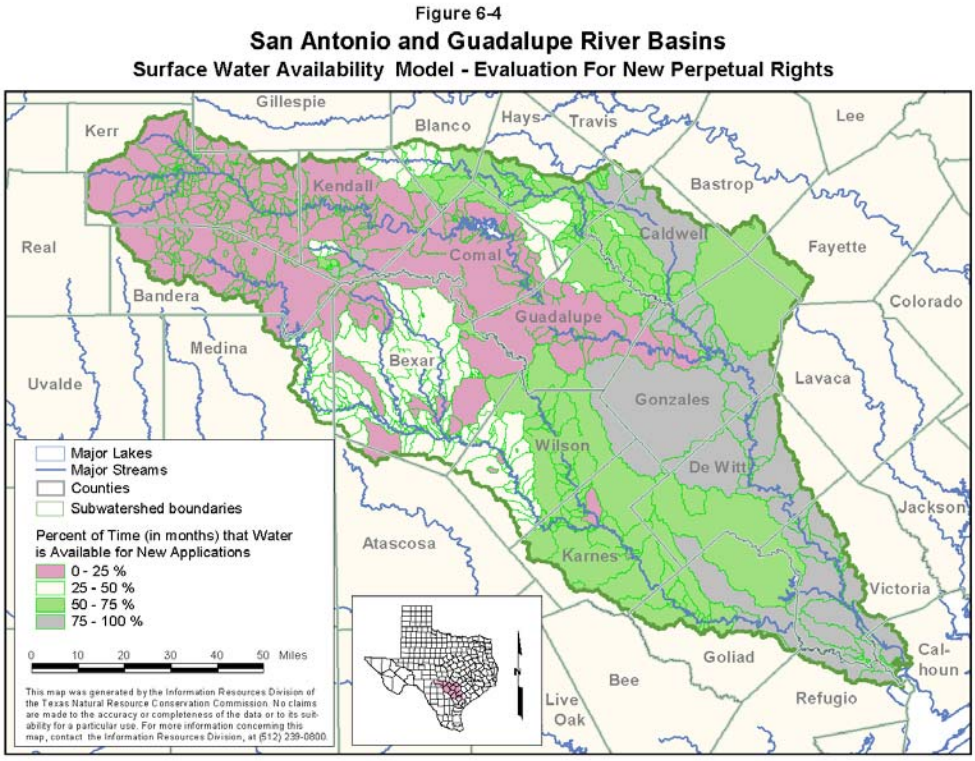
**Inflow in Drought of Record (1956) If All Water Rights Exercised:** ***64,394 acre feet***

**Median Annual Inflow, All Water Rights Exercised:** ***1.57 Million Acre Feet***

**If Freshwater Inflows Necessary to Conserve Health and Productivity of San Antonio Estuary Reserved, Water Available for Other Uses:** ***0.54 Million Acre Feet***

Source: Texas Parks and Wildlife Department, 2002.

Figure 13.




Source: Texas Natural Resource Conservation Commission, 2002.

As an alternative to the method that SMRF proposes to protect bay and estuary flows, the Lower Guadalupe Supply Project will include a permit to use a portion of the unappropriated flows at the coast, including as a special condition of the permit the reservation of the amount of flows needed to maintain the health of the bay and estuary.[243] This method of protection is consistent with the Region L Plan, and does not conflict with the Lower Guadalupe Supply Project.[244] If approved by the TNRCC, this permit for unappropriated flows would make the Guadalupe Estuary/San Antonio Bay the first Texas bay and estuary system to have dedicated freshwater inflows. According to the Texas

243. *Id.* at 1-3.
244. *Id.*

Water Conservation Association, the regional water planning process offers the preferred vehicle for addressing instream flow and bay and estuary inflow issues during the next five-year revision of the regional water plans.[245]

There is also a question concerning what type of entity should hold a permit for bay and estuary inflows. A state entity, created by the Legislature, and subject to State oversight through the newly created Texas Water Advisory Council, TNRCC and the Legislature, provides safeguards that the management of environmental flows is done for the benefit of all citizens of the state. Private groups—whether for-profit or nonprofit are not subject to oversight by the Texas Water Advisory Council and Legislature.

The development of the new State Water Plan and the filing of the SMRF water rights application have renewed Texas' focus on the question, "How much freshwater is needed to provide for healthy estuaries and bays?" To the extent it is available without harming the coastal ecology, additional diversions of unappropriated river flows could forestall the time when water supply needs require additional reservoir projects with their attendant environmental impacts and high costs.

For these and other reasons, the methods of estimating freshwater inflows are receiving additional scrutiny. A recent examination of the TWDB and TPWD freshwater inflow estimates for Galveston Bay has resulted in attention to one question in particular: (1) is the fisheries harvest data used as a surrogate for the actual abundance of a target

245. The Texas Water Conservation Association has articulated the following principles:

> 5. TWCA supports use of a regional planning process (referred to as the Basin Environmental Flows Plan) as the appropriate mechanism to determine instream and bay and estuary needs on a basin-by-basin basis, and to recommend strategies for meeting those needs as well as those for water quality. TWCA envisions a process much like that followed under SB 1 to integrate the basin-wide review of environmental flow needs, record recommendations into regional plans, as appropriate, and subsequently incorporate those plans into the State Water Plan.
>
> 6. TWCA strongly emphasizes that environmental flow needs must be defined not only in terms of desired water quantities, but also in terms of the quality, seasonality, and frequency with which such quantities must be available to ensure the long-term health and welfare of species dependent upon instream flows and freshwater inflows to bays and estuaries. Basin Environmental Flow Plans and other means of ensuring environmental flows must include appropriate drought contingency provisions consistent with the Texas climate and maintaining balance between competing demands for economical water supply and environmental flows.

Tex. Water Conservation Ass'n, Environmental Flows Committee, Policy Guidelines, presented at the regular meeting held in Dallas, Texas, Mar. 2002, at 1 (on file with author).

species in the bay an appropriate measure of actual abundance?[246] Harvest data can be affected by:

- Regulation of the fishery;
- Effort made by and the technology used by the fishing fleet;
- The skill of the fisherman;
- External stresses on the population of the target species; and
- The market demand for the target species and other economic factors such as the cost of gasoline.[247]

In addition, other issues have been raised by the Galveston Bay study with regard to the data and methodology used to prepare the freshwater inflow estimates:

- Data entry errors were found in TWDB harvest numbers (as large as 38%) which were subsequently used in the computation of target flows;
- There were substantial discrepancies found between the two sources of shrimp data used (as large as 134%);
- National Marine Fisheries Service brown shrimp abundance data sometimes included data on pink shrimp;
- Shrimp harvest data included table shrimp, but excluded bait shrimp which compromises as much as 98% of the total shrimp population; and
- Finfish harvest includes commercial catch, but excluded recreational catch which is a significant portion of total harvest.[248]

In addition, the study found that the reported harvest location was the place where the fishing fleet landed, which may be unrelated to where the harvest occurred and does not consider that there potentially can be multiple landing sites.[249] Finally, the Galveston Bay study of the current methodology for estimating inflow requirements has concluded:

- Major discrepancies exist in the estimation of harvest data from those employed by TWDB;

246. Ward, *supra* note 229, at 13. Target species include: blue crab, oyster, red drum, black drum, spotted seatrout, and brown shrimp. *See* Inflow Recommendation, *supra* note 227, at 2.

247. Ward, *supra* note 229, at 41-42; Richard Browning, George Ward, David Harkins, & Tony Smith, Status Galveston Bay Inflow Study, Presentation to Water Rights Advisory Workgroup, Austin, Texas, June 13, 2002 (on file with author).

248. Browning, Ward, Harkins, & Smith, *supra* note 247, at 14.

249. Ward, *supra* note 229, at 42.

- The magnitude of the effect of the discrepancies warrants recalculation of the optimum freshwater inflows needed to satisfy management targets, including the MaxH; and
- The preliminary analysis reveals no correlation between commercial harvest and TPWD's abundance data.[250]

The problems described above could be eliminated with the use of a direct measure of species abundance.[251] Dr. George Ward, a professor at the University of Texas Center for Research in Water Resources, testified before the Texas Legislature's Joint Committee on Water Resources that TPWD studies on the bay and estuary freshwater inflow needs may substantially over-or under-estimate the amount of freshwater needed for the estuaries and bays.[252] If additional analysis proves that TPWD's estimated bay and estuary needs are high, additional amounts of water would be available for diversion without harming the Guadalupe Estuary and San Antonio Bay, potentially forestalling the need for new reservoir projects on the Guadalupe and San Antonio Rivers beyond 2100 or in perpetuity if the cost of desalinated water decreases significantly or substantial subsides become available for desalination.

SMRF's permit could preclude 70,000 acft of surface water through the Lower Guadalupe Supply Project from being transferred to San Antonio if the Lower Guadalupe Supply Project is declared an interbasin transfer.[253] The 1.3 million acre-feet associated with the pending SMRF permit application could become senior to Lower Guadalupe Supply Project because the July 10, 2000 filing date for SMRF would be 'first in time' over a future interbasin transfer permit application for the Lower Guadalupe Supply Project. The potential cost to the Guadalupe River could eventually be the 325,800 acft per year that is discharged from Comal and San Marcos Springs on average, if San Antonio is denied an alternative to its sole reliance on the Edwards Aquifer.[254] This spring discharge is critical to instream flows in the Guadalupe River and bay and estuary inflows during drought.

San Antonio will have fewer alternatives to pump even more water from the already overburdened Edwards Aquifer. By blocking the centerpiece Region L Water Plan, the SMRF permit could ultimately result in less water for the bay as those who currently rely on the Edwards Aquifer are forced to increase their pumping.

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250. Browning, Ward, Harkins, & Smith, *supra* note 247, at 18.

251. Ward, *supra* note 229, at 42.

252. George Ward, Comments Before the Joint Committee on Water Resources, Texas Legislature (Feb. 27, 2002).

253. Water Supply and Delivery Agreement, *supra* note 185, § 5.2.3.

254. *See* author's calculation, *supra* note 14.

## V. CONCLUSIONS

The EAA was created to settle disputes by quantifying rights through groundwater permits. For those who pump from the aquifer, the price of a secured, quantified right is restrictions in three primary forms (1) an annual limit on total withdrawals, (2) annual pumping fees, and (3) additional restrictions on withdrawals during critical periods.[255] If the *Critical Period Management Plan* and other programs do not effectively reduce water use during anticipated critical periods, then pumpers have gained the security of going from a judicial forum, in this case the federal and state courts, to a regulatory forum without most of the costs of doing so.[256]

Agricultural interests contended that the regulation of Edwards water is a taking of private property in *Barshop v. Medina County Underground Water Conservation District*;[257] however, under Senate Bill 1477 the regulation and allocation of Edwards water through annual withdrawal permits is actually creating quantifiable property rights that can be protected under law for the first time.[258] Once permits issued by the EAA to withdraw specific amounts of water from the Edwards Aquifer are final, a free-market will exist because the fundamental characteristics of a property rights system will be present.

In the Edwards Aquifer, none of the conditions establishing a true property right were met prior to regulation.[259] There was no universality because entitlements could not be quantified under a system where a pumper's reserve of water was vulnerable to extraction by a neighbor under the rule of capture. Exclusivity did not exist because during periods when withdrawals were not needed, well owners did not have the option of leasing or selling the water to which they had access, since there was no established value or price nor a guarantee to assure a fixed available quantity to the purchaser. Similarly, transferability did not exist since there was no documentary evidence of a claimed right. Even if one well owner were paid not to pump water, another nearby landowner was not prevented from drilling a new well into the aquifer to begin or increase withdrawals; thus, a transfer was rendered valueless, since the purchaser was not protected from excessive withdrawals by other users. Finally, there could be no enforceability of a property right for all of the

255. *See id.* §§ 1.14, 1.29, 1.26.
256. *See id.* § 1.37.
257. *See* 925 S.W.2d 618, 618 (Tex. 1996).
258. EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355 § 1.14.
259. An efficient property rights system is one which has the following characteristics 1) universality; 2) exclusivity; 3) transferability; and 4) enforceability. *See* TOM TEITENBERG, ENVIRONMENTAL AND NATURAL RESOURCES ECONOMICS 45-47 (3d ed. 1992).

stated reasons. By the very nature of the rule of capture, there was no effective way to prevent one pumper from encroaching on another individual's claimed right.

Under Senate Bill 1477, irrigators cannot be required to pay to the EAA per acre foot-pumping fees in excess of 20% of those charged municipal and industrial pumpers.[260] Agricultural pumpers have the most security, since withdrawals for their use are currently authorized at limits substantially greater than they have ever withdrawn, and no critical period management plan is in place. The trigger level for the 2000 Withdrawal Suspension Program was 845 feet msl at the Uvalde Well, a level last reached in 1958 during the recovery period from the drought of record.[261] Irrigators in Medina and Uvalde Counties are now secure from the threat posed under the rule of capture that land could be purchased in Medina or Uvalde County, wells drilled, and water pumped in massive quantities and then piped east to San Antonio without their approval. Under Senate Bill 1477, irrigators are likely to receive rights to almost 50% of the available water, more water than they have ever used in any one year and almost twice what they are currently using, while municipal and industrial users are likely to receive less than they pumped during the historical period.[262] This result is occurring during a period when irrigation water use is declining.[263] Municipal and industrial users pay fees five times greater than irrigators to support the EAA, but are allocated less than half of the water.[264] Eventually, the likely result will be that *at least* half of the water allocated to irrigators, the statutory maximum, will be leased or sold for export to municipal and industrial users outside Medina and Uvalde counties. As discussed above, the CPMP restrictions, although currently inadequate to prevent flows from reaching take or jeopardy at the springs, will fall disproportionately upon municipal and industrial water users east of Medina County, particularly San Antonio's burgeoning population should they be imposed by the EAA during droughts. Irrigators in Uvalde County are likely to escape any water use restrictions unless faced with a repeat of the drought of record.

In an ironic twist, irrigators will reap the greatest benefits from future water leases or sales with the strictest enforcement of Senate Bill 1477 and the ESA; despite this consequence, agricultural interests sued and lost in the Texas Supreme Court in 1995 to have Senate Bill 1477

260. *Id.*
261. Water from a Stone, *supra* note 12, at 315.
262. *Id.* at 376.
263. Moore, *supra* note 168, at 30-33; Regional Water Plan, *supra* note 168, at 2-21.
264. Water from a Stone, *supra* note 12, at 315.

declared unconstitutional.[265] Collectively, limiting pumping to guarantee spring discharge above critical minimums, regional economic and population growth that will spur demand for water, and cyclical droughts will eventually establish a higher price for Edwards groundwater. While agriculture is an important contributor to a diversified regional economy, less water could probably provide an equivalent crop yield using more efficient irrigation technologies. If the cropland in Medina and Uvalde counties were not cultivated, eventually it could be infested with ashe juniper and mesquite, reducing the flow in the Nueces and San Antonio Rivers, thereby creating an additional water management problem for those downstream.[266]

An examination of the EAA's performance thus far provides some basis to characterize its performance. For the EAA to take the necessary steps to ensure that the springs do not decline below take and jeopardy levels, at least eight of the fifteen board members must vote to restrict their constituents' access to water from the aquifer.[267] Three of the current board members actively opposed Senate Bill 1477 and the creation of the EAA.[268] The four votes representing interests in the Guadalupe River Basin in the districts east of San Antonio have accepted restrictions on water use in their counties because the increased reliability of spring discharges would generally benefit their constituents.[269] The four members representing irrigation interests in the western counties still appear unlikely to accept significant restrictions on their constituents' water use. The seven remaining Bexar County board members are the key. It is likely that the majority of this voting block will determine whether the EAA fulfills the duties assigned to it by the Legislature. There was no alliance between representatives east of San Antonio and those west of San Antonio during legislative consideration of Senate Bill 1477, but some EAA board members from these areas regularly vote together now.[270] However, if the board members representing the western districts decide that their constituents would benefit from higher prices for export of their excess water as a result of the strict enforcement of the provisions of Senate Bill 1477 requiring flows at the springs to be maintained above critical levels, a shift in the balance of power could occur.

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265. *See* Barshop v. Medina County Underground Water Conservation Dist. 925 S.W.2d 618 (Tex. 1996).

266. Water from a Stone, *supra* note 12, at 377.

267. *See id.* at 378.

268. *See id.*

269. *See id.*

270. Interview with Luana Buckner, EAA Board Member (Sept. 15, 1999).

Eventually, Senate Bill 1 might generate a proactive approach to address these shortages, as opposed to the reactive approach embodied in Senate Bill 1477.[271] While the latter provides for conserving groundwater, it does not provide for developing new sources of water. The result is policy shaped by growth in water demand, by droughts, and almost inevitably, by costly litigation. This reactive approach is similar to the "emergency room" response embodied in the Endangered Species Act, a prescription that awaits the decline of a species to critical populations such that salvation often requires severe measures, imposes the highest costs, and creates the most conflicts with private property rights.

Since the 1960s, the Edwards Aquifer region generally has been in a wet cycle.[272] The total recharge in the decades of the 1970s, 1980s, and 1990s has exceeded the average for the period of record, 1934 to 2001.[273] Despite droughts in 1996 and 1998, the 1990s had the highest total recharge of any decade during the period of record, greater than the total recharge for the decades of the 1940s and 1950s combined.[274] This period of generally high recharge, during which withdrawals from the aquifer have reached their highest levels, will eventually come to an end.

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271. The author proposed the following alternative approach in 2000:

> *Flexible Pumping Limits Are Preferable*
>
> The staged pumping limits in Senate Bill 1477 do not take full advantage of the hydrologic characteristics of the aquifer. Restricting withdrawals to 450,000 acre-feet or less every year is too restrictive in years of high recharge, while withdrawing 400,000 acre-feet or more following years of low recharge could be too generous, resulting in take or jeopardy conditions subsequently at the springs and limited downstream surface water to meet essential needs. A system using a flexible cap would provide more long-term benefits. In years of high recharge, additional amounts of water (beyond what is needed to maintain minimal spring discharge, provide water to downstream users, and fulfill freshwater inflows to bays and estuaries) should be withdrawn for use or stored for use in years of low recharge. The goal should be to supply the region with water while assuring that a water reserve is accumulated to maintain minimum springs and downstream flows in the Guadalupe River during droughts to avoid violations of the ESA and surface water shortages.
>
> *Creating a Drought Reserve*
>
> Managing water in the Edwards region should be designed to take maximum advantage of the typical weather patterns and capturing [sic] as much water as possible during years of plenty to be stored for use during the periodic droughts. An active management scheme should be adopted that addresses potential future shortfalls, as opposed to the current passive system that reacts to imminent shortfalls. Such a management scheme is superior to relying upon the penalties of the ESA, triggered retroactively by harm to the listed species.

Water from a Stone, *supra* note 12, at 388-89.

272. *See id.* at 266.

273. Based on annual recharge estimates found in U.S. Geological Survey 2001. *See* U.S. GEOLOGICAL SURVEY, *supra* note 14.

274. *See id.*

Much of the population growth in the Edwards Aquifer region has occurred during the wet cycle that has characterized the last three decades; the populace has been generally accustomed to a water surplus.

Water is the key element determining both the sustainability of the environment and the economy of the Edwards Aquifer region and the Guadalupe, San Antonio, and Nueces Rivers. The Edwards Aquifer may be the first instance where the survival of endangered aquatic species has produced a limit to the use of a water resource of this magnitude. In the short-term, the interest of pumpers is unrestricted access to inexpensive water. In the long-term, sustainable development is in the local communities' interests.

The continuing conflict over the Edwards Aquifer began in the 1950s during the Texas drought of record, years before the Endangered Species Act became law in 1973. The struggle pits urban culture and economics vs. rural culture and economics; agricultural interests in Bexar, Medina, and Uvalde Counties vs. municipal, recreational, and industrial interests in San Antonio; and all of these vs. various interests in the spring communities and downstream in the Guadalupe River Basin.

A minority in San Antonio seeks unfettered use of the Edwards Aquifer without the expense of supplemental water supplies by opposing regulation of the aquifer and regional water conservation and supply projects. They consistently oppose any regulation, and believe the aquifer should be mined as has the Ogallala on the Texas High Plains. Their primary strategy appears to be the removal of the threat that the ESA will compel pumping restrictions.[275]

Another force wishes to stymie economic and population growth in the region by blocking the movement of supplemental supplies of water to the City of San Antonio.[276] The SMRF permit application could accomplish this goal by employing the Texas Water Trust to undermine

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275. There was recently a challenge in the Fifth Circuit alleging that the ESA may not be invoked to protect these intrastate species, because affording them protection would be beyond the Commerce Clause powers of Congress. Shields v. Norton, 289 F.3d 832 (5th Cir. 2002). However, the court did not find a particularized harm and dismissed the case for being unripe. *Id.* at 837.

> There may be cases in which the intrastate species does not itself move in interstate commerce or in some manner affect the channels of interstate commerce and in which the regulation of the species' habitat destruction, viewed in the aggregate, will not have a significant impact on interstate commerce, but those cases are going to be damned few! Given this and the backstopping provided by Congress's treaty making powers, it is difficult to see how the application of the ESA to intrastate species can be thwarted on constitutional grounds.

David Frederick, Analysis of the Application of the Endangered Species Act to Intra-State Species, Presentation at Austin CLE Conference (Sept. 2001) (on file with author).

276. *See* GBRA News, *supra* note 185, at 3.

the new State Water Plan. Use of the Texas Water Trust should be in harmony with the approved regional water plans contained in the State Water Plan. The Trust was envisioned as a shield for environmental water needs, not a sword to undermine the State Water Plan, its components and the consensus based process used to create the plan. The Texas Legislature will have the opportunity to decide what method is best for protecting freshwater inflows to Texas estuaries and bays during the 2003 session. Otherwise, this issue could be decided through litigation over the SMRF permit. For their part, agricultural and rural interests fear that withdrawal limits will ruin their economies and that groundwater and groundwater rights might be transferred wholesale from rural areas to the expanding urban areas, stifling development of rural areas and resulting in the loss of lifestyle and local governmental revenue.

The remaining group, the members of the South Central Texas Regional Water Planning Group, are walking a tightrope between opposing forces. This group is attempting to supplement limited Edwards withdrawals from imported groundwater and surface water supplies. If regional water projects such as the Lower Guadalupe Supply Project are not implemented, it is likely that those who seek unfettered use of the aquifer will likely prevail, given the reluctance of courts and legislature to intervene in a timely manner in regional water disputes. Without the will of the state or federal government to ensure reductions in pumping from the Edwards Aquifer, the region will return to growth based almost entirely upon a single source.

The region must continue to move to regional water management since its major aquifers and rivers are closely interlinked. The South Central Texas Regional Water Planning Group (Region L) is the logical body to continue this evolution. San Antonio cannot reduce its reliance on the Edwards Aquifer through conservation alone. Yet San Antonio must commit to the reductions in pumping from the Edwards Aquifer embodied in Senate Bill 1477.[277] In the final analysis, the solution to this complex regional transboundary water dispute over the Edwards Aquifer can be resolved in only one simple way: the water must be shared so that everyone will have enough. This logic, which all should have learned as children, still eludes many within the region today.

277. EAA Enabling Act, ch. 626, 1993 TEX. GEN. LAWS 2355.

Chronology of Events Concerning the Edwards Aquifer Issue[278]

| | |
|---|---|
| Prior to Pumping | Comal and San Marcos Springs, possibly the largest springs in the United States, have strong, continuous spring discharge at all times, even during major droughts. A unique assemblage of species dependent on spring discharge flourish. |
| 1884 | The first irrigation well is completed in Bexar County. |
| 1900 | Aquifer withdrawals reach approximately 30,000 acft per year. |
| 1904 | The rule of capture is adopted as the law of groundwater control in Texas by the Texas Supreme Court in Houston & T.C. Ry. Co. v. East. |
| 1933 | The Texas Legislature creates the Guadalupe River Authority, which is renamed the Guadalupe-Blanco River Authority in 1935. |
| 1934 | The Texas Legislature creates the Lower Colorado River Authority. |
| July 7, 1938 | A hearing is held in Seguin, Texas to support flood control on the Guadalupe River by the GBRA and the U.S. Army Corps of Engineers. GBRA General Manager Ed Cape presents data supporting the need for a flood control project as the result of floods in 1936 and 1938. Seguin Mayor Max Starcke and Congressman Richard Kleberg speak in favor of the dam. GBRA is eventually named the local sponsor for the project, known as Canyon Reservoir. |
| 1939 | The Texas Legislature creates the San Antonio River Authority. |
| 1940 | San Antonio's population reaches 200,000 people. |
| 1941 | The fledging GBRA contracts to purchase the privately owned San Antonio Public Service Company from the American Light and Traction Company (ALT) for $10,000,000. ALT is owned by utility tycoon Samuel Insull. San Antonio objects to the sale and the matter goes to court. |
| October, 1942 | With the help of Alvin Wirtz, future Senator, a compromise is reached between GBRA and San Antonio that brings the Lower Colorado River Authority (LCRA) into the region by acquiring the Comal steam plant on Landa Lake in New Braunfels. The compromise collapses when San Antonio files new litigation that eventually reaches the Texas Supreme Court where the GBRA prevails. GBRA acquires the financial capability to pursue the Canyon Reservoir project. |

278. *See* Water from a Stone, *supra* note 12, at 266.

| | |
|---|---|
| 1949 | The state authorizes voluntary creation of underground water conservation districts. |
| 1950 | GBRA hires Austin lawyer John B. Connally (future Governor of Texas) who works closely with Senator Lyndon Johnson (future President of the United States) to obtain funding for Canyon Reservoir. |
| 1950-1957 | The drought of record in Texas. For the Edwards Aquifer the drought probably began in 1942 and ended in 1957. Comal Springs dries up for 144 days in 1956, and San Marcos Springs drops to a low of 46 cfs. Portions of the aquifer are possibly contaminated by intrusion of adjacent bad-quality water containing very high concentrations of dissolved solids and hydrogen sulfide. In 1956 annual recharge is a record low 43,700 acft while withdrawals reach 321,000 acft. The Beverly Lodges index well (later replaced by J-17) in San Antonio hit its record low of 612 ft. msl. |
| 1952 | San Antonio City Master Plan recommends that San Antonio join with the Corps of Engineers and Guadalupe-Blanco River Authority (GBRA) to construct Canyon Reservoir. |
| March 2, 1953 | San Antonio files a "presentation" to the Texas Board of Water Engineers (TBWE) to participate in the Canyon Reservoir project. When their request is denied on April 2, an appeal is made to the TBWE. |
| 1955 | The Texas Supreme Court recognizes that San Antonio has a serious water supply problem and that it needs to obtain alternative supplies from other sources. *Board of Water Engineers v. City of San Antonio*, 283 S.W.2d 722, 723 (Tex. 1955).<br>Some of the early determinations of boundaries and recharge of Edwards Aquifer are made. First attempt to form the Edwards Underground Water District (EUWD). |
| June 6, 1955 | Senate Majority Leader Lyndon Johnson testifies before the Senate Public Works Committee requesting funding for Canyon Reservoir. |
| July 5, 1957 | TBWE, in 2-1 split vote, sides with GBRA against San Antonio on the Canyon Reservoir project. The matter eventually goes to the Texas Supreme Court, with GBRA prevailing. A second attempt to establish the EUWD is made but is unsuccessful. |
| 1957 | Texas Water Development Board (TWDB) created as a consequence of the drought of record. |
| 1959 | 56th Legislature creates the Edwards Underground Water District to protect and preserve the Edwards Aquifer. |
| 1961 | TBWE publishes first 20-year Texas Water Plan. |
| 1962 | TBWE reorganized as Texas Water Commission (TWC). |

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| 1964 | Governor John Connally directs the TWC to design a comprehensive state water plan. |
| 1966 | The Endangered Species Preservation Act becomes law. The Secretary of the Interior is charged with conserving, protecting, and restoring species determined to be facing extinction, primarily through the acquisition of habitat. |
| Oct. 26, 1966 | Texas Supreme Court in *City of San Antonio, et al. v. The Texas Water Commission, et al*. finds that San Antonio is authorized to purchase Canyon Reservoir water. |
| 1967 | The Water Rights Adjudication Act requires the Texas Water Rights Commission to register unrecorded water rights claims, and adjudicate and administer water rights. |
| 1967 | U.S. Fish and Wildlife Service (USFWS) lists Texas blind salamander as endangered. |
| 1968 | TWDB publishes update of Texas Water Plan. |
| 1969 | The Endangered Species Conservation Act becomes law. |
| 1970 | Texas Water Quality Board (TWQB) issues first Edwards "Board Order" for aquifer water quality protection. USFWS lists Fountain darter as endangered. |
| 1972-1984 | EUWD builds four small recharge dams over the Edwards Aquifer. |
| 1973 | The modern Endangered Species Act (ESA) becomes law. Penalties for 'taking' listed species are in place. Actions of private parties and public entities effected. |
| 1974 | TWQB issues an amended "Board Order" for aquifer water quality protection. Environmental groups form an Aquifer Protection Association (APA) with the single purpose of raising funds to purchase land on the recharge zone of the aquifer. Congress passes Public Law 93-943 authorizing construction of Cibolo Reservoir in the San Antonio River Basin near Floresville. |
| 1975 | The GBRA and San Antonio's City Water Board (CWB) begin negotiations for Canyon Reservoir water. The Edwards Aquifer is designated the first Sole Source Aquifer under the Safe Drinking Water Act. |
| 1976 | The San Antonio City Council led by Mayor Pro Tem Glen Hartman (and joined by councilman Henry Cisneros) rejects by a 5 to 4 margin a contract to purchase 30,000 acft of water per year from Canyon Reservoir and other future projects (up to 50,000 acft) in the Guadalupe Basin. The contract had already been approved by the GBRA Board of Directors and the CWB staff. |
| 1978 | USFWS lists Texas wild-rice as endangered and San Marcos salamander listed as threatened. |

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| | ESA amendments require the preparation of recovery plans. |
| July, 1979 | San Antonio City Council passes resolution #79-35-74 requesting the CWB to proceed with construction of the Applewhite Reservoir located on the Medina River in Southern Bexar County. |
| 1980 | USFWS lists San Marcos gambusia as endangered. Critical habitat designated for four of the species in the San Marcos Springs ecosystem. |
| 1980-1990 | Withdrawals have increase significantly after the drought of record and now average nearly 500,000 acft per year, far exceeding 500,000 in some years. |
| June, 1981 | The San Antonio City Council passes resolution #81-34-64 reaffirming its support for Applewhite Reservoir. |
| 1982 | ESA amendments allow for incidental takings. |
| 1984 | Flow at Comal and San Marcos Springs nearly ceases during a brief drought.<br>Texas Department of Water Resources publishes update of 1968 Texas Water Plan. |
| 1985 | The San Marcos Recovery Plan is adopted by USFWS. |
| 1986 | The TWC issues rules (called the Edwards Rules) regulating development over the aquifer recharge zone. |
| 1987 | San Antonio and EUWD endorse legislation, House Bill (H.B.) 1942. The 70th Legislature authorizes the EUWD to develop and enforce a regional drought management plan, prior to September 1988, "to minimize drawdown of the water table or the reduction of artesian pressure and spring discharge . . ." H.B. 1942 also provided for an elective board and allows counties in the district to de-annex themselves. |
| July, 1988 | A Joint Committee on Water Resources completes the *Regional Water Resources Plan* and submits it to respected entities. |
| August, 1988 | EUWD approves a drought management plan in accordance with H.B. 1942. |
| January, 1989 | Uvalde and Medina Counties vote to secede from the EUWD over disagreement about withdrawal limits and attempts to establish single-county underground water districts. |
| May, 1989 | Legislative attempt at groundwater allocation fails. A committee of legislative members, the Special Committee on the Edwards Aquifer, is established to study the aquifer. |
| June 15, 1989 | The GBRA issues a notice of intent to sue for violations of the ESA. GBRA also files suit in the Hays County State District Court to have the aquifer declared an underground river owned by the State of Texas. That case is still pending. |

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| 1989 | A long-range regional water plan, adopted by the EUWD and San Antonio after prolonged negotiation, fails enactment by the 71st Legislature. During the summer the aquifer drops rapidly in another brief drought. Annual withdrawals peak at 542,400 acft. |
| 1989-June, 1990 | TWC Commissioner John Birdwell initiates discussions to try to resolve the controversy. No consensus emerges and the Birdwell negotiations end. |
| 1989-1990 | Spring discharge plunges at Comal and San Marcos Springs; however summer rains raise spring discharge. The USFWS warns of the need to respond and threatens federal withdrawal limits. The EUWD adopts an emergency action plan, but the plan expires in December 1990 after rainfall increases spring discharge. |
| 1990 | Upon recommendation of the Special Committee on the Edwards Aquifer, a professional mediator, John Folk-Williams, is appointed to attempt to form a consensus among various aquifer interests.<br>TWDB publishes update of 1984 State Water Plan.<br>San Antonio's population passes 1 million. |
| April 12, 1990 | The Sierra Club issues a notice of intent to sue for violation of the ESA. |
| December, 1990 | The CWB begins construction of the Applewhite Reservoir. |
| 1991 | The Living Waters Artesian Springs catfish farm opens 15 miles southwest of San Antonio, using as much as 40 million gallons of water a day, by some estimates. The actual drilling of wells started in late 1988 and continued into early 1989. In October 1991, the EUWD and the San Antonio River Authority file suit in state district court, claiming the catfish farm is wasting water and polluting the Medina River. By consent decree the farm's wells are shut down pending approval of a wastewater discharge permit from the TWC. |
| March, 1991 | A consensus is reached that Edwards Aquifer mediation attempts have failed. |
| May, 1991 | The voters of San Antonio vote to abandon the Applewhite Reservoir Project. The City Council affirms the election results in a subsequent vote and directs the CWB to begin measures to abandon the project. The CWB in turn sues the city, questioning the legality of the election. |
| May 16, 1991 | The Sierra Club files a lawsuit in U.S. District Court for the Western District of Texas, Midland (*Sierra Club v. Lujan;* later *Sierra Club v. Babbitt*). The GBRA and San Antonio, along with numerous other parties quickly intervene on both sides. The suit alleges that the Secretary of the Interior and |

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| | the USFWS failed to protect endangered species dependent on the aquifer in violation of the ESA. Plaintiffs ask the court to order USFWS to determine the minimum spring discharge required at the Comal and San Marcos Springs to avoid 'takes' of, and 'jeopardy' to, the listed species. |
| 1991 | Legislation is approved establishing an underground water district for Medina County. |
| November, 1991 | Texas Attorney General Dan Morales decides it is constitutional for the TWC to regulate groundwater. |
| October, 1991 January, 1992 | Austin Mayor Bruce Todd attempts to resolve the dispute over aquifer regulation. No resolution was reached. TWC attempts negotiation. |
| 1992 | TWDB publishes update of 1990 Texas Water Plan. |
| February, 1992 | John Hall, chairman of the TWC, circulates a 1992 proposed management plan (based on previous discussions with all interested parties) describing a voluntary regional management plan for the Edwards Aquifer as an alternative to state regulation. |
| March, 1992 | Attorney General Morales reverses his opinion that the TWC has sufficient authority to regulate the use of groundwater. |
| May 14, 1992 | The Edwards Aquifer hits a record high of 703.2 at the J-17 well. Annual recharge for 1992 is a record 2,485,700 acft. |
| April, 1992 | The TWC releases its interim plan for management of the Edwards Aquifer. Sets date of April 14 as the deadline for approval by City of San Antonio, EUWD, Medina County, City of Uvalde, Uvalde County, and Industrial Water Users Association. City of San Antonio and the EUWD reject TWC's interim management plan. |
| April 15, 1992 | The TWC declares the Edwards to be an underground stream and, therefore, state water. It adopts emergency rules and initiates rulemaking proceedings. |
| August, 1992 | A Travis County District Court invalidates the commission's declaration that the aquifer is an underground river and voids the commission's new rules for the aquifer (*Texas Farm Bureau, Cattleranchers Ass'n v. Texas Water Comm'n*). State District Judge Pete Lowry, citing legislative treatment of the aquifer and the enactment of legislation creating underground water districts in the Edwards region, rules that the TWC has no legal power to impose withdrawal limits. |
| September 9, 1992 | Rules designating the Edwards as an underground river are approved by the TWC. |
| September, 1992 | Judge Bunton sets a special court date for November 16, 1992 to hear *Sierra Club v. Babbitt*. |

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| September 11, 1992 | A Travis County District Court grants irrigators' motion, striking down TWC Edwards Rules and voids TWC declaration that the Edwards Aquifer is an Underground River on grounds that the TWC did not have statutory authority to assert jurisdiction. (On appeal, that Judgment is set aside after the TWC withdrew its rules). |
| September 14, 1992 | Texas Attorney General Morales files suit against USFWS saying the federal agency is illegally trying to take control of the Edwards Aquifer and thereby "usurp the States sovereignty." |
| November 16-19, 1992 | Trial in *Sierra Club v. Babbitt* before Judge Bunton in Midland, Texas. |
| February 1, 1993 | Judge Bunton enters Judgment and separate Findings of Fact and Conclusions of Law in favor of the Sierra Club, GBRA and other plaintiffs. Among other things, Bunton finds that the "firm yield" of the Edwards (the amount of water that can be safely withdrawn each year during a major drought) is approximately 200,000 acft per year-far below the 500,000+ acft per year being withdrawn in dry years. He determines that if withdrawals from the aquifer continue without reduction, spring discharge will be diminished, and endangered and threatened species will be "taken" in violation of the ESA. The Texas Natural Resources Conservation Commission (TNRCC, which replaced TWC) is directed to devise a plan to limit withdrawals and preserve spring discharge (even in a repeat of a drought of record) by March 1, 1993. If the Legislature does not enact a regulatory plan by May 31, 1993, the judge will allow the plaintiffs to seek additional relief, and the aquifer may become subject to federal judicial control. The USFWS is ordered to determine endangered and threatened species "take" and "jeopardy" spring discharge levels for Comal and San Marcos Springs. |
| March, 1993 | The TNRCC submits its plan to the court. |
| April 15, 1993 | Pursuant to Judge Bunton's Order, USFWS determines that takes begin when Comal spring discharge declines to 200 cfs, and when San Marcos spring discharge declines to 100 cfs. |
| May 26, 1993 | Judge Bunton enters Amended Judgment and Amended Findings of Fact and Conclusions of Law pursuant to an agreement between USFWS and plaintiffs. USFWS drops its appeal. |
| May 30, 1993 | 73rd Legislature enacts Senate Bill 1477, creating the Edwards Aquifer Authority (EAA), to regulate groundwater use, abolishing the EUWD. Governor Ann Richards signs |

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| | the bill on June 11, 1993. Senate Bill 1477 establishes that the EAA will become operational on September 1, 1993. |
| June 15, 1993 | Pursuant to Judge Bunton's Order, USFWS determines that under normal conditions jeopardy occurs when flow at Comal Springs declines to 150 cfs, and when San Marcos spring discharge declines below 100 cfs (take is not specified for San Marcos Springs). |
| August, 11, 1993 | The Mexican American Legal Defense and Education Fund questions the legality of equal representation by minorities on the new Edwards Aquifer Authority appointed board, and files for a U.S. Department of Justice (USDOJ) review. |
| September 1, 1993 | Senate Bill 1477 is to take effect, but implementation is delayed while the USDOJ decides if the abolition of the EUWD elected board and substitution of an appointed board violates the Voting Rights Act. |
| September 3, 1993 | TNRCC's Underground River Rules invalidated by Judge Pete Lowry of the Travis County District Court. |
| September 22, 1993 | The catfish farm is issued a water quality permit from the TNRCC. |
| November 19, 1993 | USDOJ rules that Senate Bill 1477 does not meet the requirements of the Voting Rights Act because it would abolish an elected board (the EUWD) and replace it with an appointed one (the EAA). |
| December, 1993 | The State of Texas asks USDOJ to clarify its ruling. The state proposes that the EAA and the EUWD be allowed to coexist and implement Senate Bill 1477. |
| 1994 | New Braunfels Utilities switched from a sole dependence upon Edwards groundwater to surface water supplied by the Guadalupe-Blanco River Authority.<br>TWDB publishes the update of the 1992 Texas Water Plan. |
| January, 1994 | Eight of the nine appointees for the EAA board are named and informally meet with the Governor Richards and representatives of the TNRCC. |
| January, 1994 | The EUWD board agrees to accept that all its 12 board members be elected from single-member districts by January 1998 settling a two-year old Voting Rights Act lawsuit (*Williams v. Edwards Underground Water District.* C.A. No. SA-92-CA-144, (W.D. Texas) (1992) which had challenged the EUWD's election system on one-person, one-vote grounds. |
| February 25, 1994 | Judge Bunton appoints Joe G. Moore, Jr. as Federal Court Monitor to gather data for the court. |
| March 9, 1994 | Attorney General Morales files suit (*Texas v. U.S.*) in the U.S. District Court for the District of Columbia seeking to reverse the Justice Department's decision that Senate Bill |

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| | 1477 does not meet the requirements of the federal Voting Rights Act. The court grants the state's request to appoint a three-judge panel to consider the issue. |
| March, 1994 | The USDOJ decides that the EUWD and the EAA cannot exist concurrently because the appointed board of the new authority (created by Senate Bill 1477) would effectively replace the elected board of the EUWD, thus violating the Voting Rights Act. |
| May, 1994 | The City of San Antonio announces adoption of a water-resource plan that includes another election on whether to complete construction of the Applewhite Reservoir project on August 13, 1994.<br>Judge Bunton denies a motion to declare a water emergency. |
| June 6, 1994 | Judge Bunton orders the Court Monitor to prepare a plan by August 1, 1994 to limit groundwater withdrawals, and also orders the USFWS to publish a proposed recovery plan for the species by August 1, 1994. |
| August 1, 1994 | The Court Monitor delivers the *Emergency Withdrawal Reduction Plan for the Edwards Aquifer* to the Federal District Court. |
| August 13, 1994 | City referendum in San Antonio rejects the 2050 Plan and, for the second time, the Applewhite Reservoir. San Antonio Water System (SAWS) staff is directed to start disposal of the property in the Applewhite Reservoir site. |
| September 25, 1994 | Judge Bunton orders the formation of a panel, chaired by the Court Monitor, to draft a regional water management plan/habitat conservation plan to obtain an ESA §10(a) Incidental Take Permit. |
| March 31, 1995 | The Court Monitor delivers *Revised Emergency Withdrawal Reduction Plan for the Edwards Aquifer* to the Federal District Court. |
| April 19, 1995 | A Letter of Intent is executed to assure the transport of 15,000 acft of Guadalupe River water to the military bases in San Antonio in an attempt to remove the water supply issue as a factor in the deliberations of the Base Realignment and Closure Commission over the fate of five San Antonio military bases. |
| April 28, 1995 | The Sierra Club files an ESA suit in Judge Bunton's court against the U.S. Department of Agriculture (USDA). *Sierra Club v. Glickman* alleges that USDA is allowing agricultural activities, primarily irrigation, to harm listed species at Comal and San Marcos Springs without consulting with the USFWS. |
| May 31, 1995 | Governor George Bush approves changes to Senate Bill 1477 adopted by the 74th Legislature in H.B. 3839 to give |

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| | the EAA an elected board to satisfy the concerns of USDOJ. |
| June 23, 1995 | The Court Monitor distributes for comment *Draft Habitat Conservation Plan for the Edwards Aquifer (Balcones Fault Zone—San Antonio Region)* developed over 9 months through a panel. |
| August 22, 1995 | A group led by the Medina and Uvalde Counties Underground Water Conservation Districts challenge the constitutionality of Senate Bill 1477 in State District Court in Medina County only 8 days before the EAA is to begin operating (*Barshop v. Medina County Underground Water Conservation Dist.*, No. 95-0881 (Tex. Aug. 22, 1996)). |
| October 18, 1995 | The Court Monitor's activities are stayed by the U.S. 5th Circuit Court of Appeals. |
| October 27, 1995 | The Medina County State District Court Judge Mickey Pennington rules that Senate Bill 1477 is unconstitutional in *Barshop v. MCUWCD* |
| 1996 | Drought returns to the region. Spring discharge declines rapidly. |
| February 14, 1996 | The USFWS finishes the Comal and San Marcos Springs recovery plan bringing *Sierra Club v. Babbitt (formally Lujan)* to an end by satisfying a ruling by the U.S. Fifth Circuit Court of Appeals. |
| March 20, 1996 | Oral arguments in an expedited appeal of Pennington's decision in *Barshop v. MCUWCD*, before the Texas Supreme Court. |
| May 1, 1996 | Comal Springs drops below take and San Marcos Springs drops below jeopardy. |
| June 10, 1996 | The Sierra Club files another ESA suit in Judge Bunton's court against all Edwards Aquifer pumpers. *Sierra Club v. San Antonio*, alleges that pumpers are causing takes by lowering the aquifer, thereby reducing spring discharge. |
| June 28, 1996 | A unanimous Texas Supreme Court reverses the Medina County State District Court in *Barshop v. MCUWCD* and finds Senate Bill 1477 constitutional. |
| July, 1996 | EAA convenes first organizational meeting. |
| July 2, 1996 | Judge Bunton orders the USDA to develop a species conservation plan in *Sierra Club v. Glickman*. |
| July 31, 1996 | The EAA board abstains from voting on a declaration of a water emergency during the drought. |
| August 1, 1996 | Judge Bunton appoints the author as a Special Master in *Sierra Club v. San Antonio*. The Special Master is ordered to develop a regional water conservation plan within ten days. |
| August 17, 1996 | EAA issues first draft *Critical Period Management Plan* rules. |

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| August 23, 1996 | The Special Master delivers the *1996 Emergency Withdrawal Reduction Plan* to the Court, which has been revised and adopted after a public comment period. Judge Bunton declares a water emergency and sets a date for the plan's activation. |
| September 11, 1996 | Judge Bunton's August 23, 1996, Order is stayed by the U.S. 5th Circuit Court of Appeals. |
| October 22, 1996 | SAWS approves routing for water reuse project to provide 35,000 acft of recycled water. Later the project is expanded to 55,000 acft. |
| October 23, 1996 | The U.S. 5th Circuit grants USDA's motion for stay in *Sierra Club v. Glickman* pending an appeal. |
| October 29, 1996 | EAA passes rules for filing applications for permits for historical Edwards Aquifer use. |
| November 21, 1996 | Judge Bunton denies Sierra Club request to have *Sierra Club v. San Antonio* proceed as a class action against all well owners. |
| December 19, 1996 | EAA adopts *Interim Critical Period Management Plan* and processing rules for Edwards Aquifer claims. |
| December 30, 1996 | EAA deadline for filing historic claims for all Edwards well owners. |
| 1997 | TWDB publishes update of Texas Water Plan.<br>The Legislature develops, and adopts, a new state water planning statute, Senate Bill 1. |
| January 9, 1997 | Spring discharge still at diminished levels. The EAA receives price per acre-foot offers from irrigators to participate in the Irrigation Suspension Program. |
| April 30, 1997 | The U.S. 5th Circuit Court of Appeals vacates Judge Bunton's August 23, 1996 Order, finding that the Court should have abstained from acting on a matter that the EAA could potentially resolve. |
| August 29, 1997 | GBRA files an amendment to its Canyon Reservoir water supply permit to subordinate GBRA hydroelectric rights and increase permitted withdrawals from 50,000 acft annually to 90,000 acft annually. The Canyon permit amendment was an element of the two previous Texas Water Plans. The permit is filed prior to the effective date of Senate Bill 1, and is therefore not subject to the junior water rights provision that applies to interbasin transfers of surface water in Texas. |
| December 18, 1997 | The USFWS lists Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's cave amphipod as endangered. |
| 1998 | After significant rains in 1997, drought returns to the region. Comal Springs drops below take for 39 days. |
| August 5, | Travis County District Court Judge Joseph Hart issues a |

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| 1998 | temporary injunction on behalf of the catfish farm in *Living Waters Artesian Springs, LTD. v. Edwards Aquifer Authority*, enjoining the EAA from implementing or enforcing its rules for processing permit applications to allocate aquifer water under S.B. 1477. |
| August 14, 1998 | The Sierra Club notifies the EAA and USFWS of its intent to sue for violations of the ESA. |
| September 11, 1998 | In a second case challenging EAA rules, *Glenn and JoLynn Bragg v. Edwards Aquifer Authority and Greg Ellis*, the Medina County District Court Judge Mickey Pennington also enjoins the EAA from enforcing its rules for issuing permits as the result of violations of the Texas Private Real Property Rights Preservation Act. |
| September 14, 1998 | The Environmental Defense Fund notifies the EAA of its intent to sue for violations of the ESA. |
| September 24, 1998 | Ruling on an appeal of *Sierra Club v. Glickman* the U.S. 5th Circuit Court of Appeals finds that the ESA requires the USDA to develop programs to conserve endangered species. |
| December 1, 1998 | Judge Joseph Hart finds in *Living Waters Artesian Springs, LTD. v. Edwards Aquifer Authority* that the rules of the EAA are invalid because their adoption violated the Administrative Procedures Act. The rules of the EAA limiting withdrawals are invalidated, as well as the EAA's *Critical Period Management Plan* rules. |
| December 30, 1998 | The SAWS board of trustees gives preliminary approval for the purchase of as much as 90,000 acft (about 50% of SAWS current withdrawals from the Edwards Aquifer) from the Aluminum Company of America (Alcoa) lignite operation northeast of Austin in the Carrizo-Wilcox Aquifer. |
| 1999 | The EAA holds public meetings and begins the process of developing a habitat conservation plan to obtain an ESA §10(a) Incidental Take Permit from USFWS. |
| 2000 | San Marcos begins using treated surface water supplied by the Guadalupe-Blanco River Authority as its primary source. |
| January 1, 2000 | The Texas Court of Appeals in San Antonio vacates Judge Pennington's ruling in *Glenn and JoLynn Bragg v. Edwards Aquifer Authority and Greg Ellis* and rules in favor of the EAA. |
| July 10, 2000 | The San Marcos River Foundation (SMRF) applies for a water right for 950,000 acft of unappropriated water (later increased to 1.3 million acft) to be dedicated for freshwater inflows to San Antonio Bay and deposited into the Texas Water Trust, which is administered by the TPWD. |
| October 2000 | The SAWS Board and San Antonio City Council approve a water supply fee to finance new sources of water as well as |

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| | water conservation for the City that are anticipated to be part of the Region L Plan. |
| December 21, 2000 | The SMRF permit application for 1.3 million acre-feet of unappropriated flow in the Guadalupe River is declared administratively complete by the TNRCC. |
| January 4, 2001 | The Region L Plan, developed under S.B. 1, is approved by the members of South Central Texas Water Planning Group. |
| January 26, 2001 | SAWS Board of Trustees votes to pursue two major projects to bring water from the Guadalupe and Colorado Rivers to San Antonio. |
| May 16, 2001 | Gov. Rick Perry signs House Bill 1629, authorizing the Lower Colorado River Authority (LCRA) to sell water to a municipality outside of its existing water service area. |
| May 18, 2001 | GBRA, SARA and GBRA sign an historic contract to supply Bexar County with large amounts of surface water from the Guadalupe River. The Lower Guadalupe Supply Project would initially supply 70,000 acft annually to San Antonio, while the City reduces its pumping from the Edwards Aquifer. |
| June 20, 2001 | In a 2 to 1 vote, TNRCC Commissioners vote to send GBRA's Canyon Reservoir permit amendment to a contested case hearing before the State Office of Administrative Hearings (SOAH) on behalf of the Guadalupe River Chapter of Trout Unlimited (GRTU), to protect hatchery-raised, non-native trout stocked by the TPWD in the Guadalupe River. |
| July 17, 2001 | An agreement is approved between GBRA and GRTU, avoiding a contested case hearing before a SOAH judge. |
| July 18, 2001 | Region L Plan is approved by the TWDB Board. |
| August 9, 2001 | The Canyon Reservoir hydroelectric subordination permit amendment is approved by the TNRCC. |
| November 28, 2001 | The GBRA Board approves the preparation and submittal of permits applications to TNRCC for the Lower Guadalupe Supply Project. |
| December 19, 2001 | The GBRA, SARA and SAWS Boards meet in an historic joint board meeting to discuss the implementation of the Lower Guadalupe Supply Project. |
| January 2002 | TWBD publishes the 50-year 2002 State Water Plan. |
| February 27, 2002 | LCRA and SAWS approve a contract to bring water from the Colorado River to San Antonio. |
| April 4, 2002 | GBRA submits applications to TNRCC to amend existing water right permits for use in Lower Guadalupe Supply Project. |

Revised August 1, 2004.