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Dividing the Waters: Water Marketing as a Conflict Resolution Strategy in the Edwards Aquifer Region

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ABSTRACT

In central Texas, an increasing urban and environmental demand for water, coupled with limited supplies in the Edwards Aquifer, collided with the legal right of landowners to pump an unlimited amount of groundwater. There clearly was not enough water in the Aquifer to meet current and future needs. In response to this water crisis, the Texas legislature created the Edwards Aquifer Authority and gave it extensive regulatory power to control pumping and to reallocate water through market mechanisms. Water marketing offers a means to minimize conflicts over the reallocation of water from lower economic valued agricultural uses to higher valued domestic, industrial, environmental and recreational uses. This article outlines a conceptual framework for a market-based water reallocation system and then applies this framework to the Edwards Aquifer region. The article suggests that there is a strong willingness on the part of stakeholders in the Edwards region to use markets to reallocate water and proposes an approach to encourage market development.

I. INTRODUCTION

Texas has made Faustian choices in allocating and managing water in the Edwards Aquifer. The laissez-faire capture rule adopted by the Texas Supreme Court[1] and followed by the Texas Legislature[2] minimized political

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1. Under the Texas water law of "absolute ownership/capture," pumping is unregulated and landowners are allowed to withdraw as much groundwater from beneath their land as they can capture. In the exercise of this right there is no liability absent malice, willful waste, or subsidence. *See* Houston & Tex. Cent. R.R. v. East, 81 S.W. 279, 280 (Tex. 1904); City of Corpus Christi v. Pleasanton, 276 S.W.2d 798 (Tex. 1955); Smith-Southwest Indus. v. Friendswood Dev. Co., 576 S.W.2d 21 (Tex. 1978); City of Sherman v. Public Util. Comm'n, 643 S.W.2d 681, 686 (Tex. 1983).

2. The Texas Legislature codified this common law rule of capture by expressly

conflicts over governmental regulation of water pumping but it left the Edwards Aquifer subject to uncontrolled and harmful pumping.[3] Although the capture rule has been widely criticized[4] the Texas Supreme Court has consistently turned aside reform efforts and has deferred to the legislature to develop rules for groundwater protection.[5]

As a consequence of the capture rule the Edwards Aquifer was treated as a common pool resource,[6] resulting in distribution and supply scarcity and posing environmental risks to the endangered plants and animals living in the springs flowing from the Aquifer.[7] These risks became very apparent in 1989 and 1990, when a combination of hot summers, drought conditions and excessive pumping significantly decreased flows

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recognizing the rights of landowners in underground water. *See* VERNON'S TEXAS CODE ANN. § 52.002 (West 1994), *repealed by* Acts of 1995, 74th Leg., ch. 933, § 6 (effective Sept. 1, 1995; now codified at TEXAS WATER CODE ANN. § 911.021(a) (West 1997).

3. The capture rule applies to percolating water and not to underground streams or the underflow of rivers. *See* Bartley v. Sone 527 S.W.2d 754, 760 (Tex. Civ. App.—San Antonio 1974, writ ref'd n.r.e); Denis v. Kickapoo Land Co., 771 S.W.2d 235, 238 (Tex. App.—Austin 1989, writ denied); TEXAS WATER CODE ANN. § 911.021(a) (West 1997).

4. For trenchant articles *See* Joe Greenhill & Thomas Gee, *Ownership of Groundwater in Texas: The East Case Reconsidered*, 33 TEX. L. REV. 620, 629 (1955) (urging Texas courts and Texas Legislature to adopt rules prohibiting malicious waste of water); Corwin Johnson, *Texas Groundwater Law: A Survey and Some Proposals*, 22 NAT. RESOURCES J. 1017 (1982) (discussing wastefulness of absolute ownership of percolating groundwater); Corwin Johnson, *The Continuing Void in Texas Groundwater Law: Are Concepts and Terminology to Blame*, 17 ST. MARY'S L.J. 1281 (1986); Karen Morris, *The Stagnation of Texas Groundwater Law: A Political v. Environmental Stalemate*, 22 ST. MARY'S L.J. 493 (1990); Eric Behrens & Matthew Dore, *Rights of Landowners to Percolating Groundwater in Texas*, 32 S. TEX. L. REV. 185 (1991); Lana Shadwick, Note, *Obsolescence, Environmental Endangerment, and Possible Federal Intervention Compel Reformation of Texas Groundwater Law*, 32 S. TEX. L. REV. 641 (1991); David Todd, *Common Resources, Private Rights and Liabilities: A Case Study on Texas Groundwater Law*, 32 NAT. RESOURCES J. 233 (1992); Jana Kinkade, *Compromise and Groundwater Conservation*, 26 ST. B. TEX. ENVTL. L.J. 230 (1996).

5. In upholding the constitutionality of the Edwards Aquifer Authority, the Texas Supreme Court reaffirmed it's preference for legislative rather than judicial resolution of groundwater problems. *See* Barshop v. Medina County Underground Water Conservation Dist., 925 S.W.2d 618, 619 (Tex. 1996).

6. The often-unappreciated side effect of the absolute ownership or capture rule is that current well owners are not protected from excessive pumping by other landowners. *See* Pecos County Water Control & Improvement Dist. No. 1 v. Williams, 271 S.W.2d 503, 505 (Tex. Civ. App.—El Paso 1954, writ ref'd n.r.e.). In essence, Texas groundwater is a common pool resource because it is open to any landowner who cannot exclude any other landowner from access and unlimited use. For a discussion of the allocation dilemma of common property resources, *see* Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243 (1968).

7. *See* Endangered and Threatened Wildlife, 50 C.F.R. § 17.11 (1998); Endangered and Threatened Plants, 50 C.F.R. § 17.12 (1998). The Comal and San Marcos springs are home to five endangered or threatened species: the Fountain Darter, the San Marcos Gambusia, the Texas Wild Rice, the Texas Blind Salamander, and the San Marcos Salamander.

in the Comal and San Marcos springs. In order to protect the aquatic plants and animals that rely on springflows, the Sierra Club filed a federal lawsuit under the Endangered Species Act[8] to regulate the amount of water that municipal, industrial, military and agricultural users could pump from the Aquifer.[9] In January 1993, U.S. District Judge Lucius Bunton ruled in favor of the Sierra Club and gave the Legislature until May 31, 1993, to develop a satisfactory plan to protect the endangered and threatened species, or face federal regulation of the Edwards Aquifer.[10] He declined to issue a final order until the State of Texas had the opportunity to address the allocation issues under state law.

In response to the specter of federal regulation, the Texas Legislature again made a Faustian choice and opted for state rather than federal regulation of the Aquifer.[11] The 73d Legislature enacted Senate Bill 1477, creating the Edwards Aquifer Authority (Authority), one day before Judge Bunton's deadline.[12]

In addition to regulating water withdrawals, the Authority must also manage the conflicts between urban, agricultural and environmental interests and uses through a demand management program.[13] The Authority has a number of management options for meeting increasing water demands, including conservation, drought management, reuse, enhanced recharge methods, new surface water sources and the transfer of water through market mechanisms.[14]

This paper examines the efficacy of water marketing as a method for reallocating water to meet increasing demands and for resolving

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8. 16 U.S.C. §§ 1531-1544 (1998).

9. *See* Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353 (W.D. Tex. Feb. 1, 1993). When springflow decreased to a point that harms the endangered and threatened species, this constituted a "take" under § 9 of the ESA.

10. *Id.* at 2-3.

11. For a history of this dispute *see* Eric Albritton, *The Endangered Species Act: The Fountain Darter Teaches What the Snail Darter Failed to Teach*, 21 ECOLOGY L. Q. 1007 (1994).

12. *See* Act of June 11, 1993, 73d Leg., R.S. ch. 626, 1993 TEX. GEN. LAWS 2350, *amended by* Act of May 29, 1995, 74th Leg., R.S. ch. 261, 1995 TEX. SESS. LAW SERV. 2505 (West) (current uncodified Senate Bill 1477 [hereinafter S.B. 1477].

13. Conflicts result from (1) concerns over the preservation of irrigated agriculture and the economic and social consequences in these farming areas with few profitable alternatives; (2) increasing municipal water demands in the San Antonio Metropolitan area; (3) the need for water to support the military bases in San Antonio; (4) protection of environmental amenities and recreational activities dependent on springflows; (5) the interdependency between surface and groundwater flows; and (6) spring flows contributing to water for downstream water right holders.

14. For a discussion of options *see infra* notes 63-76.

conflicts over water use in the Edwards Aquifer.[15] A framework for a market-based reallocation system is suggested, and the paper reports on results of a transaction-willingness survey of major pumpers in the region.[16] Finally, the paper discusses barriers to the reallocation of water through market mechanisms.

II. THE EDWARDS AQUIFER SETTING

The Edwards Aquifer provides the economic lifeblood for a 13 county region in south central Texas, extending some 176 miles from Brackettville in Kinney County to Kyle in Hays County (see Figure 1). Including its drainage area, the Aquifer region covers 8,000 square miles and serves as the primary source of water for approximately 1.3 million people.[17] Counties in the western portion are rural with agriculture as the primary land use and economic activity. In contrast, Bexar, Comal and Hays counties in the central and eastern portion of the region are urban and rely on the water for municipal, industrial, environmental and recreational purposes.[18] Given this diversity, the people who live in the region have extremely divergent interests in the way the Aquifer is managed.

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15. Market transfers are predicated on consensual bargaining between conflicting parties where price is an information rich signal about scarcity that drives the parties to settlement. A water market is an institutional structure designed to facilitate the transfer of rights and titles to ownership in water or rights or in rights to use water. For more extensive literature on water marketing see Ronald Kaiser & Michael McFarland, *A Bibliographic Pathfinder on Water Marketing*, 37 NAT. RESOURCES J. 4 (1997).

16. The survey included major irrigators, municipalities, and industrial water users in the Edwards Aquifer region. Lists of individuals, companies, and agencies pumping more than 18 million gallons of water per year from the Edwards Aquifer were obtained from the Edwards Underground Water District (EUWD) and the Texas Water Development Board (TWDB). Interviews were completed with 105 pumpers consisting of 28 irrigators, 38 municipalities and 39 industries in Bexar, Comal, and Hays counties. The survey also provided data for a master's thesis. *See* Laura Phillips, Barriers to Water Marketing: Opinions of Major Pumpers on Water Transfer Issues in the Edwards Aquifer Region (1996) (unpublished master's thesis, Tex. A&M U., College Station) (on file with author).

17. The San Antonio metropolitan area is home to approximately one million people and the Aquifer is the sole source of drinking water for the tenth largest metro area in the nation. *See* EDWARDS UNDERGROUND WATER DISTRICT, EDWARDS UNDERGROUND WATER DISTRICT 2, 9 (1992) [hereinafter EUWD].

18. SAN ANTONIO WATER SYSTEM, THE CASE FOR NEW LEGISLATION FOR THE EDWARDS AQUIFER 48 (1993) [hereinafter SAWS].

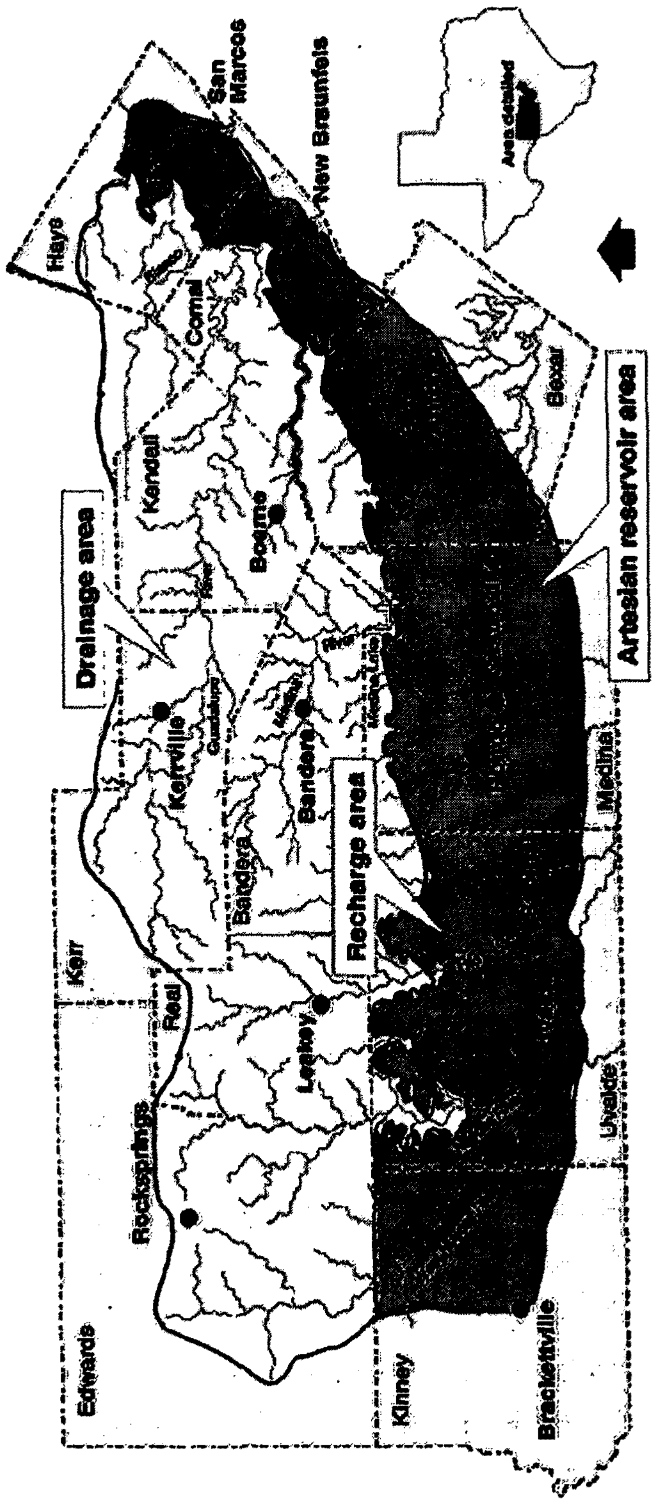

FIGURE 1. EDWARDS AQUIFER REGION

A. Aquifer Hydrogeology

General features of the Edwards Aquifer hydrogeology are well known and have been widely publicized.[19] Due to its limestone composition and its rapid recharge rate, the Aquifer is extremely transmissive, making it susceptible to rapid water level changes caused by pumping and drought.[20] The Aquifer is a single strata system and any recharge, pumping, or spring discharge affects water levels across the entire Aquifer.[21]

The Aquifer is a network of drainage, recharge and storage areas consisting of three distinct regions: the Edwards Plateau, the Balcones Fault Zone and the Coastal Plain (see Figure 1). The Edwards Plateau, encompassing some 4,400 square miles, is the catchment and drainage basin of the Aquifer. Surface water in the form of rainfall, runoff and spring flow from the Plateau is funneled into streams that flow across the recharge area where water penetrates the ground and replenishes the Aquifer. Since most aquifer recharge occurs through streambeds, this funneling effect is an important function of the drainage area.[22]

South of the drainage area lies the Balcones Fault Zone, or the recharge zone. It is approximately 1,500 square miles, and includes parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties.[23] In this area many closely spaced, nearly vertical faults occur along the relatively narrow Balcones Fault Zone, exposing fractured Edwards Limestone at the land surface.[24] As the streams originating in the Plateau cross this zone, much of their flow percolates through the streambeds into the aquifer.[25] All major streams in the region, except the Guadalupe River, lose water to the aquifer.

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19. The Edwards Underground Water District produced and distributed a report outlining the geology, water uses and economic growth in the Edwards Aquifer Region. *See generally* EUWD, *supra* note 17.

20. *See* SPECIAL COMMITTEE ON THE EDWARDS AQUIFER, COMM. REPORT TO THE 72ND LEGIS. 50 (1991) [hereinafter SCEA].

21. Changes in aquifer well levels reflect changes in pressure within the confined zone of the aquifer—not the actual movement of water underground. For this reason, recharge events raise well levels essentially instantaneously across a wide area. Correspondingly, pumpage at one site quickly affects well levels miles away. *See* SAWS, *supra* note 18, at 11.

22. *Id.* at 8.

23. *See* EUWD, *supra* note 17, at 6–7.

24. *Id.* at 7. Except during flooding, streams flowing from the western part of the Plateau lose most of their water to recharge. When streamflow exceeds the recharge rate, water flows in rivers to the Coastal Plain.

25. About 85 % of the recharge occurs where the numerous rivers and creeks cross the recharge zone. SCEA, *supra* note 20, at 49.

Directly south of the recharge zone lies the Edwards Coastal Plain, which is the Aquifer's artesian/reservoir area. It is approximately 2,100 square miles and includes parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties.[26] The groundwater in this area moves generally east and then northeast, toward the spring openings.[27] The highest yielding wells are in the artesian zone along a relatively narrow band from near San Antonio northeastward through New Braunfels to San Marcos. Wells in this band commonly yield 6,000-7,000 gallons per minute.[28]

Average annual recharge to the Edwards equals 640,000 acre-feet with an historical range from 43,000 to over 2 million acre-feet. As long as the recharge rate equals or exceeds the pumping rate, the Aquifer remains in equilibrium, and wells and springs do not dry up.

A "bad water line," which separates high quality water from brackish to saline water, defines the southern edge of the reservoir area. Movement of this bad water line could jeopardize the quality of springflows at Comal Springs and San Marcos Springs, which lie approximately three miles from the boundary, respectively. Degradation of the springs' water quality could result in the loss of aquatic biota within the springs of the Aquifer.

B. Water Uses

Water from the Edwards Aquifer is the critical resource that has supported economic growth and development in south central Texas.[29] Over the last 40 years, population growth, industrial development and agricultural expansion have increased the demand for water, exacerbated the political tensions between urban, rural interests and complicated the management of the Aquifer. San Antonio grew from 200,000 in 1940 to 1.1 million in 1990, and this growth is expected to continue.[30] The population

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26. *Id.*

27. *See* SAWS, *supra* note 18, at 8, 11, 17. There are five springs in the Edwards Aquifer region: Leona (Uvalde), San Antonio and San Pedro (San Antonio), Comal (New Braunfels), and San Marcos (San Marcos). If there were *no* pumping from the aquifer, in the long run these spring discharges would still (after some time lag) exactly offset the aquifer's recharge. However, pumping rates have continued to increase rapidly, and are projected to continue increasing as urban growth in and around San Antonio continues.

28. *See* EUWD, *supra* note 17, at 7. A well located 15 miles south of San Antonio in this artesian zone and used by a catfish farm flowed at the rate of 48,000 acre feet per year, the equivalent of 25% of San Antonio's total annual usage.

29. The settlement history of the area is closely tied to the springs that flowed from the Edwards. The first well was drilled into the Edwards in 1865 and by 1900, wells became the major suppliers of water. This is as true today as it was 100 years ago. *See* EUWD, *supra* note 17, at 4.

30. *See id.* at 9.

of the Edwards Aquifer region is expected to increase to approximately 2.3 million by 2020, with the highest concentration of people living in Bexar County.[31] This population growth will increase the demand for Edwards Aquifer water.

Pumping rates have mirrored population growth. Annual pumping from private wells has more than tripled since 1940 to an estimated 540,000 acre-feet in 1990.[32] Water resource planners project that in the next 25 years water demand could exceed 850,000 acre- feet per year and that mining of the Aquifer could begin by the year 2000.[33]

While water use patterns vary through the region, about 43 percent of the water is taken by irrigators and ranchers in Bexar, Medina and Uvalde counties and 47 percent is used by municipal, military and industrial users in San Antonio.[34] Farmers in Uvalde and Medina counties irrigate more than 82,000 acres and irrigation pumping rates have increased

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31. *See* SAWS, *supra* note 18, at 52.

32. SCEA, *supra* note 20, at 9–29.

33. *See* EUWD, *supra* note 17, at 9.

34. *See* SCEA, *supra* note 20, at 11–12. The United States Geological Service (USGS) calculates pumpage and presents the values by county and use category. The 1988 annual pumpage rates and the 1978-1988 maximum annual pumpage rates, as calculated by the USGS, are presented in the tables below.

1988 Pumpage Rates (in 1000s of acre-feet).

	Municipal		Rural Domestic		
COUNTY	Military	Industry	Irrigation	Livestock	TOTAL
Kinney	0	0	1.0	0.2	1.2
Uvalde	5.4	0.7	107.8	2.5	116.4
Medina	6.2	0	75.3	0.7	82.2
Bexar	250.8	7.5	18.5	36.1	302.9
Comal	12.8	9.1	0.2	0.7	22.8
Hays	11.1	1.5	0.1	1.7	14.4
TOTAL	286.3	18.8	192.9	41.9	539.9

Maximum Annual Pumpage Rates: 1978-1988 (in 1000s of acre-feet).

	Municipal		Rural Domestic		
COUNTY	Military	Industry	Irrigation	Livestock	TOTAL
Kinney	0	0	1.7	0.2	1.9
Uvalde	5.8	0.7	133.2	3.2	142.9
Medina	6.2	0	75.3	0.8	82.3
Bexar	252.8	11.8	18.8	37.2	319.8
Comal	13.6	9.4	0.4	0.7	24.1
Hays	11.1	1.9	0.9	3.0	16.9
TOTAL	288.7	23.8	192.9	45.1	587.9

822% from 1958 to 1989.[35] In the center of the region, San Antonio is the largest city in the United States that relies solely on a single aquifer for its water supply.[36] Municipal and industrial pumping rates in Bexar County nearly doubled from 1958 to 1989.[37]

Further to the east, the Comal and San Marcos springs are important recreational and environmental resources that have helped the region develop into a popular tourist destination.[38] The San Marcos springs are a designated critical habitat for the Edwards Aquifer endangered species.[39] If pumping continues at the current rate, the endangered species living in the Aquifer region are at risk of being harmed.[40]

The growth of the region's population and economy continues to drive the increasing demand for groundwater. Due to the nature of the Edwards, it will always be subject to very rapid draw down whenever rainfall is below normal and pumping rates increase. The region has now reached the point that, if pumping from the aquifer remains unlimited, average long-term extractions will exceed the average long-term recharge.[41]

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35. *See* SAWS, *supra* note 18, at 52.

36. *See* EUWD, *supra* note 17, at 2, 9.

37. *See* SAWS, *supra* note 18, at 52.

38. The Edwards Aquifer also affects surface water levels in Comal and Hays counties. Approximately thirty percent of the base flow of the Guadalupe River is supplied by the Springs under normal non-drought conditions, and in times of drought the Springs provide up to seventy percent of the base flow. *See* SAWS, *supra* note 18, at 10–17.

39. *See* Sierra Club v. Lujan, No. MO -91-CA-069, 1993 WL 151353 (W.D. Tex. Feb. 1, 1993); 50 C.F.R. § 17.11–12 (1993). The Springs are vital to maintaining the habitat of the Fountain Darter (Etheostoma fonticola), a one-inch long fish which lives in stream-floor areas covered with aquatic plants, both at and downstream of Comal and San Marcos Springs; the Texas Blind Salamander (Typhlomolge rathbuni), a species of salamander (perhaps the same as the San Marcos Salamander) which lives in the Aquifer itself and quite possibly in its springs; the San Marcos Gambusia, a small fish that lives in shallow water of a constant temperature, partially shaded by overhanging trees in the San Marcos River; and Texas Wild Rice (Zizania texana), a giant grass found in limited regions of the San Marcos River. The Springs are also home to the San Marcos Salamander (Eurycea nana), a threatened species.

40. According to data from the San Antonio Water System in order to guarantee springflows of at least the long run average (210,000 AF) and continuous flow during a recurrence of the drought of record, regional pumping would have to be reduced to 200,000 AF/year—38% of the 1985 pumping level. In order to guarantee springflows of approximately the long run average and the annual minimum during a drought (23,000 AF in 1956), regional pumping would have to be reduced to 250,000 AF/year—48% of the 1985 pumping level. At that annual minimum, however, Comal Springs could actually be dry for part of a year. *See* SAWS, *supra* note 18, at 24.

41. *Id.* at 112.

C. The Regulatory Context

The Edwards region has a history of conflict over the use of water. The establishment of the Edwards Aquifer Authority is the culmination of an evolutionary process to remove the exploitive incentives in Texas groundwater law. Born of economic, legal and political conflict and driven by the specter of drought, the Authority is the first serious attempt in Texas to regulate and allocate groundwater. The following discussion briefly outlines the movement from the capture rule to regulation of groundwater.

1. The Capture Rule

In 1904, the Texas Supreme Court in Houston & T. C. Ry. Co. v. East[42] found the movement of groundwater "so secret, occult and concealed that an attempt to administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would, therefore be practically impossible."[43] In following this line of reasoning the Court adopted the English rule of absolute ownership, granting landowners the right to withdraw as much groundwater from beneath their land as they capture. In the absence of malice, willful waste or subsidence this capture right is absolute and unqualified.[44] Under a capture paradigm, groundwater is legally pigeonholed into such categories as percolating water,[45] underground streams,[46] and underflow of surface streams.[47] While describing the interconnected nature of surface and groundwater, these

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42. Houston & T. C. Ry. Co. v. East, 81 S.W. 279 (1904). Impressed by the logic of the 1843 English case of Acton v. Blundell, 152 Eng. Rep. 1223 (Ex. 1843) the Texas Supreme Court adopted the rule of capture.

43. *Id.* at 280 (quoting Frazier v. Brown, 12 Ohio St. 294, 314 (1861)) (emphasis added).

44. Facially, these exceptions seem to be major constraints to landowner abuse. Yet, as applied by Texas courts they are not limitations on wasteful exploitation. For example, in City of Corpus Christi v. City of Pleasonton, 276 S.W.2d 798 (Tex. 1995), the Texas Supreme Court refused to find "waste" even though seventy-four percent of the 10 million gallons per day of groundwater that was pumped and transported through surface channels was lost to evaporation and bank seepage. The fact that very little, if any, of the water was put to beneficial use did not matter to the Court. *Id* at 802. Further, in Pecos County Water Control & Improvement Dist. No. 1 v. Williams, 271 S.W.2d 503 (Tex. Civ. App.—El Paso 1954, writ ref'd n.r.e.) the Court allowed irrigators to overpump the aquifer and dry up the springs that contributed to surface water flow at Comanche Springs.

45. *See* Bartley v. Sone, 527 S.W.2d 754, 760 (Tex. Civ. App–San Antonio 1974, writ ref'd n.r.e.) (noting that percolating groundwater does not pertain to underground streams or water flowing in a defined underground channel).

46. Denis v. Kickapoo Land Co., 771 S.W.2d 235, 238 (Tex. App–Austin 1989, writ denied). Groundwater is presumed to be percolating and therefore subject to the absolute ownership rule. *See* Texas Co. v. Burkett, 296 S.W. 273, 278 (1927).

47. *See* TEXAS WATER CODE ANN. § 11.021(a) (West 1971) (declaring state ownership in the *underflow* of every flowing river).

categories are at the apex of a disjointed legal system that subjects percolating water to absolute ownership while underground streams and the underflow of surface streams are subject to the prior appropriation system. Taken to its logical legal extreme, a landowner has a legal right to suck his neighbors' well dry, so long as the water is percolating water, but is constrained if the water is from an underground stream or from underflow of a surface stream. This rule promotes a race to the bottom of the aquifer and is economically and environmentally unsound.

Although advances in hydrology have answered many of the unknowns about groundwater movement, the Texas Supreme Court has consistently turned aside challenges to the capture rule and has deferred to the legislature to develop rules for groundwater protection.[48] In response to this deferral, Texas landowners have zealously guarded the capture rule and have successfully turned back significant legislative attempts to limit groundwater pumping.[49] The message is clear—politics and political rhetoric trump science. The political and economic totem of private property rights in groundwater is so entrenched in the Texas landowner and legislative psyche that any proposed change provokes heavy political opposition. Preaching the message of "private property rights" in groundwater has become a secular religion for many Texas landowners.

As a result of this political and legal stalemate, Texas remains a jurisprudentially anomaly where groundwater and surface water allocation rules stand in stark contrast to commonly accepted principles of hydrology. With the exception of the regulatory authority granted to the Edwards Aquifer Authority and to the Houston-Galveston Subsidence District, Texas clings to this vestige of the past. Legislative efforts to protect and manage groundwater resources have focused on the creation of underground water districts.

2. *Underground Water Districts: Planning Giants, Regulatory Dwarfs*

In contrast to the unified regulatory system for surface water, the Texas Legislature has followed a decentralized approach to groundwater

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48. The Court has followed the East rule in City of Corpus Christi v. Pleasanton, 276 S.W.2d 798 (1955); Friendswood Dev. Co. v. Smith-Southwest Indus., 576 S.W.2d 21 (Tex. 1978); and most recently in City of Sherman v. Public Util. Comm'n 643 S.W.2d 681 (Tex. 1983).

49. *See* Karen H. Norris, Comment, *The Stagnation of Texas Ground Water Law: A Political and Environmental Stalemate*, 22 ST. MARY'S L. J. 493, 494 (1990) ("Texas landowners . . . have successfully avoided any legislative or judicial action intended to limit groundwater pumpage."); Stephen E. Snyder, Comment, *Ground Water Management: A Proposal for Texas*, 51 TEX. L. REV. 289, 317 (1973) ("Political opposition from groundwater users will probably remain the most formidable obstacle to adopting an effective groundwater conservation program.").

regulation and has deferred management to local districts.[50] Notwithstanding the fact that excessive groundwater withdrawals are a statewide problem,[51] the responsibility for creating districts and managing aquifers resides with local voters.[52] Problems of self interest, limited funding, local politics and the self-limiting nature of these districts prevent meaningful management and protection of groundwater resources.[53] Essentially, the legislature has passed the buck to local communities, and the local response to the groundwater management has been slow and uneven. Indeed, the Texas legislature has moved in "strange and mysterious ways" in not removing this anomaly and in not preventing the mining of the states' groundwater resources.

In one sense, underground water districts are planning giants and regulatory dwarfs. They have extensive power to study, report,

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50. In 1949, under authority of the conservation amendment of the Texas Constitution, TEX. CONST. art. XVI, § 59, the legislature provided for the creation of Underground Water Conservation Districts. *See generally* TEX. WATER CODE ANN. ch. 52 (West 1971) *repealed by* Acts of 1995, 74th Leg., ch. 933, § 6, eff. Sept. 1, 1995.

51. Aquifer mining has been identified as a problem in a number of Texas water plans. For a recent iteration see generally TEXAS WATER DEV. BD., WATER FOR TEXAS—TODAY AND TOMORROW (1990).

52. TEXAS WATER CODE ANN. § 51.013–074 (West 1971).

53. From the very beginning, criticisms over the localized control and limited authority of districts were well known to the Texas legislature. *See* Edward P. Woodruff, Jr. & James Peter Williams, Jr., Comment, *Authority for "Texas Groundwater District Act"*, 30 TEX. L. REV. 862, 866 (1952) ("The act falls far short of being a complete independent groundwater code . . . it is merely a short appendage to the lengthy chapter on Water Control and Improvement Districts."); Snyder, *supra* note 49, at 298 (1973) (despite the gaping holes in the UWCDs management powers, however, the most serious barrier to effective action is its dependence on local politics. The district cannot be effective unless local residents, acting through popularly elected directors, are willing to impose management controls on their over pumping activities. None of the existing UWCDs have overcome this barrier and none have imposed production quotas); Corwin Johnson, *Texas Groundwater Law: A Survey and Some Proposals*, 22 NAT. RESOURCES J. 1017, 1020 (1982) ("The Edwards Underground Water District . . . is broadly authorized to conserve, protect and increase the recharge of and prevent the waste and pollution of the underground water but regulatory powers needed to implement those goals have not been conferred upon it. . . . The main function of this district appears to be data collection and dissemination."); Corwin Johnson, *The Continuing Voids In Texas Groundwater Law: Are Concepts And Terminology To Blame?*, 17 ST. MARY'S L.J. 1281, 1282 (1985) ("The legislature has passed the buck to local communities and the response has been slow and uneven."); Norris, *supra* note 49, at 501 ("The Texas legislature purports to distribute considerable power and authority to local groundwater conservation districts; however, several factors combine to limit their effectiveness."); Lana Shannon Shadwick, Comment, *Obsolescence, Environmental Endangerment and Possible Federal Intervention Compel Reformation of Texas Groundwater Law*, 32 S. TEX. L. REV. 641, 677 (1991) ("In sum, funding and management of UWCD's illustrates how greed may manifest itself through the vehicle of local politics. . . . Admittedly, UWCDs truly epitomize the state's desire to defer regulation to local areas, but the result is perhaps not what the legislature intended.").

disseminate and plan but they are limited in their ability to disturb the capture rule. The Edwards Underground Water Conservation District is a case in point. It was created in 1959 in response to drought and the growing water demands in San Antonio with a general mandate to study ways to conserve, protect and increase the discharge of the underground water in the aquifer.[54] The District was never given the power to limit pumping and although it had the paper responsibility for drought management planning and could declare the presence of a drought, it was without authority to manage and control water use during a drought.

Originally the District included five of the six counties in the aquifer recharge zone but in 1987, Medina and Uvalde counties withdrew from the District to create their own groundwater districts. Thus, the jurisdiction, political clout and cooperative planning ability were further diluted by the flight of these two counties.

After having been weakened by the flight of Medina and Uvalde counties, and considering its limited enforcement responsibilities, the Texas legislature put the organization to death when it established the Edwards Aquifer Authority.[55]

3. The Edwards Aquifer Authority: A Planning and Regulatory Giant

In response to prompting from Judge Bunton, and to prevent federal regulation of groundwater pumping, the Texas Legislature established the Edwards Aquifer Authority (Authority).[56] The Legislature created a planning and regulatory institution with sweeping powers to manage, conserve and protect the aquifer. As might be expected, the Act is a carefully crafted political compromise incorporating urban, rural, industrial, environmental and recreational interests,[57] but in many ways it is tilted to favor rural and agricultural interests.[58] As originally structured citizen representation on the Board underrepresented some groups and ran

54. *See* R.S. ch. 99, 1959 Tex. Gen. Laws 173.

55. S.B. 1477, codified as Act of June 11, 1993, R.S. ch 626, 1993 Tex. Gen. Laws 2350, § 1.41 (effectively abolishing the EUWD by transferring its assets to the Authority).

56. *Id.*

57. *See Aquifer Dust-Up: How Cities, Farms and Critters Coexist is Our Fight Too,* HOUSTON POST, Feb. 7, 1993, at C2; David McLemore, *Endangered Aquifer,* DALLAS MORNING NEWS, July 26, 1994, at A41.

58. *See* S.B. 1477, *supra* note 55, § 1.29(e) agricultural users fees cannot exceed twenty percent of municipal and industrial fees; § 1.31(b) (the Authority must maintain all agricultural water meters at no cost to the farmer); §1.26(2), (4) (irrigators and industrial users must be treated equally in the critical management plan).

afoul of the Voting Rights Act,[59] a problem the Texas legislature was forced to correct in 1995.[60]

But the legal challenges did not stop there. Soon after its passage, a consortium of rural interests challenged the constitutionality of the Act, alleging, inter alia, that the Act deprived landowners of a vested property right.[61] The Texas Supreme Court finally upheld the Act's constitutionality in June 1996.

Highlights of the Act include:

(1) Users may not withdraw water from the aquifer without a permit.[62]

(2) However, users whose wells are for domestic or livestock purposes and withdraw less than 25,000 gallons a day do not need a permit.[63]

(3) A "Pinocchio provision" requires pre-existing users to apply for permits based on their claimed historical water usage during the period from June, 1972 to May, 1993.[64]

(4) Preference is granted to pre-existing users over new users.[65]

(5) Pre-existing irrigators are guaranteed two acre-feet yearly for the maximum number of acres irrigated during the 1972-1993 time period, however, new irrigators do not have this guarantee.[66]

(6) Marketing water is allowed provided the transfers take place within the geo-political confines of the Edwards Aquifer region.[67] Irrigators may only market (lease) up to 50 percent of their water, while other permit holders are allowed to market their entire right.[68]

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59. *See* State of Texas v. United States, 866 F. Supp. 20 (1994). The Voting Rights Act is codified as amended at 42 U.S.C. § 1973c (1994) (enumerating requirement that any voting qualification, prerequisite, standard or procedure must not abridge voting rights on basis of race or color).

60. Act of May 29, 1995, R.S. ch. 261, 1995 TEX. SESS. LAW SERV. 2505 (West 1995).

61. Barshop v. Medina County Underground Water Conservation Dist., 925 S.W.2d 618 (Tex. 1996).

62. *See* S.B. 1477 *supra* note 55, at § 1.15.

63. *Id.* at §§ 1.16, 1.33.

64. *Id.* at § 1.16.

65. *Id.* at § 1.16.

66. *Id.* at §1.16(e).

67. *Id.* at § 1.34.

68. *Id.*

(7) The Authority may engage in water marketing either as a transaction facilitator or to retire water from use.[69]

(8) The Authority must develop a comprehensive water plan for the region that includes conservation, future supply development and demand management.[70] In conjunction with this effort, individual permit holders may be required to submit conservation and reuse plans.[71]

(9) In additional to the comprehensive plan, the Authority must develop and implement a critical management plan to deal with drought. The plan must designate discretionary and non-discretionary water uses and could require reductions in both types of uses. Municipal, domestic and livestock uses have the highest priority followed by industrial, crop irrigation, landscape irrigation and recreation uses.[72]

(10) Driving this planning effort is a limitation on the amount of water that can be withdrawn from the aquifer. Aquifer withdrawals are limited to 450,000 acre-feet annually (400,000 by 2008); withdrawal amounts for all users may be reduced in order to meet the total aquifer target limits.[73]

(11) The Authority must ensure that by December 31, 2012, the continuous minimum springflows of Comal and San Marcos Springs are maintained to protect those endangered and threatened species to the extent required by federal law.[74]

(12) In addition to the water quantity provisions the Authority is charged with preventing waste or pollution to the aquifer. The pollution prevention jurisdiction extends to a five-mile buffer zone outside the Edwards Aquifer. Pollution regulations must be uniform throughout the counties within the Authority.[75]

(13) Smaller scale underground water districts may co-exist within the boundaries of the Authority so long as their powers, duties and regulations are not inconsistent with those of the Authority.[76]

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69. *Id.* at § 1.22.
70. *Id.* at § 1.25.
71. *Id.* at § 1.23.
72. *Id.* at § 1.26.
73. *Id.* at § 1.14(b), (c)
74. *Id.* at § 1.14.
75. *Id.* at § 1.08.
76. *Id.* at §§ 1.42, 1.43.

Although the Authority has significant regulatory powers, it cannot impose taxes and must rely on user pumping fees[77] and legislative appropriations to operate.[78] This may prove to be its "Achilles heel," a defect perhaps intended by the Legislature to frustrate the Authority's ultimate purpose.

By late 1996, the Authority began the process of determining the amount of water to be authorized under individual pumping permits. This process will carry over for a number of years. During the winter and early spring of 1997, the Authority experimented with a water transfer program by brokering the purchase of dry year options from irrigators in Medina and Uvalde counties.[79]

An increasing water demand resulting from population growth and a limited Aquifer supply are the twin forces driving the reallocation imperative. This paper suggests that this reallocation can be accomplished by voluntarily transferring water between competing users based on a water-marketing paradigm. The remainder of the paper describes a general framework for marketing along with the results of a willingness to market survey of water pumpers conducted in 1995. Since the Authority was not operating at that time, we theorized that this survey would help gauge the potential for water transfers and marketing.

III. A MARKET FRAMEWORK FOR REALLOCATING EDWARDS AQUIFER WATER

Conflict is inherent in the management, allocation and protection of water and other shared natural resources. When shared resources are abundant, their allocation is generally free from economic, political, legal, institutional and geographical tensions. Conflict arises over competition for scarce resources, or when parties involved in decision making disagree about actions that have the potential to have negative impacts on

77. The Edwards Aquifer Authority operates on a user pays principle. The Act creating the Authority gives it the power to levy fees to defray its operational cost. *See* Act of June 11, 1993, R.S. ch 626, 1993 TEX. GEN. LAWS 2350, § 1.29. In 1997, its inaugural year for full scale operation, the Authority set pumping fees at $11 per acre-foot for municipal and industrial users and $2 per acre-foot for agricultural users. *See* Carmina Danini & Jerry Needham, *Edwards Panel Oks New Fees for Agricultural Water Pumpers*, SAN ANTONIO EXPRESS-NEWS, June 11, 1997, at 1A.

78. *Id.* The 1996-97 operating budget for the Authority totaled $ 5.2 million. Of this total, pumping fees paid by users provided about $2.3 million.

79. *See* discussion *infra* part IV, C.

environmental or human health.[80] In the Edwards Aquifer region conflicts arise from (1) concerns over the preservation of irrigated agriculture and the economic and social consequences in these farming areas with few profitable alternatives; (2) increasing municipal water demands in the San Antonio Metropolitan area; (3) the need for water to support the military bases in San Antonio; (4) protection of environmental amenities and recreational activities dependent on springflows; and (5) the interdependency between surface and groundwater flows. The status quo cannot continue. A certain, consistent and predictable supply of water is not available to meet all of these needs, and a mechanism is needed to allocate water fairly and efficiently. Water markets can, in part, provide that mechanism.

A. Benefits of Water Markets

Negotiated water transfers can play an important economic, political and social role in reallocating scarce water to meet changing demands. Water marketing is an alternative to a forced reallocation of water and has the potential to (1) provide water to growing cities;[81] (2) manage drought;[82] (3) provide water for environmental and recreational

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80. Examples include: disputes over prohibiting certain uses of national parks and forests, fish and game hunting regulations and harvest limits, and reallocation of water from agriculture to municipal uses. More recently, the 1996 Texas drought highlighted the conflicts arising from water scarcity and illustrated the importance of resolving, in an efficient and equitable manner, disputes over allocation of a critical natural resource.

81. Most of the water marketing literature describes agricultural-to-urban water transfers as a means to provide water to growing cities. *See, e.g.*, MARC REISNER & SARAH BATES, OVERTAPPED OASIS: REFORM OR REVOLUTION FOR WESTERN WATER (1990); NAT'L RESEARCH COUNCIL, WATER TRANSFERS IN THE WEST: EFFICIENCY, EQUITY, AND THE ENVIRONMENT 16 (1993); RICHARD W. WAHL, MARKETS FOR FEDERAL WATER: SUBSIDIES, PROPERTY RIGHTS AND THE BUREAU OF RECLAMATION (1989); Lawrence J. MacDonnell & Teresa A. Rice, *Moving Agricultural Water to Cities: the Search for Smarter Approaches*, HASTINGS WEST-NORTHWEST J. ENVTL L. & POL'Y, Fall 1994, at 27.

Texas' population is projected to double in the next 50 years, resulting in an increase in municipal water use and a decline in agricultural water use. Some of this new water for urban needs will come from agricultural-to-urban transfers. *See* TEXAS WATER DEV. BD., WATER FOR TEXAS, TODAY & TOMORROW 3-3 (Tex. Water Dev. Bd. 1990).

82. The California Drought Water Bank demonstrated that water marketing can meet urban water needs during drought conditions. The Bank was organized very quickly and provided over 820,000 acre-feet of water in 1991. The $125 acre-foot purchase price for water was adequate to attract enough sellers and the sales price of $175 acre-foot was attractive to a number of purchasers. The Bank spent some $100 million on purchases in 1991 and received $68 million in revenues from purchasers (the difference being accounted for by the unsold water held in storage in the State Water Project).

A number of studies and reports have chronicled the development and operation of the California Drought Water Bank. *See, e. g.*, CALIF. DEP'T OF WATER Resources, 1991

needs;[83] (4) promote efficient water use;[84] (5) encourage conservation;[85] (6)

DROUGHT WATER Bank (Calif. Dep't of Water Resources 1992); DAVID L. MITCHELL, WATER MARKETING IN CALIFORNIA: RESOLVING THIRD-PARTY IMPACT ISSUES (Bay Area Economic Forum, 1993); Richard E. Howitt et al., A RETROSPECTIVE ON CALIFORNIA'S 1991 EMERGENCY DROUGHT WATER BANK (Calif. Dep't of Water Resources 1992); RICHARD W. WAHL, WATER MARKETING IN CALIFORNIA: PAST EXPERIENCE, FUTURE PROSPECTS (REASON FOUND., POL'Y STUDY NO. 162, 1993); SHARING SCARCITY: GAINERS AND LOSERS IN WATER MARKETING (Harold Carter et al., eds. 1994).

83. A new demand for water is for instream flows that provide for non-consumptive environmental, recreational and tourism uses. Recreation and tourism drive this demand, which have become major industries in many western states, rivaling or surpassing agriculture in gross state revenues. In recent years, organizations have acquired water rights to protect instream flows for recreational uses. *See* Paul R. Williams & Stephen J. McHugh, *Water Marketing and Instream Flows: The Next Step in Protecting California Instream Values*, 9 STAN. ENVTL. L.J. 132, 166–67 (1990).

Apart from the substantial economic values associated with recreational use of water there is a growing public recognition and demand for maintenance of environmental integrity that comes from leaving a certain amount of water in place. Changing water use from consumptive off-stream uses to maintaining a certain instream and estuary freshwater inflow has become a major priority. *See* NAT'L RESEARCH COUNCIL, *supra* note 81.

A more pragmatic approach to providing water for environmental and recreational values is to authorize agencies to appropriate water for these purposes through the use of water transfers. Water in the California Drought Water Bank was purchased by the state Department of Fish and Game and used to protect environmental values and fisheries during the 1992 drought year. More than 24,000 acre-feet of water, or 15 percent of the allocation from the bank, was used to protect environmental and recreational values. *See* RONALD KAISER, LEGAL AND INSTITUTIONAL BARRIERS TO WATER MARKETING IN TEXAS 46 (Tex. Water Resources Inst., Technical Report No. 167 1994).

84. From a purely economic perspective, water transfers make good sense. The notion of valuing water based on its highest and best economic use is captured in the National Water Commission discussion on the value of water:

> *The comparison of water values in alternative uses will become increasingly important in the years ahead as growing demands compete for limited natural supplies and values in use increase. The opportunities for net gains by better allocations will be much greater. Not only will efficiency in the design of facilities be important, but also efficiency in allocation of water itself. Economic values provide the best general indication of the basic worth of water if appropriate attention is given to protection of environmental values.*

NATIONAL WATER COMM'N, WATER POLICIES FOR THE FUTURE 47 (U.S. Water Resources Council 1973) (emphasis added). The Commission basically adopted a market-based paradigm by equating highest use for water with the economists' "efficient allocation" model.

85. Three common models can be found in water conservation strategies: (1) prescriptive requirements compelling water rights holders to adopt new technology or follow best management practices, (2) government subsidies to water users enabling them to purchase new equipment, and (3) market based sales of conserved water. *See* A. Dan Tarlock, *The Changing Meaning of Water Conservation in the West*, 66 NEB. L. REV. 145 (1987).

An incentive-based approach would grant water rights holders permission to sell trade or market that water saved through conservation practices. California and Oregon allow for conserved water to be sold. *See* CAL. WATER CODE §§ 1010, 1011(b), 1012 (West Cum Supp.); OR. REV. STAT. § 537.455 (West 1988 & 1996 Supp.).

provide an alternative to new reservoir construction;[86] and (7) promote political and social harmony.[87] These benefits are apropos to the Edwards Aquifer region and can encourage the marketing of water rights. They become especially important in developing water marketing as part of the demand management program required of the Authority.

B. Water Market Requirements

Water markets differ from other natural resource commodity markets for a variety of reasons, including the long tradition of subsidized water, the concentration of large amounts of public water held by private entities, the equally long tradition that water must support a wide variety of collective public values and the distribution impacts on parties who are not part of the decision process.[88] Thus, unregulated markets do not exist for water transfers,[89] as transfers are directed and controlled by state

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86. The traditional state response to an increasing water demand and a limited supply was to augment the supply through construction of additional reservoirs. Throughout the western states proposals to augment supply face stringent fiscal and political constraints. Better management is imperative to accommodate increasing demands for consumptive and non-consumptive uses. Transfers of water from low value agricultural uses to higher valued municipal uses are becoming the norm rather than the exception. With varying degrees of enthusiasm, water suppliers, consumers, brokers, legislators and increasingly influential segments of the environmental community have accepted the premise that water marketing should be a major component of future western water law policy. *See* NAT'L RESEARCH COUNCIL, *supra* note 81, at 2.

The state of Texas recognized the potential of water marketing—the transfer of water rights from existing uses to new uses at market value—by making this reallocation mechanism a significant part of state water policy. The 1990 Texas Water Plan suggests that future municipal water demand can be met by reallocating existing water supplies with minimal need for new reservoir development. *See* TEXAS WATER DEV. BD., WATER FOR TEXAS: TODAY & TOMORROW 4-1 (1990).

87. *See* Ronald Kaiser, *Texas Water Marketing in the Next Millennium: A Conceptual and Legal Analysis*, 27 TEX. TECH L. REV. 181, 183–96 (1996).

88. Third party impacts of water transfers are an important consideration in western water reallocation. To date most of the literature has focused on identifying the array of parties and types of impacts from water transfers. The most complete discussion of third party impacts can be found in NAT'L RESEARCH COUNCIL, *supra* note 81 at, 38–69 (1992); *See also* Kenneth R. Weber, *Effects of water transfers on rural areas: a response to Shupe, Weatherford, and Checchio*, 30 NAT. RESOURCES J. 13 (1990); Douglas L. Grant, *Public Interest Review of Water Rights Allocation and Transfer in the West: Recognition of Public Values*, 19 ARIZ. ST. L.J. 681 (1987); Susan Nunn & Helen Ingram, *Information, the Decision Forum and Third Party Effects in Water Transfers*, 24 WATER RES. RESEARCH 473 (1988).

89. In theory this type of market would not be regulated or controlled by laws or institutions except to protect the unfettered freedom of the market. The perfect market describes an economists' theoretical framework. It is not the economic reality of western water practices. *See* NAT'L RESEARCH COUNCIL, *supra* note 81, at 3; BONNIE SALIBA & DAVID B. BUSH, WATER MARKETS IN THEORY AND PRACTICE: MARKET TRANSFERS, WATER VALUES AND PUBLIC

regulatory agencies.[90] In reality, water transfers more often resemble diplomatic negotiations than simple commodity transactions.

Water markets develop when a combination of economic, legal, institutional and technical factors converge so that buyers can obtain a more certain, consistent and predictable water supply relative to other options and sellers realize greater net benefits by transferring the water than by keeping it in an existing use.[91] The classic economic rationale of gains from trade motivates most water transfers, however, legal, in stitutional and technical barriers can vitiate transfers.

The success of water marketing in the Edwards Aquifer region will be determined by: (1) the increasing demand for water driven by population growth and environmental needs;[92] (2) the limited availability

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POLICY (Studies in Water Pol'y and Management No. 12, Charles Howe ed., 1987); Victor Brajer et al., *The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interests in the West*, 29 NAT. RESOURCES J. 489, 495–506 (1989).

90. In Texas all transfers of surface water rights require the approval of the Texas Natural Resource Conservation Commission. *See* TEXAS WATER CODE ANN. § 11.122 (West Supp. 1998); 30 TEX. ADMIN. CODE § 295.71 (West 1995).

91. For a bibliography on water marketing see Ronald Kaiser & Michael McFarland, *A Bibliographic Pathfinder on Water Marketing*, 37 NAT. RESOURCES J. 4 (1997). For other articles discussing the economic, legal, technical and institutional conditions necessary for water markets see, for example, Terry L. Anderson, *The Market Alternative for Hawaiian Water*, 25 NAT. RESOURCES J. 893 (1985); Victor Brajer et al., *supra* note 86; H. Stuart Burness & James Quirk, *Water Law, Water Transfers and Economic Efficiency: The Colorado River*, 23 J. LAW & ECON. 111 (1980); Arthur Chan, *To Market or Not to Market: Allocation of Interstate Waters*, 29 NAT. RESOURCES J. 529 (1989); Ronald G. Cummings & Vahram Nercissiantz, *The Use of Water Pricing as a Means for Enhancing Water Use Efficiency in Irrigation: Case Studies in Mexico and the United States*, 32 NAT. RESOURCES J. 731 (1992); Richard L. Gardner, *Institutional Impediments to Efficient Water Allocation*, 5 POL'Y STUD. REV. 353 (1985); Ronald C. Griffin & Fred O. Boadu, *Water Marketing in Texas: Opportunities for Reform*, 32 NAT. RESOURCES J. 265 (1992); KEITH HIGGINS & JACK BARNETT, WATER RIGHTS AND THEIR TRANSFER IN THE WESTERN UNITED STATES (1984); Charles Howe et al., *Innovative Approaches to Water Allocation: The Potential for Water Markets*, 22 WATER RES. RESEARCH 439 (1986); Ronald Johnson, *The Definition of a Surface Water Right and Transferability*, 24 J.L. & ECON. 273 (1981); Ronald Kaiser, *Texas Water Marketing in the Next Millennium: A Conceptual and Legal Analysis*, 27 TEX. TECH L. REV. 181, (1996); Bonnie Saliba, *Do Water Markets Work? Market Transfers and TradeOffs in the Southwestern States*, 23 WATER RES. RESEARCH 1113 (1987); RODNEY T. SMITH, TRADING WATER: AN ECONOMIC AND LEGAL FRAMEWORK FOR WATER MARKETING (1988).

92. Texas' population has doubled in the past 35 years from 9.5 million in 1960 to 19 million today. The State Water Plan predicts that Texas' population will double again in the next 50 years, increasing to over 36 million residents by the year 2050. *See* TEXAS WATER DEVELOPMENT BOARD, WATER FOR TEXAS—TODAY AND TOMORROW 3-4 (1990).

In the Edwards Aquifer region water is used primarily for irrigation, industrial uses and municipal uses. Pumping has increased dramatically in all three sectors. Nearly all the irrigation uses takes place in Medina and Uvalde counties. Since 1966, irrigation use in these two counties has increased from an estimated 43,0000 acre-feet/yr to an estimated 160,0000 acre-feet in 1990—a 400 percent increase. Municipal pumping has increased with the growth

of alternative supplies;[93] (3) undervalued water uses;[94] (4) a critical mass of buyers and sellers;[95] (5) available water information;[96] (6) reasonable

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of the regions' population and economy. In the same 1966-1991 time period, all municipal and industrial use increased from 164,0000 acre feet/yr to 308,000 acre-feet/yr —a 180 percent increase. San Antonio's water use has increased from 90,000 acre-feet/yr in 1966 to 158,000 acre-feet/y in 1991—a 60 percent increase. It is estimated that total municipal water demand will roughly double by 2040 from 285,000 acre-feet/yr in 1990 to 566,000 acre-feet in 2040. *See* SAWS, *supra* note 18.

93. Historically, water has been obtained through: (1) appropriating surface water rights in the basin to which no previous claim has been made; (2) constructing surface water development projects to capture, store, and transport water for areas in the basin where local supplies are perceived as inadequate; (3) interbasin transfer of water; and (4) pumping groundwater. The economic and political difficulty encountered in seeking to justify large-scale surface water development projects makes the future of this option very dim. In Texas, complete appropriation of some surface water and mining of groundwater supplies is a problem. According to data from the Texas Natural Resource Conservation Commission there is limited or no water available for new appropriation in the Colorado River Basin; (the Guadalupe River Basin upstream of Canyon and Coleto Creek Reservoirs; the San Antonio River Basin upstream from Lakes Medina and Applewhite; the Nueces River Basin upstream of the Zavala/Dimmit counties water. Thus, little, if no, surface water is available in the San Antonio river basin for appropriation. As a result, San Antonio must seek to acquire water through interbasin transfers, reuse of treated effluent, or purchase of water rights in the Edwards Aquifer. *See* TEXAS NATURAL RESOURCE CONSERVATION COMM'N, A REGULATORY GUIDANCE DOCUMENT FOR APPLICATIONS TO DIVERT, STORE OR USE STATE WATER 19 (March 28, 1994).

94. The reallocation of water through a market system is driven by the prospect of economic gains from transferring water to a location, season or purpose of use in which it generates higher net benefits than under the existing use pattern. In other words, if it's cheaper to obtain water by pumping groundwater or by building a new reservoir than it is to buy water from another user, then purchases will be forsaken for pumping or dam building. In spite of claims of water's enormous economic importance, water actually exhibits a relatively low marginal value. The estimated direct marginal value productivity of irrigation water falls in the range of $25-$75 per acre-foot. *See* Robert Young, *Why Are there So Few Transactions Among Water Users?* 68 AM. J. AGRIC. ECON. 1143, 1144 (1986).

95. For a market to function efficiently, no one buyer or seller, or group of buyers or sellers should have the power to fix the price of water. Monopolistic practices result when one buyer or one seller can control the market. In economic terms, a "critical mass" is not numerically defined but simply means that no one party acting alone can affect the price of water. Applying this concept to water transfers would mean that more than one city (purchaser) and more than one supplier (farmer, rancher or water district) should be involved in the market process. *See* Brajer et al., *supra* note 89.

96. An important predicate to successful transfer program is the availability of market information. Data on prices, potential sellers and buyers, delivery conditions and other market transactions must be available to the parties in order to have an efficient market. Buyers and sellers must have easy and inexpensive access to this type of information for a market to work successfully. *See* Kaiser, *supra* note 87, at 209–11; 1 LAWRENCE MACDONNELL, THE WATER TRANSFER PROCESS AS A MANAGEMENT OPTION FOR MEETING CHANGING WATER DEMANDS (USGS Grant Rep. No. 14-08-001-G1538, 1990); Victor Brajer et al., *supra* note 89.

transaction costs,[97] (7) defined and enforceable rights to water;[98] (8) minimal transfer restrictions, (9) public interest reviews;[99] (10) a conveyance system;[100] and (11) institutional promotion.[101] (See Figure 2). Most of these

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97. Water transfers can be greatly influenced by transaction cost. In economic terms, transaction costs are the aggregate costs incurred as part of the transfer process that can be apportioned to buyers, sellers, state or local agencies and institutions, and third parties. They are the costs associated with making the market system work. Transaction costs are incurred in searching for trading partners, in application and brokerage fees, in public hearing and agency reviews, in legal and technical help, in identifying the legal and physical characteristics of water rights (priority date, point of diversion, consumptive use and other permit conditions), in arranging price, financing and other transfer terms, in satisfying conditions imposed by state laws, in internalizing externalities imposed on third parties, and in treating, transporting and storage costs. *See generally*, NAT'L RESEARCH COUNCIL, *supra* note 81, at 43; MACDONNELL, *supra* note 96, at 43–45; BONNIE COLBY ET AL., WATER TRANSFER AND TRANSACTION COSTS: CASE STUDIES IN COLORADO, NEW MEXICO, UTAH AND NEVADA 54 (Dept. of Agric. Econ., Univ. of Ariz., July 1989).

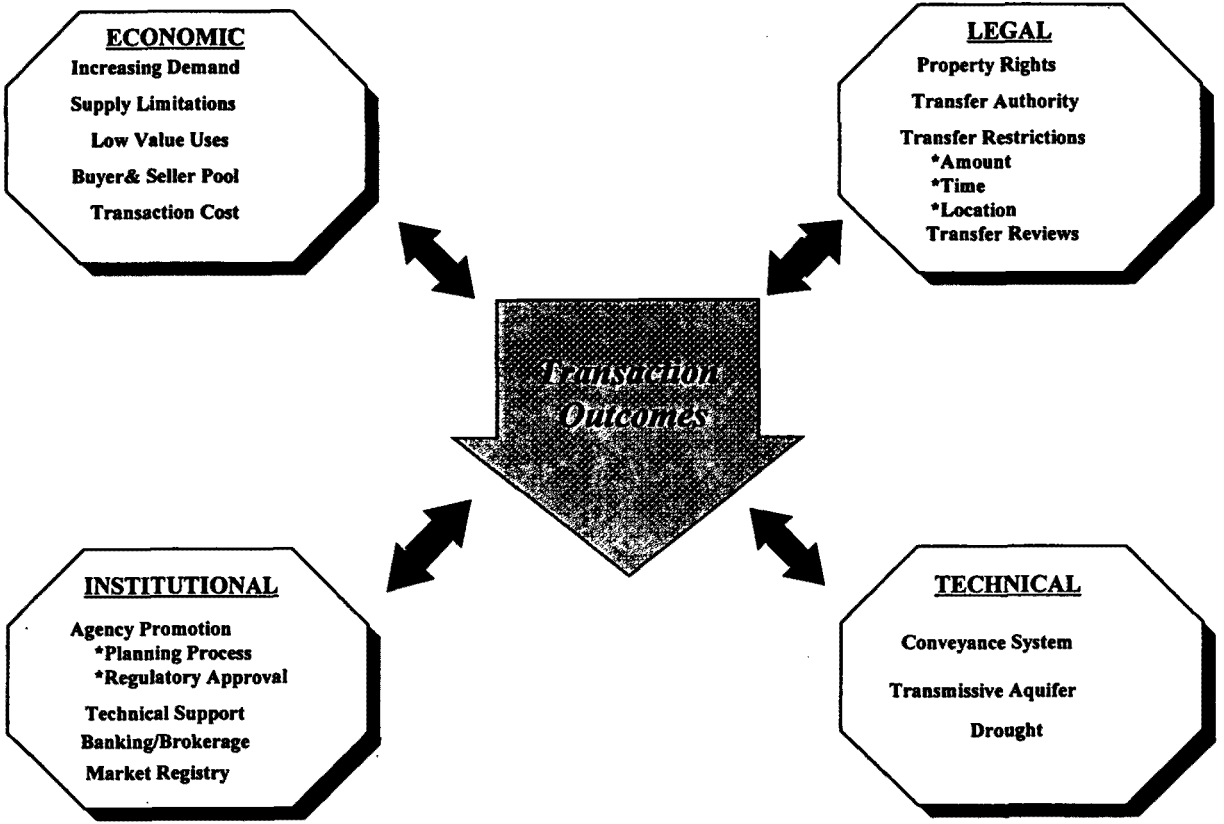
98. Economists argue that defined and enforceable property rights in water are a critical factor in facilitating market-based transfers. A property rights system that embodies water ownership, exclusivity, transferability and enforceability can produce an efficient allocation of water. *See generally* SMITH, *supra* note 91; HIGGINS & BARNETT, *supra* note 91; SALIBA & BUSH, *supra* note 89; TOM TIETENBERG, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS ch. 3 (3d ed., 1992).

99. Except for Colorado and Oklahoma, all of the western states require "public interest" reviews for surface water transfers. These statutes vary considerably in outlining the criteria for public interest review and in granting regulatory agencies the discretion in defining the term. Some statutes simply require a public interest review without defining what is meant by the term. New Mexico, South Dakota, Nevada, and Texas allow a regulatory agency to reject a transfer application where the transfer is detrimental to the public interest, not in the public interest, threatens to prove detrimental to the public interest, or is detrimental to the public welfare. For a discussion of public interest reviews see generally Consuelo Bokum, *Implementing the Public Welfare Requirement in New Mexico's Water Code*, 36 NAT. RESOURCES J. 441 (1997); Kaiser, *supra* note 87, at 219–22; NAT'L RESEARCH COUNCIL, *supra* note 81, at 255; Douglas Grant, *Public Interest Review of Water Right Allocation and Transfer in the West: Recognition of Public Values*, 19 ARIZ. ST. L.J. 681 (1987).

100. A means of efficiently and effectively moving water from the seller to the new purchaser must exist. This conveyance is not a problem for surface water transfers if the purchaser is downstream from the seller. The seller merely uses the natural conduit (the river) to convey water. The importance of a conveyance system to an effective water market is illustrated by the states of California and Colorado. Both have elaborate systems for moving water from the source of supply to the user. California moves water from the northern to the southern portion of the state—a distance of more than 500 miles. Similarly, Colorado has developed a system for moving water across the continental divide to serve the growing population centers on the Front Range of the Rocky Mountains. For a description of the California conveyance system see JOSEPH SAX ET AL., LEGAL CONTROL OF WATER RESOURCES 679 (2d ed. 1991).

101. Water institutions typically are structured to plan, develop, manage and regulate water resources. Institutions that have planning and regulatory functions can play a significant role in promoting and facilitating water transfers. Planning processes that encourage transfers as a means of reallocating scarce water resources represent a positive form of state water policy. For a generally overview of institutional promotion of marketing see Barton Thompson, Jr., *Institutional Perspectives on Water Policy and Markets*, 81 CAL. L. REV. 671, 707–23 (1993).

Figure 2. A Water Marketing Paradigm



criteria are theoretically present in the Edwards Aquifer region and the potential for marketing does exist. Some uncertainty is present regarding a critical mass of buyers and sellers, information on water availability and pricing, transfer restrictions and a conveyance system for the water. This article attempts to answer some of these questions.

IV. WILLINGNESS TO MARKET

Since there is no evidence that groundwater rights were transferred in the Edwards region before the passage of the Edwards Aquifer Act, this study sought to determine if a potential exists for water markets based on a "willingness to transfer profile" of groundwater pumpers. The rationale is that in the absence of a market, a willingness to transfer is the best evidence to suggest the potential for markets.

A. Data Collection

Data for this study is taken from telephone interviews with 105 groundwater pumpers who individually extract more than 18 million gallons of water per year from the Edwards Aquifer.[102] Due to pending litigation by some Medina and Uvalde county irrigators, all attempts to obtain a list of irrigators in these counties were denied. Efforts to obtain a list under state and federal Freedom of Information Acts were not successful. For this reason, the scope of the study was limited to Bexar, Comal, & Hays counties. However, the experimental 1997 Irrigation Suspension Plan of the Edwards Aquifer Authority in Medina and Uvalde counties tends to corroborate the findings of this study. We believe that these large pumpers are more likely than smaller operators to be in a position to participate in water marketing ventures.

Because this group is not large, we surveyed the entire population. Twenty-eight irrigators, and representatives of 38 municipalities and 39 industries (n=105) completed the interviews. The value of this study is that it provides important information regarding major pumpers in the area who would likely be involved in any water marketing.[103]

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102. The list of individuals, companies, and agencies pumping water from the Edwards Aquifer were obtained from the Edwards Underground Water District (EUWD) and the Texas Water Development Board (TWDB). EUWD's lists included irrigators, municipalities, and industrial water users in Bexar, Comal, and Hays counties that pump 18 million gallons per year or more.

103. Descriptive statistics and non-parametric analysis of variance were the analytical tools used in this study. Initial testing showed that the data did not pass the assumption of homogeneity of variance required in analysis of variance testing. Therefore, a non-parametric, one-way analysis of variance test (the Kruskal-Wallis one-way analysis of variance test) was

B. The Transfer Landscape

There is a strong desire on the part of many irrigators and municipalities for water transfers, and we believe that conditions exist for the development of water markets in the Edwards Aquifer. Experiences from other regions of Texas and from other western states suggest that organized markets in the Edwards Aquifer region will develop in response to scarcity.[104] A willingness to market does not always equate to an actual market practice.

Pumpers in the Edwards Aquifer region indicated that in varying degrees they would pursue water transfers (see Table 1). Irrigators and municipalities exhibited the greatest willingness to engage in transfers. Nearly 60 percent of the irrigators and 55 percent of the municipalities indicated some degree of likelihood that they would pursue marketing in the near future.

All groups thought that some barriers to marketing existed but that over time these barriers would fall. Uncertainties over legal rights to groundwater and over how to structure transfer agreements were the major barriers to willingness to engage in transfers, but these were not insurmountable hurdles preventing water transfers.

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employed in the analysis. This test is less stringent when assumptions of normality and equal variance are violated. The null hypothesis for the Kruskal-Wallis test postulates that there are no differences between the groups; the alternate hypothesis is that at least one group differs from the others.

Analysis of variance usually employs a multiple comparison test, such as Scheffé, Duncan or Tukey. These tests were not applicable here. Instead, the Wilcoxon rank sum test, which is similar to a t-test but has less stringent assumptions regarding normality and equal variance, was employed to identify group differences. The null-hypothesis of the Wilcoxon test is that the populations are identical; the alternate hypothesis is that one of the groups is different. For a discussion of this statistical procedure *see* DENNIS E. HINKLE ET AL., APPLIED STATISTICS FOR THE BEHAVIORAL SCIENCES 18, 102–24 (1994).

104. *See infra* notes 127–28.

Table 1. Likelihood That Respondents Will Pursue Water Marketing In The Near Future.

LIKELIHOOD	Irrigators		Municipalities		Industries	
	Freq.	%	Freq.	%	Freq.	%
Not at all likely	6	21	14	38	20	56
Not very likely	0	0	2	5	1	3
Somewhat likely	5	18	3	8	4	11
Not very likely	5	18	3	8	5	14
Extremely likely	6	21	14	38	5	14
Don't Know	6	21	1	3	1	3

1. Agriculture to Urban Transfers

Edwards Aquifer transfers will most likely move water from lower valued agricultural uses to higher valued urban and industrial uses. This is consistent with the dominant trend in western water transactions where water has moved from irrigation to urban uses.[105] An analysis of responses to a number of questions on transfers indicated that there are statistically significant differences between irrigators, cities or industries in their willingness to sell water. When asked about selling water for compensation, 50 percent of irrigators indicated that they would be willing to sell or lease water if approached by a willing buyer whereas only 22 percent of municipalities and 31 percent of industries were willing to sell.[106]

There exists a potential to move a large volume of water through transfers, which could provide a major source of water for cities during times of drought. For example, irrigators who are willing to transfer water for compensation demonstrated a willingness to transfer relatively large amounts of water (Table 2). Forty-two percent of these irrigators indicated that they would sell or lease more than 75 percent of their entitlement.[107] Municipalities and industries who indicated a willingness to sell or lease

105. *See supra* note 81.

106. There were statistically significant differences between groups' responses to this question (alpha = .05, critical value (df, 2) = 5.99, chi-square = 10.65, p = .01). Further pairwise testing showed that irrigators' responses were significantly different than municipalities' (p = .002) and industries' (p = .017) at the .05 level.

107. This raises interesting questions over the amount of water than can be transferred since irrigators are restricted from leasing more than 50 percent of the irrigation rights initially permitted. *See* S.B. 1477, *supra* note 55, at § 1.34(c). Perhaps the legislature was concerned over a large-scale transfer of agricultural water to cities and sought to protect agricultural users from themselves and the foibles of the marketplace.

water were more conservative; 33 percent of municipalities and forty-six percent of industries would sell 30 percent or less. More than one-quarter of irrigators and municipalities responded that they "didn't know," which indicates that these individuals either have not yet given the issue serious consideration or that they prefer to keep this information confidential.

Table 2. How much of your water right would you be willing to sell or lease?

SALE	Irrigators		Municipalities		Industries	
	Freq.	%	Freq.	%	Freq.	%
0 > 30	0	0	3	33	5	46
30 > 75	4	29	2	22	3	26
75 > 100	6	42	1	11	2	18
Don't Know	4	29	3	33	1	10

2. A Dilemma for Irrigators

We theorized that irrigators would place greater importance on keeping water in agricultural use than other uses. As posited in the literature, irrigators may have more at stake in water marketing than just water; agricultural lifestyle and the social, economic and political fabric of agricultural communities may be at risk when water is transferred to non-agricultural uses.[108] We tested irrigators' sensitivity to this issue by asking

108. Positive and negative impacts of water transfers are often expressed in economic, environmental, recreational, and social terms. Economic effects, measured at the firm or sector level, include impacts on incomes, jobs and business opportunities that can have positive and negative contributions on local, regional and state economies. One study found that third-party impacts, though a valid concern and deserving of attention, were overstated in the public debate. In this study, the types of crops affected, the level of agricultural production disrupted, and the resulting employment losses were small compared to the historical fluctuations within agriculture. An employment loss in agriculture will be offset many times over by the creation of new jobs in urban areas. *See, e.g.*, Harold Carter et al., eds., *supra* note 82.

These effects can extend to the fiscal conditions of state and local governments. For example in La Paz County Arizona, the purchase of water farms (farms with appurtenant water rights) by one municipality removed 10 percent of the taxable land from its tax base. This potentially could increase county tax rates and place a heavier burden on remaining taxpayers. *See* Susan Nunn & Helen Ingram, *Information, the Decision Forum and Third-Party Effects in Water Transfers*, 24 WATER RESOURCES RES. 473-480 (1988)].

Social impacts tend to be non-economic, intangible and difficult to measure. Intangible impacts include changes in; (1) the quality of community life, (2) political empowerment, (3) connectedness to the land and (4) a sense of community. Rural

if they would prefer to keep water in agricultural use rather than transfer it to urban use. Analysis of the irrigator responses indicates that they favor sales to other ag-users (irrigators and ranchers) more than they favor transfers to other groups.[109] Sixty-four percent of irrigators either favored or strongly favored transfers to both irrigators and ranchers. Electric power providers were their second most frequent choice (43 percent), followed by municipalities (39 percent), industries and government agencies (32 percent).

Since the marketing literature indicated that purely economic forces might drive the sale or lease of water rights, we asked respondents if they would be willing to sell water rights to any willing buyer if the price were right. Nearly half of the irrigators indicated that they would sell water to the highest bidder.

Thus a number of irrigators are caught on the horns of a dilemma. They can personally make more money by transferring their water to cities and industries but in so doing they risk harming their community. This suggests that there may be a myth and a reality to farmer economic behavior when it comes to water transfers. The myth may be that farmers act as economic optimizers in seeking to balance individual and community interests benefits and costs in transfers and the reality may be that many act as individual economic maximizers.

One social and economic impact study of possible agricultural to urban water transfers in Medina and Uvalde sought to measure this community impact. The study projected that business economic output in

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communities, individuals and the courts are taking stands to provide a modicum of legal protection for an agricultural lifestyle threatened by transfer of water rights. In a celebrated New Mexico case involving the sale of 75 acre-feet of agricultural water rights to a ski resort, local irrigators challenged the transfers claiming that it was contrary to the public welfare. The trial court judge overturned the state engineer's approval of the transfer, finding that although the proposed ski resort would bring additional jobs that over the long run, the local inhabitants lose management jobs to outsiders and are relegated to tourism service jobs such as waiter and maids. The judge's ruling held that greater economic benefits are not always more desirable than preservation of cultural identity. The trial judge was later reversed by the New Mexico court of appeals based on the fact that the specific public interest language was not added until after the application to transfer was filed. *See In re* Application of Sleeper, No. RA84-53(c), slip op. (N.M. 1st Jud. Dist., Apr. 16, 1985), *rev'd*, 760 P.2d 787 (N.M. App. 1988), *cert. quashed*, 759 P.2d 200 (1988).

109. Respondents were asked if they (1) strongly favor, (2) favor, (3) neither favor nor oppose, (4) oppose, or (5) strongly oppose selling or leasing water rights to certain users including irrigators, ranchers, municipalities, industries, hydroelectric power providers, environmental interests, government agencies, or other private interests. To test the hypothesis, we constructed an "agricultural use" scale (AGUSE). This scale was constructed by taking the mean responses to preferences for transfers to irrigators and ranchers. A reliability test (Cronbach's alpha) for this scale was .917, indicating that the scale is very reliable and that the items are in fact correlated.

the two counties might decrease by $67 million, that 900 jobs might be lost and population might decrease by up to 2,200 people.[110] A limitation of this analysis is that it only examined negative community impacts in Medina and Uvalde counties and did not examine benefits to those communities receiving the transferred water.[111]

3. Transaction Assessments—The Hesitant Irrigator & the Willing City

Irrigators may be worried about the economic, environmental and social consequences to their communities if they transfer water to cities, but they are less interested in determining and revealing these impacts than are cities.[112] (Table 3). Cities were most convinced that specific impact assessments should be completed prior to transfer approval, while less than half of irrigators and industrial respondents held this view.[113]

Respondents were asked to express preferences as to who should be responsible for conducting and reviewing the results of impact assessment. Irrigators tended to favor local control whereas cities and industries favored state oversight, but the differences between them were small.[114]

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110. BBC RESEARCH & CONSULTING, SOCIAL AND ECONOMIC IMPACTS OF WATER TRANSFERS: A CASE STUDY OF THE EDWARDS AQUIFER XIII-4 (1996).

111. *Id.*, at VI-2.

112. Pairwise comparisons of responses to the questions about economic impact assessment showed that municipalities' responses were significantly different from irrigators' ($p = .004$) and industries' ($p = .000$). Regarding environmental impact assessment, municipalities' responses were also significantly different from irrigators ($p=.037$) and industries ($p = .000$). There were also statistically significant differences in responses regarding social impact assessment between municipalities and irrigators ($p = .001$). As in previous pairwise comparisons, these tests of significance were performed at the .05 level.

113. There were statistically significant differences between groups' responses to this question (alpha = .05, critical value (df,2) = 5.99, chi-square = 16.07, $p = .000$). Pairwise testing showed that municipalities' responses were significantly different than irrigators ($p = .000$) and industries ($p = .001$) at the .05 level.

114. Twenty-three percent of irrigators, twenty-five percent of municipalities, and nineteen percent of industries believed that the Edwards Aquifer Authority should be the agency primarily responsible for economic impact assessments. Twenty-three percent of irrigators said that the seller should be responsible, and thirty-one percent of municipalities favored state government. Twenty-five percent of industries favored local government. There were no statistically significant differences between groups' responses to this question (alpha = .05, critical value (df, 2) = 5.99, chi-square = .63, $p = .73$).

Environmental impact assessments showed a similar pattern. When asked exactly who should be responsible for the EIS, forty-six percent of irrigators indicated that the Edwards Aquifer Authority should be responsible, as opposed to twenty-six percent of municipalities and twenty-seven percent of industries. Municipal and industrial responses were also high in the state government category (twenty-nine and forty percent respectively). There were no statistically significant differences between groups' responses to this question (alpha = .05, critical value (df,2) = 5.99, chi-square = 2.02, $p = .37$).

The reluctance of irrigators to reveal their participation in water transfer transactions was also present in the 1997 Irrigation Suspension Plan.[115] Irrigators sought, without success, to have their identities and payment schedules protected from public disclosure by the Edwards Aquifer Authority.[116]

Table 3. Types of impact assessments favored by respondents.

ASSESSMENT	Irrigators		Municipalities		Industries	
	Freq.	%	Freq.	%	Freq.	%
Economic	13	46	32	86	16	44
Environmental	13	46	31	84	15	42
Social	11	39	27	73	11	31

4. Transaction Oversight and Supervision

While the Authority has the regulatory responsibility for water transfer oversight,[117] pumpers in the Edwards Aquifer region place varying levels of importance on the need for transfer oversight. Not surprisingly, irrigators want little or no oversight over transfers while cities and industries are willing to accept greater control. Only 39 percent of irrigators, as contrasted with 50 percent of industries and 89 percent of municipalities, indicated that some kind of prior approval process is in fact necessary.[118] Correspondingly, there was no consensus between the groups surveyed as to who should take on the responsibility of transaction

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Respondents seemed less sure about social impact assessments than they were about the others, but thirty-nine percent of irrigators, seventy-three percent of municipalities and thirty-one percent of industries believed a social impact assessment should be completed prior to transfer approval). As was the case for environmental impact assessment, irrigators tended to favor the Edwards Aquifer Authority (thirty-six percent), whereas municipal and industrial respondents favored state government (twenty-six and thirty-six percent respectively). There were no statistically significant differences between groups' responses to this question (alpha = .05, critical value (df,2) = 5.99, chi-square = .04, p = .98).

115. See *infra* Part IV.C, for a discussion of this program.

116. Interview with Greg Ellis, General Manager, Edwards Aquifer Auth. in Austin, Tex. (Oct. 23, 1997).

117. While the Act does not explicitly grant the Authority the power to review and approve permit transfers, this power could be inferred from sections 1.08, 1.11, 1.15, 1.22, 1.34 & 1.35 of the Act. *See* S.B. 1477, *supra* note 55.

118. There were statistically significant differences between groups' responses to transaction oversight. (alpha=.05, critical value =5.99, chi square=16.07, p=.000). Pairwise testing indicated that municipal responses were significantly different than irrigators (p=.000) and industries (p=.001) at the .05 level.

oversight. However, forty-five percent of irrigators, thirty percent of municipalities and thirty-nine percent of industries favored the Edwards Aquifer Authority as the entity primarily responsible for such oversight (Table 4).

Table 4. Agency most responsible for transfer approval.

APPROVALS	Irrigators		Municipalities		Industries	
	Freq.	%	Freq.	%	Freq.	%
State	0	0	12	36	3	17
County	2	18	1	3	3	17
City	0	0	2	6	1	6
Groundwater dist.	0	0	3	9	1	6
Edwards Aq. Auth.	5	46	10	31	7	39
Landowners	4	36	2	6	2	11
Don't Know	0	0	3	9	1	6

The willingness of some Edwards Aquifer irrigators, and municipalities to transfer water in the Edwards Aquifer was reinforced in 1997 by the expression of interest in the Irrigation Suspension Plan instituted by the Edwards Aquifer Authority. More than 100 irrigators made offers to participate in the program.

C. THE 1997 IRRIGATION SUSPENSION PLAN

In late-1996 and early-1997, the Authority instituted a water bank, known as the Irrigation Suspension Plan, as a hedge against a summer drought.[119] Under this voluntary program, the Authority obtained pledges from selected irrigators in Bexar, Medina, Uvalde, Comal and Atascosa counties to forgo irrigating crops during the summer of 1997. The Authority received offers from 117 farmers covering 25,987 acres of irrigated land. About 95 percent of the offers came from farmers in Bexar and Medina counties. The Authority used a scoring matrix that included

119. The program used the dry year option as a management tool to reduce irrigation demand from the Edwards during a drought. It is a financial inducement to farmers for voluntary suspension of irrigation in exchange for a specified payment. An agreement would give a buyer the option to suspend the farmers' irrigation use for a specified drought period. Municipal and industrial users of Edwards water are potential purchasers of this water. *See* G. E. ROTHE COMPANY, INC., A PILOT DRY YEAR OPTION PROGRAM TO REDUCE EDWARDS AQUIFER IRRIGATION DEMAND IN 1996, (report prepared for the Edwards Aquifer Liaison Committee members in Cooperation with the San Antonio Water System and the Guadalupe-Blanco River Authority, 1996)

price, well location, type of irrigation equipment, types of crops grown and commitment to grow a dryland crop to winnow the list down to 40 irrigators.[120] Ultimately, 40 irrigators were paid an amount ranging from $40 to $750 an acre to not irrigated about 10,000 acres of land.[121] This program resulted in a theoretical savings of 20,000 acre feet of water, about half of which would be used to insure minimum springflows and the other half to be available for pumping.

Some 30 contributing cities, counties, water purveyors and businesses provided about $2.4 million in funding for the bank.[122] Calculations of the monetary contribution for each purchaser were generally determined based on their 1995 pumpage as a percentage of total pumping.[123] Some contributors, such as the city of Victoria and the Guadalupe-Blanco River Authority, do not pump from the Aquifer, but are located downstream of springs that emanate from the Aquifer. They made payments hoping that the effort would maintain springflows.[124] In exchange for these payments, contributors to the bank would be allowed to pump 140 percent of their winter allowance rather than the 130 percent allowed under the drought stage. That 10 percent difference ranges from 14 million gallons per day for San Antonio to thousands of gallons per day for smaller cities.[125]

It is difficult to assess the success of this pilot banking program, as fortuitous summer rains replenished the aquifer and provided much needed water for farmers. From an agricultural perspective, the program was very successful because 40 irrigators received windfall payments of some $ 2.3 million not to irrigate and mother nature provided moisture for the crops that otherwise would not have been available.

Unknowns further complicate program assessment over aquifer transmission. Until the geology is better understood, it is difficult to determine whether a reduction in pumping in Medina and Uvalde Counties actually produces a corresponding and measurable increase in water for pumpers in Bexar County. The Authority is attempting to gauge

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120. *See* Jerry Needham, *117 Farmers Interested in Water-for-Cash Swap*, SAN ANTONIO EXPRESS NEWS, Jan. 11, 1997, at 1B.

121. *Id.*

122. The Authority retained about 3 percent of the $ 2.4 million to cover administrative costs and the remainder was distributed to 40 farmers. *See* Chuck McCollough, *EAA Plans to Purchase irrigation Rights from Farmers*, SAN ANTONIO EXPRESS NEWS, Jan. 29, 1997, at 1.

123. *Id.*

124. *See* Jerry Needham, *No-Irrigation Payments for Farmers Starts: Aquifer Pilot Program Covers 5 Counties*, SAN ANTONIO EXPRESS NEWS, Feb. 7, 1997, at 1B.

125. *See* McCollough, *supra* note 122.

the transmissive nature of the Aquifer in Medina County by drilling test wells to monitor water flow.[126]

V. CONCLUSION

The long political war over the management and regulation of the Edwards Aquifer ended in Austin with the passage of the Edwards Aquifer Authority Act; what remains are economic, legal and emotional skirmishes over the nuances of management and the distribution consequences of that management. The new challenge for Edwards Aquifer stakeholders and for the Authority will be to find common ground for developing negotiated solutions to reallocating water where the benefits of cooperation exceed the rewards of rivalry. A market system, driven by enlightened economic self-interest and tempered by regulatory oversight to minimize externalities and balance equity, can provide a mechanism to help meet this challenge.

Water markets require a nexus between legal, institutional, economic and conveyance factors to insure the transfer of water. While water scarcity, limitations on use and increasing demand drive the need for markets, laws and institutions shape markets and determine their ultimate success. As this paper suggests, these factors are coalescing in the Edwards Aquifer region so that water marketing paradigm could develop. That market will undoubtedly be driven by drought and shaped by the Edwards Aquifer Authority.[127] The transfer rules and individual pumping permits that will be issued by the Edwards Aquifer Authority will in great part determine not only the shape of water markets but also their speed in developing. It is likely to take five to ten years for staff to review the more than 900 pending applications for withdrawals from the Aquifer. This suggests that, absent a drought or some other stimuli, a stable market transfer system for the Edwards Aquifer region may still be a few years away.

Based not only on the results of this "willingness to market" study but also on the experiences with the 1997 Irrigation Suspension Plan, greater institutional promotion and education may be required to promote the development of water markets. While the Edwards Aquifer Authority is to be lauded for leading in the development of the Irrigation Suspension Plan,

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126. Interview with Greg Ellis, General Manager, Edwards Aquifer Auth. in Austin, Tex. (Oct. 23, 1997).

127. Experience in the West suggests that water markets have largely been confined to drought water banks and intraorganization sales. Most states suffer from a dearth of transfers other than at the intraorganization level, or within the confines of a small geographical scale. *See* WATER MARKETING—THE NEXT GENERATION (Terry Anderson & Peter Hill eds., 1997); Kaiser, *supra* note 87; SAX ET AL., *supra* note 100; Barton Thompson, *Institutional Perspective on Water Markets*, 81 CAL. L. REV. 671 (1993). *But cf.* 1 MACDONNELL, *supra* note 96.

the potential for market and regulatory mischief is present when a regulatory agency seeks to act as a brokerage agency. One way to overcome this potential problem is for the State Water Bank to assume leadership in promoting and facilitating market transfers in the Edwards Aquifer region.[128] Institutional intransigence and lack of funding seems to be the major reason that the Bank has not developed to its statutory potential. Leadership and legislative prompting may energize the Bank to take a more proactive role in the Edwards Aquifer region.

Market transfers are not an elixir for all of the region's water problems. However, they provide a means to respond to changing economic, environmental and social water needs in a way that helps ensure that water is put to its highest and best use. The Edwards Aquifer Authority has a number of planning, regulatory and managerial tools in its statutory tool box that should be used in combination with market transfers to allocate water in the Edwards in ways that minimize economic, political and social instability.

Eventually, the region may well face another Faustian choice so that markets alone will not resolve allocation conflicts. The time may come when water is so scarce and ecological demands are so great that people may face the divestiture of tangible lifestyles to protect intangible species.

128. The Texas Water Dev. Bd. has been authorized to establish and administer a bank to facilitate the transfer of water among willing buyers and sellers. This authority extends to surface and groundwater as well as water saved through conservation practices. *See* TEXAS WATER CODE ANN. §§ 15.701-708 (West Supp. 1998)