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Cover photo: An artesian well, belonging to catfish farmer Ronnie Pucek, in the Edwards Aquifer in 1993. © Peter Essick

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The Edwards Aquifer Water Wars: The Final Chapter?

Robert L. Gulley[1,2], Jenna B. Cantwell[1,2]

Abstract: On December 28, 2011, the Edwards Aquifer Authority's Board of Directors approved the recommendations of the Edwards Aquifer Recovery Implementation Program with respect to a historic Habitat Conservation Plan. The Habitat Conservation Plan could resolve decades of acrimonious rancor and litigation over the use of the Edwards Aquifer. It provides the protection required by the federal Endangered Species Act for 8 listed species stemming from the use of the Edwards Aquifer and associated Comal and San Marcos springs while recognizing the region's ever-growing need for water. The plan was developed by a diverse group of stakeholders through a consensus-based process and submitted to the U.S. Fish and Wildlife Service on January 5, 2012, in support of the Edwards Aquifer Recovery Implementation Program's application for an Incidental Take Permit. The U.S. Fish and Wildlife Service noticed the availability of the Draft Environmental Impact Statement for public comment and conducted 7 public meetings to receive public comment. The public comment period closed on October 18, 2012. On February 15, 2013, the U. S. Fish and Wildlife Service issued its Record of Decision approving the issuance of the Incidental Take Permit and the Habitat Conservation Plan. This paper discusses the history of the dispute over the use of the aquifer, previous attempts to resolve the dispute, the strategic plan for protecting the aquifer, and the decision-making process used to develop the plan.

Keywords: Edwards Aquifer, groundwater, Endangered Species Act, Habitat Conservation Plan

[1] The authors are currently employed by the Edwards Aquifer Authority and are involved in the implementation of the Edwards Aquifer Habitat Conservation Plan. This paper was prepared while the authors were employed at Texas A&M Institute of Renewable Natural Resources. The views in this paper are those of the authors and do not reflect the views of the Edwards Aquifer Authority or its Board of Directors.

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Terms used in paper

Short name or acronym	Descriptive name
AMP	Adaptive Management Process
AMFs	Aquifer Management Fees
ASR	Aquifer Storage and Recovery
CPM	Critical Period Management
DEIS	Draft Environmental Impact Statement
EAA	Edwards Aquifer Authority
EARIP	Edwards Aquifer Recovery Implementation Program
ESA	Endangered Species Act
FMA	Funding and Management Agreement
FWS	U.S. Fish and Wildlife Service
GBRA	Guadalupe-Blanco River Authority
HCP	Habitat Conservation Plan
IA	Implementing Agreement
IRP	Initial Regular Permit
ITP	Incidental Take Permit
NMFS	National Marine Fisheries Service
SAWS	San Antonio Water System

"At a time when dysfunction marks the upper levels of American government and politics, the Edwards region found a way to compromise and meet the needs of a hugely diverse set of interests." - San Antonio Express-News Editorial Board, "Aquifer Plan a Major Success," December 29, 2011

INTRODUCTION

For over 2 decades, the Edwards Aquifer region of central Texas has been deeply divided over how to balance the needs of species listed under the federal Endangered Species Act (ESA) that reside in the Comal and San Marcos spring systems with the water needs of the people supplied by the aquifer. In 2006, the U.S. Fish & Wildlife Service (FWS) brought together stakeholders from throughout the region to develop a consensus-based plan to contribute to the recovery of the federally listed species while accommodating the needs of the region for water. Subsequently, the Texas Legislature mandated that the Edwards Aquifer Authority (EAA) and 4 state agencies participate in the stakeholder process.

Entering into the process, the stakeholders had their doubts that this process would succeed where other similar attempts to find a solution had failed.[1] Four years later, the Edwards Aquifer Recovery Implementation Program (EARIP) made it possible for the Edwards Aquifer region to maintain control of this important resource. This article describes the history of the disputes against which the stakeholders had to reach their decisions; the plan they came up with; why the process was successful in overcoming the obstacles; and why this may be the final chapter in the long saga of the Edwards Aquifer's water wars.

BACKGROUND

Edwards Aquifer system

The Edwards Aquifer is a unique karst aquifer flowing 180 miles through highly porous limestone. It is an artesian aquifer, meaning the water is contained underground under pressure, which forces the water upwards through wells and natural springs.

The aquifer is the primary source of drinking water for more than 2 million people in south central Texas and serves the domestic, agricultural, industrial, and recreational needs of the area. It is the source of the 2 largest springs remaining in Texas: the Comal and San Marcos springs. These springs are vital to several protected species and feed tributaries to the Guadalupe River that, in turn, provide freshwater inflows to bays and estuaries on the Gulf Coast.

The FWS has listed 8 species that depend directly on water in or discharged from the Edwards Aquifer system. These species include the fountain darter, San Marcos salamander, San Marcos gambusia,[2] Texas blind salamander, Peck's cave amphipod, Comal Springs dryopid beetle, Comal Springs riffle beetle, and Texas wild-rice. The primary threat to these species is the intermittent loss of habitat from reduced springflows that is the combined result of naturally fluctuating rainfall patterns, regional intermittent pumping, and temporal drawdown of the aquifer. Other threats include invasive non-native species, recreational activities, predation, habitat destruction or modification by humans, and factors that decrease water quality.

The drought of record in the Edwards region occurred between 1947 and 1957. The minimum rainfall during this period was 11.22 inches in 1956.[3] This was well below the historical mean rainfall in the region. On June 13, 1956, measured spring discharge at Comal Springs ceased for 144 consecutive days.[4] Due largely to this cessation of flows, the fountain darter population in the Comal Springs system was extirpated.[5] The San Marcos Springs never completely stopped flowing, allowing for fountain darters to be successfully reintroduced into the Comal River from the San Marcos River in the mid-1970s.[6]

Texas Water Law

In Texas, the administration of water rights depends on the type of water in question—surface water or groundwater. Texas' water law is a legacy of having been ruled by 6 different legal codes since Spain first claimed the territory in 1519. While the existence and movements of surface water were straightforward, groundwater was mysterious. As a result,

[1] Joy Nicolopoulos, currently the FWS Deputy Regional Director for Region 2 and the person responsible for bringing the stakeholders together, subsequently admitted, "Politically, nobody gave this a snowball's chance." Colin McDonald, "Lawyer was the bridge over troubled waters," San Antonio Express-News, January 15, 2012.

[2] The San Marcos gambusia has not been seen since 1982 and may be extinct.

[3] Edwards Aquifer Recovery Implementation Program, "Habitat Conservation Program," December 2011 (HCP) at 3-16. http://www.eahcp.org/files/uploads/Final20HCP.pdf

[4] Todd Votteler, "Water from a Stone: The limits of the sustainable development of the Texas Edwards Aquifer" Southwest Texas State University, February 2000.

[5] John R. Schenk and B.G. Whiteside, "Distribution, habitat preference, and population size estimate of *Etheostoma fonticola*," 76(4) Coepia, 697, 700 (1976).

[6] *Id.*

divergent regulatory schemes developed for the 2.

Surface water is governed by the "prior appropriation doctrine," which is common in most western states. Under this doctrine, the State of Texas owns all surface water in trust for the benefit of its people, subject to a state-granted right to use. Ronald A. Kaiser, Texas Water Research Institute, "*Handbook of Texas Water Law: Problems and Needs*," (1987) at 19. The State grants permission through an administrative process to beneficially use the water on a seniority basis. *Id.* at 22.

Under Texas common law, groundwater is governed by the "rule of capture." Under this doctrine, a landowner may drill a well to seek groundwater, withdraw any groundwater that may be encountered, and place the water to beneficial use without significant limitation as to amount, place, or purpose. Kaiser at 32. Moreover, this common law privilege may generally be exercised without regard for any negative impacts to adjacent landowners or springflows. *Id.*

In February 2012, the Texas Supreme Court, in a long-awaited ruling, held that landowners own the groundwater beneath their property and that this property right is constitutionally protected. *Edwards Aquifer Authority v. Day* (slip op., No. 0964) (Feb. 14, 2012) at 1. The Court found that the use of groundwater can be regulated but that regulation is subject to compensation if the right is "taken." *Id.* at 27.

As coexisting legal frameworks, the prior appropriation doctrine and rule of capture do not encourage conjunctive use of groundwater and surface water. *See* Todd H. Votteler, "Raiders of the Lost Aquifer? Or the Beginning of the End of Fifty Years of Conflict over the Texas Edwards Aquifer," 15 Tulane Environmental Law Journal, 257, 267 (2002). In fact, since the 1950s, the aquifer users and downstream surface water users have been at odds over the need to regulate the use of the aquifer to protect downstream surface flows. As discussed below, in *Sierra Club v. Babbitt*, the ESA was used to obtain limitations on pumping to benefit surface water users.

The Endangered Species Act

The ESA provides the federal government authority to protect threatened and endangered species from both federal and non-federal actions. Endangered Species Act, Pub. L. No. 93-205, 87 Stat. 884 (1973), codified at 16 U.S.C. §§ 1531-1544. The U.S. Secretary of the Interior, through the FWS or the Secretary of Commerce, through the National Marine Fisheries Service (NMFS), administers and enforces the ESA. 16 U.S.C. § 1533; 50 C.F.R. § 222.101 and 50 C.F.R. § 17.01.[7] For purposes of this article, the pertinent provisions are found in sections 9 and 10 of the ESA.

Section 9 of the ESA

Section 9 of the ESA prohibits the "take" of listed endangered fish and wildlife. 16 U.S.C. § 1538(a)(1). "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct." 16 U.S.C. § 1532(19). "Harm" includes significant habitat modification that actually kills or injures a listed species through impairing essential behavior such as breeding, feeding, or sheltering. 50 C.F.R. § 17.3; *Babbitt v. Sweet Home Chapter of Communities for a Greater Or,* 515 U.S. 687 (1995). Listed plants are not subject to the "take" prohibition in Section 9. However, under Section 9, plants listed as endangered may not be imported into or exported from the United States, removed from, or damaged on federal property, used in commercial activities, or removed or damaged from any area in knowing violation of any state law or regulation.[8] 16 U.S.C. § 1538(a)(2).

Enforcement of fish and wildlife violations under Section 9 may come in the form of civil penalties. U.S.C. § 1540. Knowing violations may trigger criminal fines and imprisonment of less than 1 year, and injunctions. 16 U.S.C. § 1540(b). Citizen suits to enjoin violation or compel action of the Secretary are also allowed. 16 U.S.C. § 1540(g).

Courts have found that a regulatory agency's actions or failures to act may violate the ESA. For example, the First Circuit found that Massachusetts's fishing regulations caused a "take" of the endangered Northern Right whales.[9] *Strahan v. Coxe*, 127 F.3d 155, 166 (1st Cir. 1997). The state had authorized gillnet and lobster pot fishing in the whales' critical habitat, but the NMFS had issued a final interim rule proposing to modify those fishing practices as entanglement with fishing gear was a leading cause of depletion of the whales. *Id*. at 159. The court found that the ESA not only prohibits the acts of the person causing a take but also bans the acts of a third party that bring about the taking, *i.e.*, vicarious liability. *Id*. at 163 citing 16 U.S.C. § §1538(a)(1)(B). The court concluded "a governmental third party pursuant to whose authority an actor directly exacts a taking of an endangered species may be deemed to have violated the provisions of the ESA." *Id*.

[7] The species at the Comal and San Marcos springs are regulated by FWS, which is within the Department of the Interior. Thus, the use of the term "Secretary" herein refers to the Secretary of the Interior.

[8] *See infra* at n. 37.

[9] *See Palila v. Hawaii Department of Land and Natural Resources*, 639 F.2d 495 (9th Cir. 1981) (Hawaii Department of Land and Natural Resources liable for "take" of Palila bird by failing to manage herds of feral sheep and goats); *Loggerhead Turtle v. County Council of Volusia County*, 148 F.3d 123, 1251 (11th Cir. 1998) (Volusia County may be liable for take resulting from its regulatory actions); *see also Sierra Club v. Yeutter*, 926 F.2d 429 (5th Cir. 1991) (U.S. Forest Service's even-aged management practices violated section 9 of the ESA); *Defenders of Wildlife v. Administrator, EPA*, 882 F.2d 1294 (8th Cir. 1989) (Environmental Protection Agency liable for take of the endangered black-footed ferret due to its pesticide registration program).

Section 10(a) of the ESA

Section 10(a) of the ESA provides relief under certain circumstances from federal or citizen suits alleging violations of Section 9. For example, permits may be issued that allow a taking if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 16 U.S.C. § 1539(a)(1)(B). These permits are referred to as incidental take permits (ITPs).

An ITP must have an approved conservation plan, commonly known as a Habitat Conservation Plan (HCP). *Id.* The HCP must specify the likely impact of the taking; the steps the applicant will take to minimize and mitigate such impacts and the funding available for the steps; the alternative actions considered and the reason why such alternatives are not being used; and such other measures the Secretary may require as necessary or appropriate. 16 U.S.C. § 1539(a)(2)(A)(i)-(iv); 50 C.F.R. § 17.22(b)(iii). An ITP will be issued if the Secretary finds that the taking will be incidental; the applicant, to the maximum extent practicable, will minimize and mitigate the impacts of the taking; the applicant ensures funding for the HCP; the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and the applicant assures the HCP will be implemented. 16 U.S.C. § 10(a)(2)(B); 50 C.F.R. §§ 17.22(b)(2) and 17.32(b)(2).

While the ESA does not prohibit the taking of listed plants on non-federal land, a HCP may need to include conservation measures to protect listed plant species as the ESA requires that the FWS consider, in its Section 7[10] biological opinion regarding its issuance of the permit, impacts to any listed species, including plants. 16 U.S.C. § 1536(c). Once an incidental take permit has been issued, so long as the permittee complies with the terms of the permit, the FWS may not require the commitment of additional funding or resources from the permit holder for changed or unforeseen circumstances. 50 C.F.R. §§ 17.32(b)(5)(iii)(B). This is often referred to as the "no surprises" rule.

The use of the ESA to protect surface water rights from groundwater pumping was put to the test when the Sierra Club sued the FWS for failing to protect the endangered species located in the San Marcos and Comal springs. *See infra* at n. 12.

Section 7 of the ESA

Section 7(a)(2) requires all federal agencies, in consultation with the FWS, to ensure that any action "authorized, funded, or carried out" by an agency is "not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification" of designated critical habitat. The issuance of an ITP is a federal action subject to Section 7 of the ESA.

While the ESA does not define "jeopardy," federal regulations define it as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery[11] of a listed species in the wild by reducing the reproduction, numbers or distribution of that species." 50 C.F.R. § 402.02. To determine whether the effects of the incidental take will appreciably reduce the likelihood of the survival and recovery of the listed species, the direct and indirect effects of the action and the cumulative effects are aggregated with the environmental baseline. *Id.* It is important to note that, unlike the Prohibition in Section 9 of the ESA that applies to individual members of a listed species, the Section 7 analysis looks at the effects of the action on the species as a whole.

The ESA describes critical habitat as those areas that contain the "physical or biological features 1) essential to the conservation of the species and 2) which may require special management considerations or protection." 16 U.S.C. § 1532(5)(A)(i). FWS regulations identify the "constituent elements" of critical habitat to include "those that are essential to the conservation of the species," such as "roost sites, nesting grounds, spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, host species or plant pollinator, geological formation, vegetation type, tide, and specific soil types." 50 C.F.R. § 424.12.

The results of the Section 7 consultation are documented in biological opinions developed by the FWS. A biological opinion is generally produced near the end of the ESA permitting process to document conclusions regarding the likelihood of jeopardizing the continued existence of, destroying, or adversely modifying designated critical habitat for, any listed species.

SIERRA CLUB V. BABBITT

In 1991, the Sierra Club brought a suit in the U.S. District Court for the Western District of Texas against the FWS, *Sierra Club v. Babbitt* (No. MO-91-CA-069, U.S. Dist. Ct., W.D. Texas). The suit alleged that the FWS had violated the take prohibition in Section 9 of the ESA by failing to protect the federally listed species in the Comal and San Marcos springs.[12] Following a non-jury trial, the court ruled in favor

[10] *See* Section 7 of the ESA heading.

[11] The term "recovery" means "improvement in the status of a listed species to the point at which listing is no longer appropriate." 50 C.F.R. § 402.02.

[12] The Guadalupe-Blanco River Authority (GBRA) was a plaintiff-intervener in the suit. In an interview, the former GBRA General Manager, John Specht, stated that GBRA's motivation in *Sierra Club v. Babbitt* was to pro-

of the plaintiff. *Sierra Club v. Lujan*, 1993 WL 151353 (W.D. Tex.) (May 26, 1993), *sub nom, Sierra Club v. Babbitt*, 995 F. 2d 571 (1993).

In his decision, Lucius Bunton, the presiding judge, made it clear that he expected the Texas Legislature, then in session, to act immediately to protect the species. *Sierra Club v. Babbitt,* Amended Findings of Fact and Conclusions of Law, May 26, 1993 (Amended Findings) at 69 ("The next session of the Texas Legislature offers the last chance for adoption of an adequate state plan before the 'blunt axes' of Federal intervention have to be dropped."); *id.* at 56 ("Even the USFWS now agrees that if Texas does not establish adequate pumping controls in the next regular session of the Texas Legislature, which began in January of 1993, the 'blunt axe' must fall."). The Court explained that it would allow plaintiff and plaintiff-interveners to seek appropriate relief immediately after the Legislative session ended "*if the State of Texas does not have in effect at such time* … a regulatory system pursuant to which withdrawals from the Edwards Aquifer can and will be limited to whatever extent may be required to avoid unlawful takings of listed species, any appreciable reduction in the likelihood of survival and recovery of listed species in the wild, and any appreciable diminution of the value of critical habitat for the survival and recovery of the species, even in a repeat of the drought of record." *Sierra Club v. Babbitt*, Amended Judgment at 6 (emphasis in original).

In the Court's Amended Findings of Fact, the Court repeatedly emphasized the importance of continuous minimum springflows in protecting the listed species.

> The endangered or threatened species living either at or downstream of the Comal and San Marcos Springs or in the Edwards rely on adequate and continuous natural flows of fresh water through the Edwards and exiting from the natural spring openings as an environment for their survival.

Sierra Club v. Babbitt, Amended Findings of Fact, May 26, 1993 at 10-11; *see also id.* at 17, 28, 32, 34, 45 and 56. Further, Judge Bunton found that the FWS had not identified the necessary minimum flows to be maintained. *See e.g., Sierra Club v. Babbitt*, Amended Findings at 48. Judge Bunton equated the necessary minimum flows with the jeopardy levels. *See*, *e.g.*, *id*. at 48 ("At a minimum, the objective requires pumping controls to avoid jeopardy to the species by maintaining aquifer levels which assure a minimum spring flow at Comal Springs,").

The Court ordered the FWS to make, within 45 days, determinations relative to: 1) the springflow levels at which take of fountain darters and Texas blind salamanders begins at Comal and San Marcos springs, 2) springflows necessary to avoid appreciable diminution of the value of critical habitat of any listed species; 3) the springflow at which Texas wild-rice begins to be damaged or destroyed; 4) the minimum springflow to avoid jeopardy for the fountain darter, San Marcos gambusia, San Marcos salamander and Texas blind salamander; and (5) the springflow levels at which take of San Marcos gambusia and the San Marcos salamander begins at San Marcos Springs. *Sierra Club v. Babbitt*, Amended Judgment at 3-4. The Court established "minimum springflow findings" to serve as interim springflow findings until the FWS made its determinations. *Id*. at 2-3. The Court stated that the FWS "may at any time and from time to time modify any of its minimum springflow or Edwards Aquifer level determinations, based on available information and in the exercise of its best professional judgment." *Id.* at 4.

The FWS made the determinations required by the Court[13]. These determinations can be seen in Table 1.[14] Although its response was highly qualified, the FWS explained that because its "take" evaluation was conducted with much less data than are normally available, it was forced to base its determination on its "best professional judgment" and that its determinations were conservative. *Sierra Club v. Babbitt*, "Springflow Determinations Regarding 'Take' of Endangered and Threatened Species," April 15, 1993 at 2. It further explained that as more information becomes available, the numbers [it was providing] "may change to more accurately reflect that best available scientific and commercial information." *Id.*

With respect to jeopardy, the FWS reiterated its concern regarding the "significant gaps in knowledge." *Sierra Club v. Babbitt*, "Springflow Determinations Regarding Survival and Recovery and Critical Habitat of Endangered and Threatened Species," June 15, 1993 at 1. It explained that these gaps resulted in a "conservative approach" regarding the flow estimates. *Id.* The FWS found that flow levels at Comal Springs could be reduced to 60 cubic feet per second for short time periods during certain times of the year without jeopardizing the continued existence of the fountain darter if a "very effective" program to control the giant rams-horn snail was in place and if there was the ability to control the timing and duration of low springflows. *Id*. at 4.

The FWS also found that short-term reductions in flow levels below 100 cubic feet per second might avoid jeopar-

tect the water resources of the Guadalupe River Basin as contrasted with Sierra Club's interest in protecting the listed species. Votteler, 15 Tulane Envt'l Law J. at 274, n. 70. Simply put, according to Mr. Specht, GBRA realized that, if a court were to order pumping cuts to provide springflows to protect listed species, it would perforce protect a significant contribution to existing surface water rights downstream.

[13] *Sierra Club v. Babbitt*, "Springflow Determinations Regarding 'Take' of Endangered and Threatened Species," April 15, 1993; *Sierra Club v. Babbitt*, "Springflow Determinations Regarding Survival and Recovery and Critical Habitat of Endangered and Threatened Species," June 15, 1993.

[14] All figures are placed at the end of this paper.

dy for Texas wild-rice if: 1) exotic species (*e.g.*, nutria) could be effectively controlled; 2) an aquifer management plan is implemented to control timing and duration of lower flows; and 3) the distribution of the species is improved throughout its historic range. *Id*. at 7. The FWS, however, did not specify what flow levels might be acceptable if those conditions were satisfied.

SENATE BILL 1477: TEXAS LEGISLATURE'S RESPONSE TO THE JUDGMENT IN *SIERRA CLUB V. BABBITT*

In response to the judgment in *Sierra Club v. Babbitt*, the Legislature enacted Senate Bill 1477[15] that created the EAA. In effect, the Court's ruling supplanted the common law rule of capture for the Edwards Aquifer in favor of regulation of groundwater by statute.

In S.B. 1477, the Legislature directed the EAA to manage withdrawals from the aquifer. EAA Act § 1.15(a). It prohibited, with certain limited exceptions, withdrawing water from the aquifer without a permit from the EAA. *Id.* at § 1.15(b). Further, it established guaranteed statutory minimum amounts that each qualified permittee would receive. *Id.* at § 1.16(e). It also established specific withdrawal caps, *id.* at §§ 1.14(b) and (c), and required measures to be implemented that would ensure "continuous minimum springflows" to protect the listed species, *id.* at 1.14(h). In addition, S.B. 1477 specifically required the EAA to "prepare and coordinate implementation" of a Critical Period Management (CPM) Plan for periods of drought. *Id.* at § 1.26.

Statutory Minimums

S.B. 1477 required the EAA to issue permits with minimum pumping rights based on historic use and guaranteed specific withdrawal rights for qualifying use. EAA Act § 1.16(e). The Legislature set specific "statutory minimums" for permitting purposes.

> An existing irrigation user shall receive a permit for not less than two acre-feet a year for each acre of land the user actually irrigated in any one calendar year during the historical period. An existing user who has operated a well for three or more years during the historical period shall receive a permit for at least the average amount of water withdrawn annually during the historical period.

EAA Act § 1.16 (e).

Withdrawal Caps

S.B. 1477 not only directed the EAA to limit the permitted withdrawals to 450,000 acre-feet per year, but further required the EAA to prepare and implement a plan for reducing the maximum annual volume of water authorized to be withdrawn under regular permits to 400,000 acre-feet per year beginning January 1, 2008. EAA Act §§ 1.14(b) and (c), *id.* at § 1.21(a). The plan had to be enforceable and include water conservation and reuse measures, measures to retire water rights, and other management measures designed to achieve the necessary reduction levels. *Id*. at § 1.21(b). The Legislature directed the EAA to make proportional adjustments to the amount of water authorized for withdrawal under the permits to meet the amount available. *Id.* § 1.16(e). Each existing user, however, would be guaranteed its statutory minimum withdrawal amount. *Id.*

The Texas Legislature required that the cost of reducing withdrawals or permit retirement to get to the 450,000 acre-foot cap was to be borne solely by the pumpers. *Id*. at § 1.29(a)(1). The cost of retiring the water rights to get from 450,000 to 400,000 acre-feet was to be borne equally by aquifer users and downstream water rights holders. *Id*. at § 1.29(a)(2).[16]

Continuous Minimum Springflows

With respect to continuous minimum flows, S.B. 1477 directed the EAA, by June 1, 1994, to "implement and enforce

[15] Act of May 30, 1993, 73rd Leg., R.S., ch. 626, 1993, Tex. Gen. Laws 2350, as amended (hereinafter "S.B. 1477" or the "EAA Act").

[16] The 450,000 acre-foot and 400,000 acre-foot withdrawal cap requirements do not appear in the Court's Findings or Judgment. In 1992, the Texas Water Commission (TWC) issued a "concept paper" for a comprehensive water management plan based on the J-17 aquifer water elevations. Texas Water Commission, "Avoiding Disaster: An Interim Plan to Manage the Edwards Aquifer," February 18, 1992. In the first 10 years of the plan, when the elevations fell below 666 feet, the total water pumped would be restricted to 450,000 acre-feet. After 10 years, this water use limit would fall to 400,000 acre-feet. 400,000 acre-feet is 80% of the average pumping that occurred between 1934 and 1967 as described in the 1968 State Water Plan. The 1968 Water Plan further explained that 400,000 acre-feet was the necessary amount to maintain a healthy water supply and guarantee the ability of the aquifer to recover following a drought. *See* Votteler "Water from a Stone…". If J-17 fell below 625 feet mean sea level, water use would be reduced to 350,000 acre-feet. *See* Bruce A. McCarl, Wayne Jordan, R. Lynn Williams, Lonnie Jones, and Carl R. Dillion, "Economic and Hydrologic Implications of Proposed Edwards Aquifer Management Plans," March 1993.

The FWS characterized the plan as a "positive step" but criticized the TWC's failure to address the drought of record, noting that Comal Springs would cease to flow for 1 1/2 years. Letter from M.J. Spear, Regional Director, U.S. Fish and Wildlife Service, to John Hall, Chairman, Texas Water Commission, dated March 26, 1992, Attachment, at 1. The FWS explained that once "the Service further refines its opinion on the jeopardy level (i.e., where above 0 cubic feet per second jeopardy occurs), all activities must ensure that the Springs are maintained at or above that level." *Id.* at 2.

water management practices, procedures, and methods to ensure that, by December 31, 2012, the continuous minimum springflows of the Comal Springs and the San Marcos Springs are maintained to protect the endangered and threatened species to the extent required by federal law." EAA Act § 1.14(h).

EAA'S ATTEMPT TO IMPLEMENT THE WITHDRAWAL CAPS REQUIRED BY S.B. 1477

The EAA began processing applications for Initial Regular Permits (IRPs) in 1996. A series of legal challenges, however, delayed the implementation of S.B. 1477. In 1995, the Medina County Underground Conservation District challenged the constitutionality of S.B 1477, alleging that the legislation took a vested property right in groundwater under the land. In 1996, the Texas Supreme Court rejected the claim. *Barshop v. Medina County Underground Conservation District*, 925 S.W.2d 618 (Tex. 1996). In addition, a challenge was filed related to whether S.B. 1477 violated the Voting Rights Act, 42 U.S.C. § 1973. The Texas Legislature resolved the disputed voting rights issues in 1995.[17] In 1998, Living Waters Artesian Springs, LTD, filed suit in District Court in Travis County challenging the EAA pumping limits and its regional drought rules and alleging that the rules did not comply with the Administrative Procedures Act.[18] The Court found in favor of the plaintiff and invalidated the permit rules. In *Bragg v. EAA*,[19] the District argued that the EAA violated Texas Private Real Property Rights Preservation Act by failing to prepare a takings impact assessment before issuing its permit rules. The court invalidated the rules.[20] The EAA did not appeal the judgment, but instead repealed the rules and proposed and partially adopted new ones.

In 2000, EAA had issued a rule requiring a proportional adjustment of all permits if the 450,000 acre-foot cap was exceeded and compensation for affected pumpers for the difference between the statutory minimum at the fair market value for the water.[21] TAC § 711.176(b)(6) (2000). As of November 1, 2003, EAA had approved IRP for 502,517 acre-feet. Hicks & Company, Regulatory Impact Assessment for propose Rules Chapter 711, E (Groundwater Withdrawal Permits), G (Groundwater Available for Permitting: Proportional Adjustment; Equal Percentage Reduction) and K (Additional Groundwater Supplies), December 2003 at 11 (hereinafter "Regulatory Impact Assessment"). Thus, by January 1, 2004,[22] the EAA had to implement these rules to limit withdrawals to 450,000 acre-feet annually (with compensation) or come up with an alternative solution.

The cost of the compensation would have been substantial, even in 2004.[23] In 2003, it was estimated that the cost for an initial purchase of 107,000 acre-feet to reduce permitted withdrawals to 450,000 acre-feet would range from $128,400,000 (if the cost of water was $1,200 per acre-foot) to $214,000,000 (if the cost of water was $2000 per acre-foot). Regulatory Impact Assessment at 35.

Because of the high cost of compensation, the EAA abandoned the compensation rule in December 2003 in favor of an "interruptible/uninterruptible" IRP structure to reduce the permitted withdrawals to 450,000 acre-feet. Resolution and Order No. 12-03-478 attached to the Minutes of the Board of Directors of the Edwards Aquifer Authority (Dec. 16, 2003). Under the rule, the EAA would reduce the total amount of every permitted withdrawal proportionally to bring the authorized amount to 450,000 acre-feet. *Id.* The water rights remaining after the proportional reductions were designated "senior" or "uninterruptable" withdrawal amounts. *Id.* The amount of each permit's reduction between the statutory minimum and the proportionally reduced amount was designated as "junior rights," which could not be used if the levels in J-17 and J-27 fell below certain triggers. EAA Rules § 711.164 (2004).

In January 2007, Texas Attorney General Greg Abbott issued an opinion that concluded the EAA did not have the statutory authority to reduce the withdrawal rights of permit holders or issue interruptible "junior" withdrawal rights below the statutory minimum. Letter from Greg Abbott to the Honorable Harvey Hilderbran, Opinion No. GA 0498, dated January 9, 2007.

[17] Act of May 29, 1995, 75th Leg. R.S. ch 261, Tex. Gen. Laws 2505. A new challenge to how the EAA elects its board was filed in June 2012. *League of United Latin Am. Citizens v. Edwards Aquifer Auth.*, No. 5:12-CV-00620 (W.D. Tex. June 21, 2012).

[18] *Living Water Artesian Springs, LTD. v. Edwards Aquifer Authority*, No. 98-02644 (353rd Dist. Ct. Travis County, Dec. 17, 1998).

[19] *Bragg v. Edwards Aquifer Authority*, No. 98-07-14535CV, 38th State District Court, September 11, 1998. The Court of Appeals vacated in part and reversed and rendered in part. *Bragg v. Edwards Aquifer Authority*, 21 S.W.3d 375 (Tex. App. San Antonio, 2000). The Texas Supreme Court affirmed the court of appeals. *Bragg v. Edwards Aquifer Authority*, 710 S.W. 3d 729 (Tex. 2002).

[20] In Senate Bill 2, the Texas Legislature repealed the requirement that the EAA's rulemaking comply with the Administrative Procedures Act. Act of May 28, 2001, 77th Leg., R.S., ch 966, § 6.01, 2001Tex. Gen. Laws 1991, 2075.

[21] Fair market value of the water would be based on the definition of that term in Section 11.0275 of the Texas Water Code. Regulatory Impact Assessment at 31.

[22] IRPs issued during a year did not become effective until January 1 of the following year.

[23] In October 2002, the EAA offered all irrigation applicants or permittees $600/acre-foot for any water rights they wanted to sell or retire. Regulatory Impact Assessment at 34. Interest in the offer was extremely low. *Id.* at 35.

Thus, in 2007, the withdrawal cap issue was unresolved. Meanwhile, the cost of an acre-foot of Edwards' water had risen to over $5000 per acre-foot. The cost to the pumpers of buying down permits to 450,000 acre-feet and retiring permits to get to 400,000 acre-feet was estimated to be $725 million. The costs to downstream surface water users responsible for one-half of the cost of retiring permits to get from 450,000 to 400,000 acre-feet was $125 million.

EAA'S ATTEMPTS TO IMPLEMENT THE CONTINUOUS MINIMUM SPRINGFLOW REQUIREMENT IN S.B. 1477

When the EARIP HCP is approved and in effect, the EAA will have complied with the continuous minimum springflow requirement in S.B. 1477.[24] EAA, however, was under pressure in the late 1990s with respect to this requirement. In 1998, EAA received notices of intent to sue regarding alleged violations of Section 9 of the ESA. *See*, *e.g.*, Letter from Sierra Club to Edwards Aquifer Authority and Department of Interior, "Notice of Violation of Federal Endangered Species Act and Notice of Intent to Sue, dated August 14, 1998 (alleging, among other things, failure to impose meaningful limits on pumping). In 2000, the FWS also threatened to bring a Section 9 action against EAA.

> As we have communicated to you previously, your current drought management plan provides reductions in aquifer water use that we believe are not sufficient to adequately protect flows to avoid take or jeopardizing the continued existence of listed species. This inadequate regulation of aquifer pumping has likely resulted in illegal take of listed species. Unless EAA takes further actions to reduce pumping to essential uses, the Service will consider enforcement action against your agency for noncompliance with the ESA.

Letter from David C. Fredrick, Supervisor, to Mr. Greg Ellis, General Manager, EAA, dated September 18, 2000.

To address the continuous minimum springflow requirement, the EAA began preparing a HCP in 1999. After more than 5 years, the EAA completed a draft of the HCP in March 2005. Edwards Aquifer Authority, "Draft Edwards Aquifer Authority Habitat Conservation Plan," March 2005. The plan assumed a withdrawal cap of 450,000 acre-feet. It proposed reducing pumping through a 4-stage Drought Management/CPM program. EAA HCP at 5-4. In Stage IV, pumping would be restricted to 346,400 acre-feet if the worst drought conditions were in effect for an entire calendar year. *Id.*

According to the draft plan, a simulation of the historical record with pumping of 450,000 acre-feet and the CPM program predicted that Comal Springs flows would have no flow (*i.e.*, 0 cubic feet per second) for 1,400 days, about 10 times that which was experienced during the actual drought of record. *Id.* at 4-14. Even excluding the drought of record from the analysis, no flows would occur for approximately 100 days. To ensure survival of the species, the EAA HCP relied on off-site refugia and captive propagation rather than deeper reductions during the CPM. *Id*. at 4-15; *but see* 65 Fed. Reg. 56,916, 56,919 (Sept. 20, 2000) ("Controlled propagation is not a substitute for addressing factors responsible for an endangered or threatened species' decline. Therefore, our first priority is to recover wild populations in their natural habitat wherever possible, without resorting to the use of controlled propagation.").[25]

The 346,400 acre-foot floor for the CPM in the EAA HCP, however, ignored the continuous minimum flow requirement in S.B. 1477, the subsequent "jeopardy" determinations by the FWS, and the Court's views of what would be required just to maintain continuous springflows.[26] *Sierra Club v. Babbitt*, Amended Findings of Fact at 71-2. ("Pumping 350,000 acre-feet per year throughout a repeat of the drought of record of the 1950's will cause the Edwards to drop to levels far below the historic low of 612.51 feet mean sea level, dry up Comal Springs for years and San Marcos Springs for substantial periods of time… .").[27] Further, it ignored the comments of its own Biological Advisory Team.

> Biological goals as stated in the EA/HCP do not comply with the Edwards Authority Act 1.14(h), which states the EAA must ensure "the continuous

[24] As part of the compromise that led to the creation of the EARIP, the Texas Legislature removed the requirement that the EAA implement measures prior to December 31, 2012, by removing the June 1, 1994 date. This amendment, however, would not cure any potential violation of Section 9 of the federal ESA.

[25] Unlike the EAA HCP, the EARIP HCP uses the refugia as a safety net in case the assumptions regarding the protectiveness of the measures proved wrong.

[26] In August 1992, the FWS suggested that the TWC consider obtaining an incidental take permit. Letter from M.J. Spear, Regional Director, U.S. Fish and Wildlife Service, to John Hall, Chairman, Texas Water Commission, dated August 19, 1992. The FWS stated that to obtain such a permit, direct pumping from the Aquifer must be limited to no more than 450,000 acre-feet per calendar year; within 10 years, the pumping must be reduced to 400,000 acre-feet and a drought management plan must be in place to reduce pumping to 350,000 acre-feet per year at any time the water level in J-17 fell below 625 feet mean sea level. Id.

[27] See also *Sierra Club v. Babbitt*, Amended Findings of Fact at 70 ("Limiting pumping to an average of roughly 200,000 acre-feet per year during the drought would provide some minimal continuous daily Comal springflows."); *id.* at 71 ("The firm yield of the Edwards, assuming protection of just minimal continuous daily springflows from Comal Springs, is on the order of roughly 200,000 acre-feet per year during a repeat of the drought of record.").

> minimum springflows of the Comal Springs and San Marcos Springs are maintained" for the protection of listed species.

Letter to Robert J. Potts, General Manager, EAA, from Dr. Randall E. Moss, Chairman, Biological Advisory Team, dated January 31, 2005.

Although the HCP would not have provided even continuous springflow during severe drought, the EAA, nonetheless, submitted the draft HCP to the FWS. The EAA, however, did not include the Draft Environmental Impact Statement (DEIS) and other required supporting documentation. Letter from Robert Potts, General Manager, EAA, to Mr. Robert Pine, FWS, dated March 11, 2005 (transmitting the draft HCP). The FWS did not take any action on the submittal.

Thus, as 2007 approached, the EAA had not satisfied the withdrawal cap requirements and had not meaningfully addressed the continuous minimum flow requirement of S.B. 1477.

SENATE BILL 3 AND THE CREATION OF THE EARIP

Midst this gathering storm, in late 2006, the FWS brought together stakeholders from throughout the region to participate in a "recovery implementation program" [28] to develop a plan to contribute to the recovery of the federally listed species dependent upon the Edwards Aquifer. Meanwhile, the Attorney General's opinion on interruptible/non-interruptible rights and the reality of the impending cost of a permit buy-down brought the stakeholders to meetings in Austin during the 2007 legislative session to determine if a compromise could be reached.[29] In May 2007, the Texas Legislature enacted a compromise generally agreed to by the stakeholders as part of Senate Bill 3 (S.B. 3).[30]

Senate Bill 3

S.B. 3 amended the EAA Act to, among other things, provide that ". . . for the period beginning January 1, 2008, the amount of permitted withdrawals from the aquifer may not exceed or be less than 572,000 acre-feet of water per calendar year . . ." EAA Act 1.14(c). This amount constituted the IRPs already issued and those pending as of January 1, 2005. *Id.* Pumping under this withdrawal cap is subject to the CPM withdrawal reduction in the amounts indicated in Tables 1 and 2 of Section 1.26(b) of the EAA Act, which are included in Tables 2 and 3 of this paper.

If the full amount of the 572,000 acre-foot cap is assumed pumped, even with the critical period changes, simulated springflow ceases at Comal Springs for 38 months during a repeat of the drought of record. Habitat Conservation Plan, § 4.2. Indeed, even assuming a 381,000 acre-foot[31] level of pumping, simulated springflow still would cease flowing for 36 months during a repeat of the drought of record. *Id.*

Accordingly, the Legislature directed the EAA and 4 state agencies[32] to "cooperatively develop a recovery implementation program" through a facilitated, consensus-based stakeholder process.[33] S.B. 3 § 1.26A(a). S.B. 3 further directed the EAA and other state agencies to participate in the EARIP and to jointly prepare, along with other stakeholders, a "program document that may be in the form of a habitat conservation plan used in the issuance of an incidental take permit."[34] S.B. 3 § 1.26A(d). It required that the program document provide, among other things, "recommendations for withdrawal adjustments based on a combination of spring discharge rates of the San Marcos and Comal springs and levels at the J-17 and J-27 index wells during critical periods to ensure that federally listed, threatened, and endangered species associated with the aquifer will be protected at all times, including throughout a repeat of the drought of record." *Id.* at § 1.26A(d)(1). In addition, S.B. 3 required that the plan take effect by December 31, 2012. *Id.* at § 1.26A(d)(3).

[28] A "recovery implementation program" is a voluntary, multi-stakeholder initiative developed by the FWS that seeks to balance water use and development with the needs of federally listed species. Such programs were developed under then Secretary Bruce Babbitt to blunt efforts in 1995 to substantially amend the ESA. John D. Echeverria, "No Success Like Failure: The Platte River Collaborative Watershed Planning Process," 25 Wm & Mary Envtl. L. & Pol'y Rev. 559, 567 (2001): Joseph L. Sax, "Environmental Law at the Turn of the Century: A Reportorial Fragment of Contemporary History," 88 Cal. L. Rev 2375, 2381 (2000).

[29] Press Release from the Office of State Senator Glenn Hegar, District 18, "Senator Hegar Files Edwards Aquifer Legislation," dated March 7, 2007; Austin American-Statesman, "San Antonio Seeks More Pumping; Drought-Protection More Limited than Environmentalists Wanted," May 25, 2007 (discussing the cost of a buy back if the cap was not raised).

[30] Act of May 28, 2007, 80th Leg. R. S. ch 1430, §§ 12.01-12.12, 2007 Tex. Gen. Laws 5848, 5901 (Senate Bill 3).

[31] The average level of withdrawals from 2000 through 2010.

[32] Texas Department of Agriculture, Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and Texas Water Development Board.

[33] Press Release from the Office of State Senator Glenn Hegar, District 18, "Senator Hegar Files Edwards Aquifer Legislation," dated March 7, 2007 ("I have a lot of concerns over raising the pumping cap without addressing critical management (drought) issues.").

[34] The EARIP stakeholders agreed that the program document would be an HCP in support of an ITP.

The Edwards Aquifer Recovery Implementation Program

S.B. 3 called for the creation of a steering committee to oversee and assist in the development of the EARIP. S.B. 3 § 1.26A(e). The EARIP Steering Committee included 26 members representing environmental, water authority and purveyor, industrial, municipal, public utility, state agency, and agricultural interests related to the Edwards Aquifer. Twenty-one of the members of the Steering Committee were established in S.B. 3. *Id.* The remaining 5 members were added by the Steering Committee to ensure a broad diversity of representation. In early 2008, some 40 stakeholder groups or individuals executed a Memorandum of Agreement with the FWS setting out how the EARIP process would be conducted.[35] *See Table 4.*

Approximately 50 to 80 people routinely attended and participated in the EARIP meetings. The stakeholders met at least monthly, often twice a month. Including work group meetings, many stakeholders attended EARIP meetings on a weekly basis.

The EARIP used small work groups and committees to examine and make recommendations regarding specific issues. The use of these groups proved very effective in facilitating resolution of complex or contentious issues in the decision-making process. A list of the various committees and work groups used by the EARIP are set out in Section 1.7.1 of the HCP. *See Table 5.*

S.B. 3 set out specific tasks and deadlines that the EARIP must accomplish.

- Create a steering committee by September 30, 2007
- Hire a program manager by October 31, 2007
- Enter into a Memorandum of Agreement by December 31, 2007
- Appoint an expert Science Subcommittee by December 31, 2007
- The Science Subcommittee must submit to the Steering Committee and stakeholders initial recommendations on issues identified in S.B. 3 by December 31, 2008
- Establish a Recharge Facility Feasibility Subcommittee (no deadline)
- Enter into an implementing agreement to develop a program document by December 31, 2009

Each of these mandates was met within the required timeframe and accomplished in the collaborative spirit the legislature expected. In the summer of 2011, after much debate and compromise, the EARIP agreed on a HCP, the final task mandated by the Legislature.

[35] http://www.eahcp.org/files/uploads/Final20HCP.pdf.

THE HABITAT CONSERVATION PLAN[36]

Elements of the HCP

The proposed term of the HCP is 15 years. The implementation of the HCP is divided into 2 phases. In the first phase, habitat protection measures to increase the viability of the species will be implemented immediately at Comal and San Marcos springs. These measures will include habitat restoration and replacement with native vegetation favored by the listed species, maintenance of dissolved oxygen through removal of decaying aquatic vegetation during low flows, sediment removal, predator control, and fountain darter gill parasite control.

The minimization of the impacts of recreation at low flows will be accomplished through the creation of scientific study areas by the Texas Parks and Wildlife Department.[37] *See* TPW Code § 81.501. Access to sensitive habitat, such as areas of Texas wild-rice, will be limited during such periods. Water quality measures will include an incentive program for low impact development, best management practice implementation, support for coal tar sealant bans, and expanded water quality monitoring.

In addition, the first phase will include a package of actions to ensure continuous minimum springflow during a repeat of the drought of record. The flow protection measures will include a voluntary irrigation suspension program during severe drought, a regional municipal conservation program, the use of the San Antonio Water System's (SAWS) Aquifer Storage and Recovery (ASR) facility to store water to offset pumping during severe drought,[38] and additional emergency Stage V CPM cutbacks.[39]

[36] The HCP submitted to FWS can be found on the documents page of the EAA website: http://www.eahcp.org/files/uploads/Final20HCP.pdf.

[37] On March 29, 2012, the Texas Parks and Wildlife Department adopted a rule creating the San Marcos River State Scientific Area. 31 TAC § 57.901. This scientific area is designed to protect Texas wild-rice by restricting recreation in these areas during flow conditions below 120 cubic feet per second. The rule makes it unlawful for any person 1) to move, deface alter, or destroy any sign, buoy, boom or other such marking delineating the boundaries of the area; 2) uproot Texas wild-rice within the area; and 3) enter an area that is marked. The regulations are intended to preserve at least 1,000 m^2 of Texas wild-rice. The rule went into effect on July 8, 2012.

[38] ASR technology is a method of storing water in an aquifer. In the case of the SAWS ASR, water is pumped from the Edwards Aquifer and stored in the Carrizo Aquifer in south Bexar County. See http://www.saws.org/Your_Water/WaterResources/Projects/asr.cfm.

[39] The EAA has amended its Critical Period Management program to add, effective on FWS's approval of the HCP, a new emergency Stage V reduction of 44% applicable in both the San Antonio and Uvalde pools. Stage V is designed to be triggered only when other measures have not proven sufficiently effective in maintaining springflow during drought conditions. EAA Rules § 715.221. For the San Antonio Pool, Stage V would be triggered by a

All of the measures will be evaluated through a comprehensive monitoring program and adjustments made through a robust adaptive management process (AMP). The AMP will include an applied research program to test the assumptions underlying the biological goals and objectives. The research will focus on the biological effects of low flows on species and habitat. In addition, the existing MODFLOW model will be improved, and a mechanistic ecological model developed to evaluate all of the impacts on habitat.

In the second phase, the EARIP will implement any additional measures needed to achieve the biological goals. The decision regarding whether any additional measures are needed will be based on the best available science at that time and will rely heavily on information developed in the AMP.

The HCP establishes a presumptive measure for Phase II of the HCP, should it be determined additional measures are needed to achieve the biological goals and no other alternatives can be agreed to. That presumptive measure involves the continuation of the Phase I measures with the expanded use of the SAWS ASR. If expanding the availability of the ASR is unable to fully meet the additional springflow necessary to meet the minimum flow objectives, the balance will be obtained through alterations to the conservation measures, including an increase in Stage V withdrawal reductions.

The HCP also establishes long-term biological goals and objectives for each species. With respect to springflows, the minimum springflow objective is 45 cubic feet per second (monthly average) at Comal Springs and 52 cubic feet per second (monthly average) at San Marcos Springs. HCP § 4.1. These objectives are not to exceed 6 months in duration followed by 80 cubic feet per second (daily average flows) for 3 months. *Id.* Further, the long-term average springflow objective for Comal Springs is 225 cubic feet per second, and for San Marcos Springs, it is 140 cubic feet per second. *Id.* Many of the other objectives are stated in terms of water quality and habitat. *See* HCP, Section 4.2.

The applicants for the incidental take permit include the City of San Marcos, the City of New Braunfels, the EAA, Texas State University, and the City of San Antonio through SAWS. The understandings among the permittees as to how the plan will be managed and implemented are set out in the Funding and Management Agreement (FMA). An Implementing Committee consisting of the applicants will oversee and manage the implementation of the HCP. The Guadalupe-Blanco River Authority will be a non-voting member of that committee. The EAA will have primary responsibility for managing the day-to-day activities related to the HCP and responsibility for the flow protection measures except for the SAWS ASR facility for which SAWS will have responsibility. The cities of San Marcos and New Braunfels and Texas State University will have primary responsibility for implementing the habitat measures within their respective jurisdictional boundaries.

Approval of the HCP

Starting on October 18, 2011, with the City of San Marcos, the HCP and its supporting documents was presented to the permittees for approval. Approval of the plan was unanimous by the San Marcos City Council and SAWS Board. The City of New Braunfels passed the plan with only one vote in opposition. On October 24, 2011, the administration of Texas State University approved the plan.

At the November 7, 2011 meeting of the EARIP, the Steering Committee recommended to the EAA Board of Directors, for final approval, the HCP and the supporting documents. The recommendation passed with one objection[40] and one abstention. This vote marked a huge step forward that had long seemed unattainable.

On December 13, 2011, the EAA Board of Directors voted to approve the HCP. It, however, tabled a decision on the related FMA by an 8-7 vote. That decision to table a vote on the FMA resulted from a split in the board regarding whether a rebate program should be applied to the Aquifer Management Fees (AMFs) for the HCP costs.

On December 28, 2011, the EAA Board of Directors approved the FMA by a vote of 15-0. The HCP and supporting documents were submitted to the FWS along with the incidental take permit application on January 5, 2012.

On July 20, 2012, the FWS published a notice of availability in the Federal Register regarding the DEIS under the National Environmental Policy Act and the draft HCP. 77 Fed. Reg. 42,756 (July 20, 2012). The proposed action was the issuance of the ITP. *Id.* at 42,757. The FWS sought public comment on the DEIS. *Id.* at 42,756. The FWS also announced that it would conduct 7 public meetings to receive comments on the proposed action. *Id.* The meetings were held between August 3 and August 15, 2012, in San Marcos, New Braunfels, San Antonio, Uvalde, Kerrville, Corpus Christi, and Victoria. The public comment period remained open until October 18, 2012. *Id.*

On February 15, 2013, the FWS issued its Record of Decision approving the issuance of the Incidental Take Permit and the HCP. 78 Fed. Reg. 11,218 (Feb. 15, 2013). While awaiting this decision, the Implementing Committee developed work plans and budgets for each task in the HCP and put a

combination of monthly average J-17 levels below 625 feet or springflows of either 45 cubic feet per second based on a 10-day rolling average at Comal Springs or 40 cubic feet per second based on a 3-day rolling average. The Uvalde Pool would trigger Stage V using the Uvalde County Index Well (J-27) water level of 840 feet-mean sea level.

[40] The one stakeholder who objected did not object to the HCP but to the method of paying for its implementation.

management structure in place to oversee the work. The preparatory work for actually implementing the HCP began in January 2013.

Effectiveness of the HCP

The simulated effects of the flow-protection measures on springflow have been modeled over the historical record, including a repeat of the drought of record, to assess whether they are capable of ensuring continuous minimum springflows. The discharge rates can be seen in Tables 6 and 7.

The Phase I package of springflow protection measures provides substantial benefit to the listed species. It ensures minimum continuous springflow even during a repeat of the drought of record. Under current baseline conditions (without the HCP measures in place), modeling predicts that Comal Springs will cease to flow for 38 months during a repeat of drought of record conditions, and the springflows are predicted to be below 30 cubic feet per second (monthly average) for 54 months. At San Marcos Springs, in the simulation of a repeat of the drought of record, the minimum flow will be 2 cubic feet per second, and springflows will be below 52 cubic feet per second (monthly average) for 20 months.

By contrast, with the implementation of the Phase I springflow protection measures, Comal Springs is predicted to have continuous springflow during a repeat of drought of record conditions. As set out in the Table 6, the minimum springflow projected at Comal Springs for Phase I is 27 cubic feet per second (monthly average) and springflow only falls below 30 cubic feet per second on a monthly average for 2 months over a simulated repeat of the drought of record. The long-term average springflows at Comal Springs is projected to decline to 196 cubic feet per second.

At San Marcos Springs, the simulated minimum monthly springflow for Phase I is 50.5 cubic feet per second. Springflow falls below the flow objective of 52 cubic feet per second only twice during a simulated repeat of the drought of record. The long-term average springflows at San Marcos Springs is projected to decline to 155 cubic feet per second.

Hardy (2010)[41] found that these springflows will not appreciably reduce the likelihood of survival and recovery of the listed species over the first 7 years of the HCP, even if a repeat of drought of record conditions were to occur during that time, so long as all recommended measures are implemented to restore and protect the habitat of the listed species. The springflow protection measures ensure continuous springflows at both Comal and San Marcos springs, offering significant improvements over the environmental baseline. A hydrograph can be found in Figure 1 that shows a simulation of a repeat of the drought of record that compares the effects of the pumping cap and critical period reductions in S.B. 3 with the HCP measures.

Currently available information indicates that, if necessary, the presumptive Phase II measure will provide the necessary additional springflow to meet the minimum flow objectives necessary to attain the biological goals as currently defined. If the presumptive Phase II measure is implemented with an additional 3% Stage V cutback, the minimum monthly average springflow at Comal Springs is 47 cubic feet per second. The minimum monthly average springflow at San Marcos Springs is 52 cubic feet per second.

The AMP will include applied research to evaluate the impact of low flows on the listed species and their habitat. It will also evaluate the long-term average flow requirement and the requirement for 80 cubic feet per second "pulses" during periods at minimum flow levels.

The fact that the springflows do not meet the jeopardy numbers submitted to the Court by the FWS in 1993 does not mean that the proposed actions are not adequately protective.[42] First, a jeopardy flow number is "specific to the action under consideration; a myriad of interrelated factors including the duration and timing of the action, the extent of impacts, the current environmental baseline, and anticipated alterations to the baseline based on project design…" *Sierra Club v. Babbitt*, "Springflow Determinations Regarding Survival and Recovery and Critical Habitat of Endangered and Threatened Species," June 15, 1993 at 2-3 (emphasis added). In 1993, to respond to the Court's Order in the absence of a specific project or action, the FWS was required to make several assumptions about duration, timing, extent, and impacts of possible actions. *Id.* at 3. The HCP sets out a specific action that includes a specific flow regime and minimization and mitigation measures well beyond those assumed by FWS in 1993. Thus, the jeopardy analysis perforce would be different.

Further, the EARIP HCP does not just set 1 minimum flow goal such as was done in 1993. Instead, it establishes a flow regime that includes a minimum flow but also includes limitations on the duration of the minimal flows as well as long-term average flow goals. Collectively, these goals not only ensure the survival of species during a repeat of the drought of record but also ensure that the species retain the potential for recovery following such an event.

[41] Hardy, T.B., K. Kollaus, and K. Tower. 2010. Evaluation of the Proposed Edwards Aquifer Recovery Implementation Program drought of record minimum flow regimes in the Comal and San Marcos River Systems. December 28, 2010. http://www.eahcp.org/files/admin-records/EARIP-HCP-docs/Hardy,%20Kollaus,%20Tower%202010.pdf

[42] *See* Department of Defense Biological Opinion, Groundwater Withdrawal in Bexar County at Fort Sam Houston, Lackland Air Force Base and Randolph Air Force Base, dated January 11, 2008 ("The Service views on the springflow regime needed to support listed species would be influenced by implementation of an effective aquifer management plan that provides for continuous springflow of adequate magnitude.").

Finally, FWS's determinations in 1993 were, as the FWS conceded, very conservative to reflect the lack of data available at that time. *Id.* at 2. Subsequently, significant new data have become available including, but certainly not limited to, the instream flow modeling by Dr. Thomas Hardy, a nationally recognized expert on instream flow requirements, and field studies of BIO-WEST on species and their habitat in the spring ecosystems over the last 11 years. The EARIP also sponsored other studies, the most important of which were subjected to independent peer review. *See infra* at 22-23. Thus, it would be expected if some the conservatism in the estimated jeopardy flow number in 1993 would be unnecessary.

The Funding and Management Agreement

The EARIP developed a FMA, which serves to bind the 5 permit applicants to implement the HCP. The FMA establishes the procedures and mutual commitments among the permittees for funding and management of the HCP and the AMP. This agreement will be executed only by the 5 permittees. Key components include:

- A commitment by each permittee to discharge its duties and responsibilities to implement the HCP;
- A process by which the Implementing Committee will develop and amend as necessary a comprehensive work plan and budget to identify the conservation measures, adaptive management activities, and associated costs necessary to implement the HCP;
- A commitment by the EAA to fund the conservation measures and adaptive management activities with special AMFs paid to the EAA by industrial and municipal pumpers from the Edwards Aquifer;
- A process by which the EAA will provide funding to implement conservation measures; and
- The procedural steps and responsibilities of the permittees, the FWS, and other EARIP stakeholders for making AMP decisions and the actions that will be taken because of the decisions.

The Implementing Agreement

In addition to the HCP and FMA, the permittees entered into an Implementing Agreement (IA) with the FWS. The IA is an agreement that, among other things, "defines the obligations, benefits, rights, authorities, liabilities, and privileges of all signatories" to the HCP. FWS, "Habitat Conservation Planning and Incidental Take Permit Process Handbook" (FWS Handbook), Nov. 1996 at 3-37. The decision to develop an IA is within the sole discretion of the FWS's Regional Director. *Id.*

Because of the multiple parties involved and the complexity of the HCP, it was anticipated that an IA would be necessary for the HCP. Accordingly, the applicants developed a draft IA for their HCP and submitted it along with the program documents. In July 2011, the FWS determined an IA was not necessary but said that if the applicants wanted such an agreement, it would being willing to enter into an agreement that tracked closely with the template document set out in Appendix 4 of the FWS Handbook.

On July 19, 2012, the applicants submitted a draft IA to the FWS that was consistent with the FWS's template. The FWS agreed to the template IA submitted by the applicants with minor changes. The IA has been executed by the applicants and is awaiting execution by the FWS if the permit is approved.

The Cost of the HCP

The annual cost of implementing the HCP is substantial. During the first 7 years, those costs are estimated to average over $18.6 million per year. *See* Table 8. The municipal and industrial users of the aquifer will bear almost all of the cost of implementing the HCP through increased AMFs.[43] AMFs are collected by the EAA, which will then be responsible for distributing the funds for the purposes of fulfilling the obligations of the HCP. Downstream surface water right holders who benefit from the increased springflow from the aquifer will contribute $736,000 annually towards the cost of implementing the HCP.

The decision regarding how to fund the implementation of the HCP was perhaps the most contentious decision the EARIP faced. Indeed, the use of the AMFs was not the EARIP's first choice because it did not generate any contributions from the irrigators that pump substantial amounts of water from the aquifer.[44] In early 2011, bills were introduced in the Texas House and Senate on behalf of the EARIP that would have allowed voters in the Edwards region to decide whether to pay for the HCP through revenues from a sales tax. The maximum amount of the tax would have been one-eighth of 1%. The House Bill (H.B. 2760) had a hearing before House Natural Resources Committee. The Senate Bill (S.B. 1595), assigned to Senate Natural Resources Committee, did not get a hearing. Neither bill emerged from their committee. At that point, serious discussions began regarding the use of AMFs and contributions from the downstream interests to pay for the HCP.

The stakeholders will continue to search for alternate fund-

[43] *See* EAA Act § 1.29 ("The authority shall assess equitable aquifer management fees … to finance its administrative expenses and programs … .").

[44] Irrigators who use about 30% of the water pumped from the aquifer will not share in the costs because their AMFs are capped at $2 per acre-foot by state law. EAA Act §1.29(e).

ing mechanisms that will more equitably spread the burden across the region, including seeking a vote in the region on a sales tax in subsequent legislative sessions. The stakeholders also will seek funding from Congress and from state and federal grants to help fund the implementation of the HCP.

The decision-making process: How was it possible to reach consensus

In S.B. 3, the Legislature directed the EARIP to develop its plan through a facilitated, consensus-based stakeholder process. In its operating rules, the Steering Committee defined consensus as the absence of opposition to a decision. Although the rules provided for consensus decision making by a supermajority of 75% of the Steering Committee members when opposition occurs, in practice decisions generally were made without opposition and without the need for a vote by Steering Committee members.[45]

The key to consensus decision making for the EARIP was the stakeholders themselves. Throughout the process, the stakeholders evinced a clear understanding that the EARIP offered the last realistic chance for a regional decision rather than one imposed by a federal judge or the Texas Legislature. Furthermore, the final stages of the decision-making process played out against the backdrop of severe drought conditions that sharpened the realization that litigation was a likely alternative if they failed to come up with a plan to protect the species.

The process developed by the stakeholders also aided the decision-making. That the process was required to be an open and transparent process enabled the stakeholders to develop trust for the other stakeholders. Further, early in the process, the stakeholders agreed that no decision was final until all the issues had been resolved. This agreement encouraged the stakeholders to reach important interim decisions without fear that they would be bound by that decision if subsequent issues were not resolved in a manner acceptable to them. Moreover, the deadlines imposed by S.B. 3 kept the stakeholders focused on the issues before them and helped maintain momentum in the process. Frequently, when the stakeholders found themselves unable to reach consensus on an issue, they moved on the other issues with less controversy, returning later to the unresolved issue.

Finally, and most importantly, the stakeholders took ownership of the process. At several points in the process, the EARIP was perilously close to impasse. At each of those points, one of the stakeholders would remind the others that they had come too far to let the process fail—soon thereafter a compromise was reached. Indeed, the first time that happened was really the defining moment for the EARIP.

IS THE COMPLETION OF THE HCP THE FINAL CHAPTER IN THE EDWARDS AQUIFER WATER WARS?

Perhaps the decades-old war over the use of the aquifer is rapidly drawing to a close. There is now a regional consensus on how to use the aquifer to protect the federally listed species in the spring systems. The solutions incorporated in the HCP protect the listed species while recognizing the region's need for water from the aquifer.

Assuming FWS approval, the requisite measures to ensure continuous minimum springflow levels will be in place. To the extent refinement of these measures is needed because of the new science developed during the adaptive management process, the FMA sets out a process for resolving any disputes that may arise.

With the issuance of the ITP will come protection against suits under the ESA regarding the use of the aquifer. Control of the aquifer will stay in the region rather than with a Federal District Judge.

The completion of the HCP does not mean that all of the issues have been resolved. The region needs a more equitable funding mechanism such as a regional sales tax, or, at least, the region should be allowed to vote on such a tax as an alternative to the AMFs. Moreover, the U.S. Department of Defense's military bases have a Biological Opinion that allows them to withdraw almost 2% of the annual withdrawals from the aquifer; yet they do not pay AMFs. The Defense Department did not participate in the EARIP, but its facilities will be a beneficiary of the EARIP's HCP when the biological opinion regarding its military facilities' use of the aquifer is up for renewal in early 2013. Some contribution to the implementation of the EARIP HCP would certainly be equitable and appropriate.

Some have speculated that the recent decision by the Texas Supreme Court in *EAA v. Day* may have an impact on the HCP. Any such speculation is premature. The obligations of the EAA under the ESA are separate and apart from its obligations of the EAA Act. That the landowners own groundwater in place does not diminish the EAA's obligation under § 9 not to take listed fish and wildlife through their use of the aquifer. The Supreme Court said that the EAA complied with the Act in issuing the permits. The issue is whether the regulation of the use of the aquifer under a very narrow set of facts requires compensation. That is something that may take years to adjudicate. Can future court cases affect the issuance of permits or use of the aquifer in a way that makes it difficult or too costly for the EAA to be able to fulfill its obligations under the Act? Possibly, but any such scenario would only be speculative now.

[45] http://www.eahcp.org/files/uploads/05-14-09RevisedPOR.pdf

The permittees and stakeholders now must implement the HCP and engage in a robust adaptive management process, including a decision in year 7 as to whether additional measures must be implemented. The latter issue has the potential to be contentious. The EARIP, however, has taken steps to facilitate the decision-making process that includes an Adaptive Management Science Committee to advise the Implementing Committee and stakeholders and an independent Scientific Review Panel, which will serve as a formal review body and "provide resolution of major scientific issues." The Scientific Review Panel also will determine whether the scientific record supports the specific findings regarding the need for additional measures.

In addition, the stakeholder's experience in the open, transparent EARIP process should foster cohesive, productive conversations during the implementation of the HCP. Such discussions will determine the ultimate success of the HCP and whether the final chapter in this epic saga has indeed been written.

Table 1. FWS 1993 determination of minimum springflows needed to prevent take, jeopardy, or adverse modification of critical habitat (from HCP, Section 4.2)

Species	Take	Jeopardy	Adverse Modification
Fountain darter in Comal	200	100	100
Fountain darter in San Marcos	60	50	150
San Marcos gambusia	100	100	60
San Marcos salamander	50	N/A	100
Texas blind salamander	100	60	N/A
Damage and Destruction			
Texas wild-rice	100	100	100

Note: All flow rates are given in cubic feet per second.

Table 2. Critical period withdrawal reduction stages for the San Antonio Pool (from HCP, Chapter 1)

Critical Period Stage	Comal Springs Flow (cfs)	San Marcos Springs Flow (cfs)	Index Well J-17 Level (MSL)	Withdrawal Reduction - San Antonio Pool
I	<225	<96	<660	20%
II	<200	<80	<650	30%
III	<150	N/A	<640	35%
IV	<100	N/A	<630	40%

cfs = cubic feet per second; MSL = mean sea level

Table 3. Critical period withdrawal reduction stages for the Uvalde Pool (from HCP, Chapter 1)

Critical Period Stage	Index Well J-27 Level (MSL)	Withdrawal Reduction Uvalde Pool
I	N/A	N/A
II	<850	5%
III	<845	20%
IV	<842	35%

MSL = mean sea level; N/A= not applicable

Table 4. Participants in the Edwards Aquifer Recovery Implementation Program

The following 39 stakeholders have executed the 2007 Memorandum of Agreement with the U.S. Fish and Wildlife Service regarding participation in the Edwards Aquifer Recovery Implementation Program:	
Aquifer Guardians in Urban Areas	Guadalupe County Farm Bureau
Alamo Cement Company	John M. Donahue, Ph.D.
Bexar County	Larry Hoffman
Bexar Metropolitan Water District	Mary Q. Kelly
Carol G. Patterson	Nueces River Authority
City of Garden Ridge	New Braunfels Utilities
City of New Braunfels	Preserve Lake Dunlap Association
City of San Marcos	Regional Clean Air and Water Association
City of Victoria	San Antonio River Authority
Comal County	San Antonio Water System
CPS Energy	San Marcos River Foundation
Dan Laroe	South Central Texas Water Advisory Committee
Dow Chemical	South Texas Farm and Ranch Club
East Medina Special Utility District	Texas Bass Federation
Edwards Aquifer Authority	Texas Commission on Environmental Quality
Gilleland Farms	Texas Department of Agriculture
Greater Edwards Aquifer Alliance	Texas Living Waters Project
Greater San Antonio Chamber of Commerce	Texas Parks and Wildlife Department
Guadalupe Basin Coalition	Texas Water Development Board
Guadalupe-Blanco River Authority	Texas Wildlife Association

Table 5. Committees and work groups of EARIP

Subcommittees	Science Subcommittee
	Recharge Feasibility Subcommittee
	Public Outreach Subcommittee
	Ecosystem Restoration Subcommittee
Work Groups	Additional Studies
	Phase I Implementation Work Group
	Voluntary Irrigation Suspension Option Work Group
	Conservation Work Group
	Environmental Restoration and Protection Work Group
	Funding Work Group
	Recreation Work Group
	Refugia Work Group
	Agricultural Water Enhancement Program Work Group
	Covered Species Work Group
	Restoration Work Group
	Low Impact Development Work Group
	Implementing Agreement Drafting Work Group
	SAWS ASR Work Group
	MOA Work Group
	Facilitation Work Group

Table 6. Comal Springs discharge statistics (HCP, Section 4.2)

Springflow statistics (Evaluated for 1947-2000)		**Scenario**			
		S.B. 3 assuming full pumping of the EAA permits	**S.B. 3 assuming pumping of 381,000 ac-ft of EAA permits annually**	**Phase I**	**Phase II**
Minimum Monthly (cfs)		0	0	27	47
Minimum Rolling 6 month Average (cfs)		0	0	39	54
Long-term Average (cfs)		178	237	196	196
Number of Months below	150 cfs	221	165	185	185
	120 cfs	157	128	127	125
	80 cfs	99	82	53	53
	45 cfs	62	56	7	0
	30 cfs	54	47	2	0
	0 cfs	38	36	0	0

cfs = cubic feet per second

Table 7. San Marcos Springs discharge statistics (from HCP, Section 4.2)

Springflow statistics (Evaluated for 1947-2000)		Scenario			
		S.B. 3 assuming full pumping of the EAA permits	S.B. 3 assuming pumping of 381,000 ac-ft of EAA permits annually	Phase I	Phase II
Minimum Monthly (cfs)		2	5	51	52
Minimum Rolling 6 month Average (cfs)		12	14	53	55
Long-term Average (cfs)		153	160	155	155
Number of Months below	100 cfs	121	113	114	114
	80 cfs	52	51	48	47
	50 cfs	19	17	0	0
	30 cfs	7	6	0	0
	10 cfs	3	2	0	0

cfs = cubic feet per second

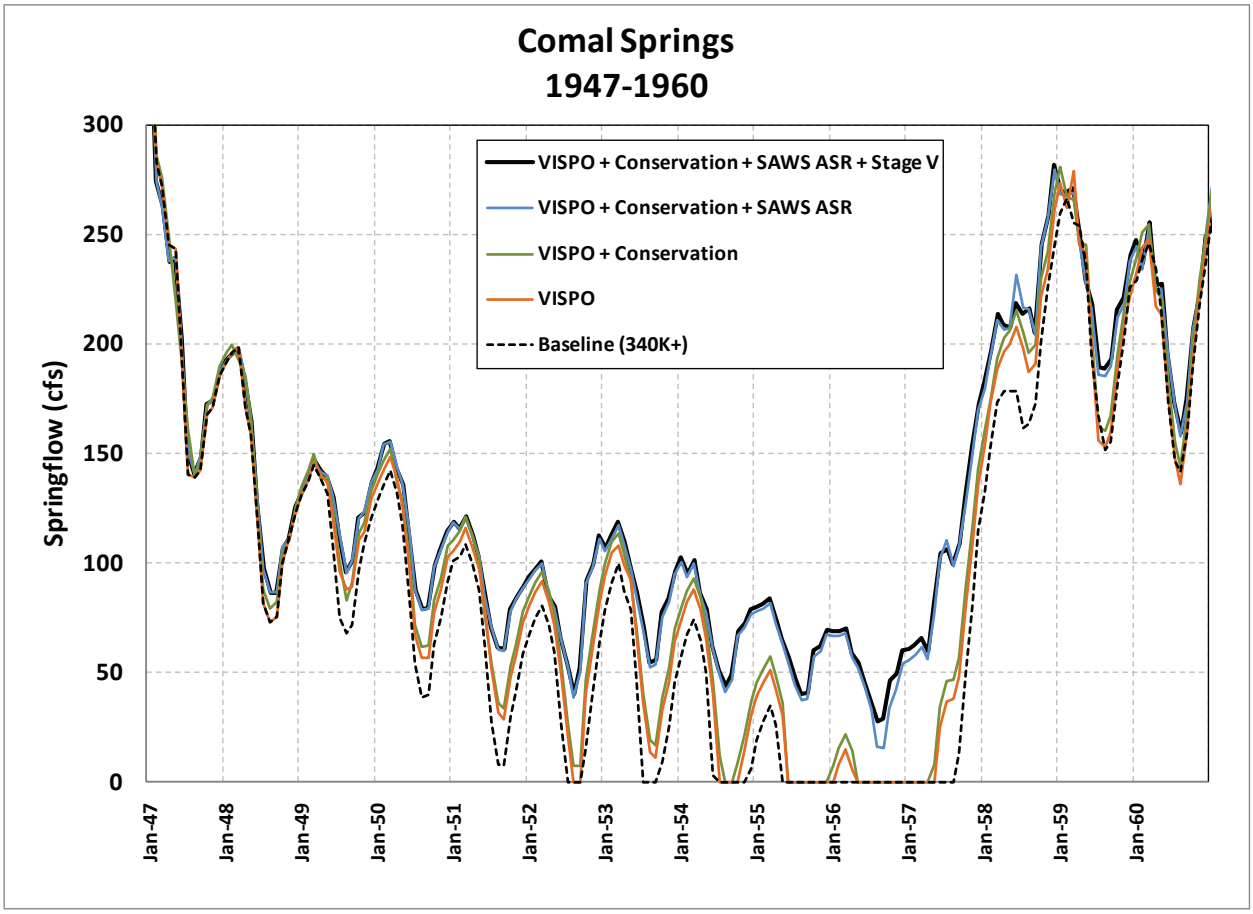

Figure 1. Comal Springs springflow under bottom-up package (from HCP, Section 4.2) cfs = cubic feet per second

Table 8. Annualized implementation costs (years 1–7)

Analyzed Implementation Costs (Years 1–7)		
Flow-related Measures	CPM Stage V	$0
	Use of SAWS ASR	
	Obtaining Water Leases	$4,759,000
	Share of SAWS O&M Based on Use	$2,194,000
	Regional Water Conservation Program	$1,620,679
	Voluntary Irrigation Suspension Program Option	$4,172,000
Habitat and Water Quality Measures	Comal Springs	$1,272,857
	San Marcos Springs	$1,295,143
Modeling and Research		$892,857
NFHTC Refugia		$1,678,597
Project Management		$750,000
Average Annualized Cost		**$18,635,133**

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Groundwater Levels in Northern Texas High Plains: Baseline for Existing Agricultural Management Practices

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Abstract: New groundwater policies are being debated for the Northern Texas High Plains because of Ogallala Aquifer depletion. These policies should be evaluated using a calibrated groundwater model for assessing their impact on subsequent groundwater levels. The objective of this study was to calibrate and validate a regional groundwater model for predicting the impact of existing agricultural management practices on groundwater levels beneath 4 counties located in the Northern Texas High Plains. Results indicated that the MODFLOW-2000 groundwater model was calibrated and validated satisfactorily based on reproducing and comparing groundwater levels with coefficients of determination of 0.97 and 0.98, root mean square errors of 28.0 meters (91.9 feet) and 15.5 meters (50.9 feet). The model showed normalized root mean square errors of 6.9% and 4.3%, for calibration and validation, respectively. Analysis of prediction results indicated that 2 zones would become depleted if the current level of aquifer exploitation continues with no modification for the next 50 years. The calibrated model should assist water managers in evaluating alternative agricultural management policy scenarios.

Keywords: groundwater modeling; irrigation; MODFLOW; Ogallala Aquifer; water management

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Terms used in paper

Short name or acronym	Descriptive name
NPGCD	North Plains Groundwater Conservation District
TWDB	Texas Water Development Board
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

INTRODUCTION

Groundwater supplies are diminishing in multiple locations of the Ogallala Aquifer. Specifically, groundwater depletion in the Northern High Plains of Texas has been observed, and there is limited recharge to the aquifer. Irrigated crop production in the study area accounts for the majority of groundwater withdrawal. Reduction in water availability will reduce regional crop production that would impact the state, regional, and national economies. Policy-makers and stakeholders are considering ways to extend the life of the aquifer to maintain economic viability, and several strategies were identified via a stakeholder survey (Amosson et al. 2008). This region is key for securing a national food supply and for the Texas economy.

The Ogallala Aquifer is one of the largest and most productive groundwater resources in the world. It underlies an area of about 45 million hectares in the central United States covering parts of Texas, New Mexico, Oklahoma, Kansas, Colorado, Wyoming, Nebraska, and South Dakota. About 66 million cubic meters (or 66 gigaliters) of groundwater is withdrawn per day from this aquifer to meet agricultural and urban water demands (Maupin and Barber 2005). The Ogallala Aquifer sustains more than one quarter of the United States' agricultural production (Gurdak et al. 2009). The magnitude of agricultural water demand in this area makes water-use assessment critical in future planning efforts (Marek et al. 2009). The aquifer supports about $20 billion of production per year in the United States agricultural industry that includes 19% of wheat and cotton and 15% of corn produced (Qi and Scott 2010). The dominant land uses are rangeland (56%) and agriculture (38%) (McMahon et al. 2007). About 5.8 million hectares, or approximately 33% of agricultural land, has been reported as irrigated in eastern Nebraska, southwestern Kansas, and the west-central part of the Texas Panhandle (Gurdak et al. 2009).

Few regional aquifers have been studied as extensively as the Ogallala, and multiple computer models have been developed for the aquifer. Texas Water Development Board (TWDB) has supervised the most recent modeling efforts for the Ogallala Aquifer in Texas. These efforts have concentrated on assessing groundwater availability over a 50-year planning horizon. The North Plains Groundwater Conservation District (NPGCD) also determined desired future conditions for its district and adopted them in 2009 (NPGCD 2008a). The main purpose of Texas regional planning studies is to ensure the availability of groundwater supply and to evaluate water management strategies to further conserve groundwater. A regional modeling study, using a 1 mile x 1 mile (1,609 meter x 1,609 meter) grid, concluded that water from the Ogallala Aquifer could be greatly depleted by 2050 in 4 heavily irrigated counties (Dallam, Sherman, Hartley, and Moore counties) located in the Northern Texas High Plains (Dutton et al. 2001). However, there is a need to provide more detailed information. Therefore, a newer version of the MODFLOW model with higher resolution (800 meter x 800 meter) is presented in this paper. As a framework, a list of Ogallala Aquifer models prepared for Texas (Dutton et al. 2001) is presented in Table 1. This list was updated up to year 2010 to include the previous Northern Texas Panhandle model.

The objectives of this study were to 1) calibrate and validate a groundwater model using observed groundwater levels between 1937 and 2007 and 2) to define a baseline of the existing agricultural management practices on groundwater levels in the Ogallala Aquifer for the most intensively irrigated 4-county area located in the Northern High Plains of Texas. The general rationale for this study was the need to develop tools to help improve the understanding of impacts about water policies and new technologies that might affect water levels in the Ogallala Aquifer.

This study is a major component of a comprehensive regional analysis of the Ogallala Aquifer Program with the purpose of understanding short- and long-term effects of existing and

Table 1. Past modeling studies for the Ogallala Aquifer, which include partial or full areas of Texas.

YEAR	AUTHOR	MODELED AREA
1970	Claborn et al.	Parmer, Castro, Bailey, and Lamb counties (Texas)
1979	Bell and Morrison	Carson County
1982	Simpkins and Fogg	Texas Panhandle
1982, 1984	Knowles et al.	Texas High Plains
1984	Knowles	Texas High Plains
1984	McAda	Lea County (New Mexico), Cochran and Yoakum counties (Texas)
1984	Luckey	Central and Northern High Plains
1986	Luckey et al.	States: Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, Wyoming
1987	Luckey and Stephens	Southern High Plains of Texas and New Mexico
1993	Peckham and Ashworth	Texas High Plains
1995	Mullican	Roberts and Hutchinson counties (Texas)
1996	Dorman	Texas High Plains
1997	Mullican et al.	Southern High Plains
1999	Luckey and Becker	States: Oklahoma (Northwestern), Colorado (Southeastern), Kansas (Southwestern), New Mexico (Northeastern), and Texas (Northwestern)
2000, 2004	Dutton et al., Dutton	Northern Texas Panhandle
2003	Blandford et al.	Southern High Plains of Texas and New Mexico

alternative land use scenarios on groundwater level changes. The concern is that diminishing groundwater supplies will severely impact regional crop and animal production, which in turn will affect economic activity in the region. It is desirable to minimize adverse impacts on the regional economy due to the extensive future withdrawals of the limited groundwater resource.

STUDY AREA

This study is geographically limited to a 4-county area in the Northern Texas High Plains that includes Dallam, Sherman, Hartley, and Moore counties (Figure 1). The study area shares state borderlines with Oklahoma to the north and New Mexico to the west, and it occupies an area of 12,196 square kilometers (1.2 million hectares). In the Northern Texas High Plains, groundwater from the Ogallala Aquifer is the main source for agricultural and public water supplies that has sustained economic development in the region. Agriculture in the study region includes irrigated cropland, dryland cropland, and rangeland. Irrigated crop production for grain, fiber, forage, and silage accounts for 89% of groundwater withdrawals from the aquifer (Marek et al. 2004), and the regional economy is heavily dependent on the use of groundwater from the Ogallala Aquifer. Major crops are corn, cotton, hay, peanuts, sorghum, sunflower, soybeans, and wheat. According to the 2007 water-use survey summary estimates (TWDB 2007a), for the 4-county area during the irrigation season, 4 million cubic meters (or 4 gigaliters) of groundwater is withdrawn on average per day, and 3.9 million cubic meters (3.9 gigaliters) are withdrawn for irrigation purposes. The rest of the water is used for livestock, municipalities, manufacturing, mining, and power generation.

Historically, groundwater in this study area was not exploited extensively until the mid-20th century, even though some wells had been reported with records as early as 1919 (Musick et al. 1990). Irrigation development in the Texas High Plains began when farmers started drilling irrigation wells in the Ogallala Aquifer during the major drought of the 1930s. Yields of dryland crops were low at that time, and drought-relief financial assistance became available to bring new economic resources to the region. According to historical information, the aquifer was underexploited in land development for years before 1950. In the southern portion of the Texas

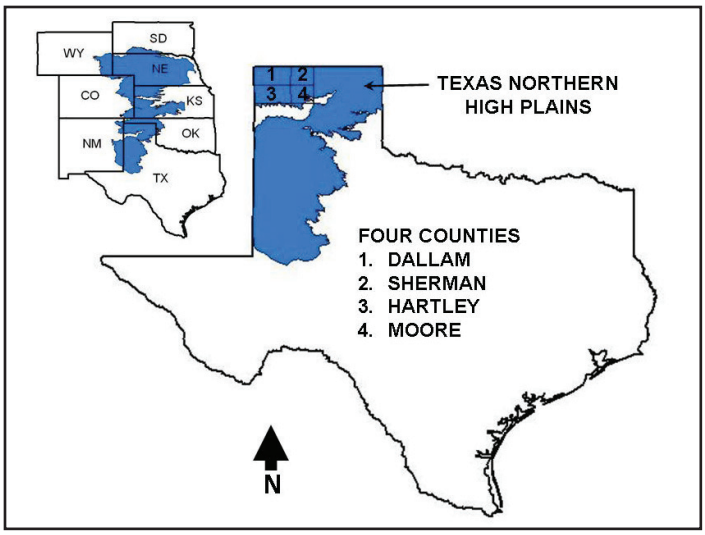

Figure 1. The Texas 4-county area of the Ogallala Aquifer region.

High Plains, rapid irrigation development began in the late 1950s and peaked in the late 1970s. In the Northern Texas High Plains, irrigation data gathered by Ouapo et al. (2012) demonstrated a peak in irrigation development in the late 1970s followed by a decline but then a higher peak in 2000. Center-pivot systems became more reliable allowing previously non-irrigated land to be irrigated. Thus, the analysis done for this study covers 2 unequivocal periods: the "predevelopment period" and the "exploitation period."

According to agricultural census data (NASS 2008), harvested cropland area has increased appreciably (by 64%) during the period of 1987–2007. Total cropland was 635,310 hectares in 2007 in the 4-county study area. About 42% of the total cropland (269,240 hectares) in the study area was under irrigation and about 80% of that was irrigated corn. This area contributes about 30% of the total corn production (81.6 megabushels or 2,073 gigagrams) in Texas (NASS 2008), and it is known for greater county-wide yields at 13.2 megagrams/hectare (210 bushels/acre) due primarily to the corn production being irrigated with practically no dryland corn production.

Hydrometeorology

The study area has an arid to semi-arid climate. Surface runoff is limited to the late summer season. The precipitation rate increases from 381 millimeters/year in the northwest to 483 millimeters/year in the southeast. Potential evaporation from free water surfaces ranges from 2,200 to 2,400 millimeters/year, significantly exceeding the precipitation rate and allowing little water for recharge to the groundwater system. Net recharge rates for the most recently calibrated groundwater model in the study region (Dutton et al. 2001) were less than 2% of precipitation. Annual average temperature ranges from 4 °C in January to 27 °C in July (NOAA 2009). The only surface water in the study area appears in ephemeral streams.

Geology

The Ogallala Aquifer is a remnant of a vast plain formed by sediments deposited by streams flowing eastward from the ancestral Rocky Mountains (Reilly et al. 2008) and is considered an unconfined aquifer (Gutentag et al. 1984). The Ogallala formation overlies Permian, Triassic, and Cretaceous strata and consists primarily of heterogeneous sequences of coarse-grained sand and gravel in the formation's lower part, grading upward into fine clay, silt, and sand. The sands are generally tan, yellow, or reddish brown, medium to coarse-grained, moderate to well sorted, and poorly consolidated to unconsolidated, although local cementation by calcium carbonate and silica occurs. The gravel is usually associated with sand, silt, and clay, and it is occasionally cemented (NPGCD 2008b).

The Ogallala formation in Texas was described by Seni (1980) as a series of coalescing, humid type alluvial fans for a depositional model. The Ogallala Aquifer is an exhaustible resource (Osborn 1973; Wheeler at al. 2006). No fractured rock zones and faults were identified within the study area, and some hydraulic continuity occurs between the Ogallala formation and the 2 underlying local aquifers, Rita Blanca and Dockum aquifers.

Rita Blanca Aquifer is a minor aquifer that underlies Ogallala Aquifer in Dallam and Hartley counties over an area of 2,400 square kilometers (TWDB 2007b) in the north-west vicinity of these counties. This aquifer is composed of coarse-grain sand and gravel layers of the Lytle and Dakota formations as well as in the Exeter Sandstone and Morrison formation. In some places, the Rita Blanca is also hydraulically connected to the underlying Dockum Aquifer. The Dockum Aquifer extends under 46 counties in Texas (TWDB 2007b) with a subsurface area of 57,000 square kilometers. The aquifer underlies Dallam and Hartley counties in their entireties and about 25% of Moore County (Figure 1). The Dockum Aquifer consists of sand and conglomerate inter-bedded with layers of silt and shale. The quality of water is generally poor because of salinity, hardness, and radioactivity, and does not meet drinking water standards in some locations. The water is, however, useful for irrigation, oil field operations, and municipal water supplies in other cases. The cross-formational flow between these local aquifers was not accounted for in the modeling for this study. According to the literature, flows between Rita Blanca, Dockum, and Ogallala aquifers have not been quantified. No studies were found to define this cross-

formational flow, and there is consensus that multiple wells might be crossing more than 1 aquifer.

Hydraulic conductivity and specific yield are highly variable in this study area, and they do not follow any particular spatial tendency due to dependency on sediment types, which vary widely horizontally and vertically (Gutentag et al. 1984). Estimated hydraulic conductivity values are between 8 and 120 meters per day, and specific yield ranges from 2.5% to 27.5% (USGS 2008). Estimation of saturated thickness of the Ogallala Aquifer in the 4-county area (Hallmark 2008) indicates that maximum saturated thickness ranges from 15 to 140 meters with an average of 50 meters, and depth to groundwater level ranges from 15 to 137 meters. Aquifer base elevation varies from about 900 meters above mean sea level in the eastern edge of the study area in Sherman and Moore counties to about 1,400 meters above mean sea level in the north-west corner of Dallam County.

METHODOLOGY

The hydrologic simulations for this study were done using MODFLOW-2000 (Harbaugh et al. 2000), a computer program that solves the 3-dimensional groundwater flow equations through a porous media using a finite-difference method. A Visual MODFLOW Pro 4.3[1] (SWS 2008) interface was used to facilitate data input and resulting analyses. The main sources of data for this modeling effort include the U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), TWDB, and the NPGCD.

Calibration and validation of the groundwater model for the study area were performed for 2 well-differentiated periods. During the first period (before 1950), the aquifer was considered to be in natural equilibrium based on the assumption that aquifer exploitation was not perceptible before 1950, and it will be referred as the predevelopment period. The second period (1950–2007) was the groundwater exploitation period for considering anthropogenic effects through time, and it will be referred as the exploitation period in this study.

Groundwater levels in the Ogallala Aquifer were predicted and evaluated differently for each period. We hypothesize that during the predevelopment period, Ogallala Aquifer water was discharged naturally through seepage into streams and springs when the aquifer was not able to hold the percolated water. Also, these discharges diminished during dry periods and natural groundwater levels remained almost constant until the next season, restarting the cycle. According to this hypothesis, the Ogallala Aquifer was naturally in equilibrium during the predevelopment period for modeling purposes (by obtaining recharge from precipitation and by withdrawing water by means of evapotranspiration from plants, stream flows, and spring discharge), keeping groundwater levels stable. The described hydraulic performance can be assimilated to a steady-state water flow, and it is represented by a steady-state aquifer model. The difference between aquifer behaviors for the exploitation period relative to the predevelopment period is the effect of pumping water from the aquifer by wells. In general, the naturally described processes for the predevelopment period continued to occur during the exploitation period. Groundwater usage during the exploitation period can be depicted as external actions that are applied to the aquifer resulting in non-equilibrium as a consequence. Those actions, combined with the natural response, generate variability in aquifer levels over time. This variability can be assimilated to a hydraulic transient-state, and it is represented by recreating a transient model for the aquifer.

Conceptual Model

A conceptual model has been created to represent the Ogallala Aquifer system beneath the study area to assess the effects of future groundwater exploitation on groundwater levels. The core information used to create the conceptual model was obtained from the USGS, USDA, the Ogallala Aquifer Program, TWDB, the Texas Natural Resources Information System, and NPGCD. Ancillary information was obtained from the National Agricultural Statistics Service, National Oceanic and Atmospheric Administration, Food and Agriculture Organization of the United Nations, and several Texas and Oklahoma institutions. Most information was originally on paper documents, printed maps, graphs, text files, and geographic information systems files. The soil structure and hydraulic properties were obtained from the USGS data repository (USGS 2008) with minor modifications to match NPGCD's red-bed layer data.

Boundary conditions were applied to cells located over the spatial limits of the computer model. Natural boundaries were preferred to artificial boundaries to make the model more realistic. Natural boundary conditions for the computer model included conditions present in nature and represent inherent aquifer characteristics. In contrast, artificial boundaries were defined to reduce computational expenses whenever natural boundaries were too far from the study area.

The conceptual model domain was extended beyond the 4-county area to reach the Ogallala Aquifer boundary to the south (Figure 2), to the west, and to about half of northern side of the region. The purpose of extending model boundaries was to decrease the length of artificial boundaries in spite of

[1] The use of trade, firm, or corporation names in this article is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Agricultural Research Service of any product or service to the exclusion of others that may be suitable.

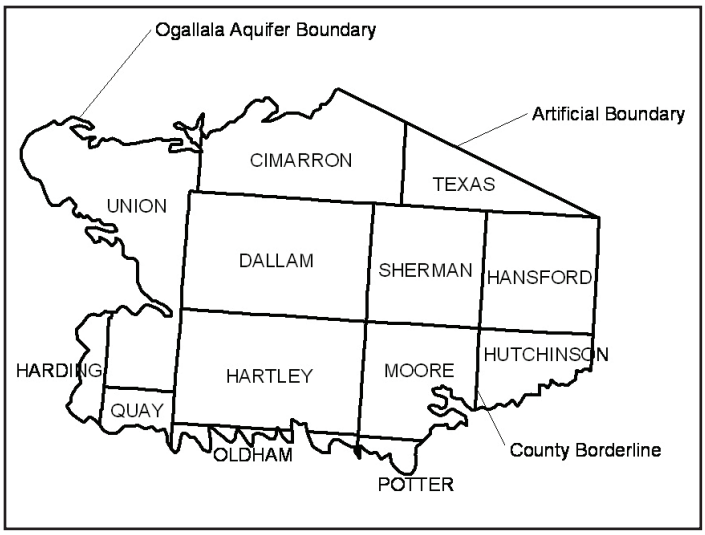

Figure 2. A delineation of boundary lines for the simulation.

increasing computing time, making the model more robust. Additionally, the straight-line border located to the north was simulated as a no-flow boundary because this groundwater flows approximately in the west-east direction (Gutentag et al. 1984) according to water table slope. The groundwater boundary was defined as a no-flow boundary condition. Historical spring data were obtained from a previous study (Brune 1975).

Artificial boundary conditions were defined for the eastern edge of the study area in the absence of natural boundaries. A general head-dependent flow boundary corresponds to a cell that flows from or to an external source proportionally to the head difference between the cell and the head assigned to the external source. For the eastern boundary and a portion of the north-east straight line, a general head boundary was defined. A general head-dependent flow was defined using different heads and distances to the external source depending on historic water table elevations. A general head boundary for the predevelopment period was 850 meters obtained from Gutentag et al. (1984). For the exploitation period, a general head boundary was defined at an elevation of 800 meters, which was adjusted during calibration process. Criterion applied to define distances from the study area boundary to the general head-dependent source was 3 times longer than the average depth of the aquifer in the boundary area.

The use of an 800 meter x 800 meter grid size for this study was partially based on considerations for future research, to accommodate similar or multiple pixel sizes from satellite imagery, and to efficiently use computational time. Each cell had internal, uniform characteristics for computational purposes.

Pumping for irrigation purposes is the primary mechanism used for aquifer discharge and precipitation is the main mechanism for recharge. Precipitation represents a small proportion of recharge due to the high evaporation rate from the soil and the high transpiration rate from plants. The distribution of recharge in the region is poorly known (Mullican et al. 1997). A need for further research on predicting recharge from precipitation and other variables was identified (Dutton et al. 2001).

A detailed study for the region by Luckey and Becker (1999) reported recharge rates of 16 to 24 millimeters/year for sand dune areas in Dallam and Hartley counties and rates from 1.6 to 2.1 millimeters/year for soils with low permeability in Sherman and Moore counties. More recent groundwater modeling studies (Dutton 2004; Dutton et al. 2001) of the Ogallala "n" model showed the necessity of increasing recharge rates in some areas in Dallam and Hartley counties by up to 10 millimeters/year and in Sherman County by up to 4 millimeters/year for modeling convergence. Therefore, recharge rates applied in this study ranged from 6 to 16 millimeters/year (2-3% of mean annual precipitation rate respectively), and they were applied to the uppermost active layer of the model in all cases. These recharge rates are greater than those shown in regional data that included the 4-county area (11 millimeters/year from Wood and Sanford 1995, and 10 millimeters/year from Dutton 2004), but they are feasible according to values reported by Luckey and Becker for sand dunes (16 to 24 millimeters/year).

The initial conceptual model considered uniform recharge rates of 5 millimeters/year and 11 millimeters/year over the study area, and the model never converged due to the generation of dry-cells in the north area of Union County, New Mexico (Figure 2). The model represented cyclic, dry-wetting conditions in some areas resulting in computational instability. To solve this issue, the model was divided into 5 identical layers. Additionally, dry cell wetting options were set to keep a minimum saturated thickness of 5 meters for the bottom layer, and the top 3 layers for Union County were set as inactive. Having the top layers inactive did not affect validity of the model because recharge was applied over the first active layer in the model, and this particular area was outside of the scope of this study. These conceptual model modifications allowed cells in the inactive zone to act as dry cells if the cells below the inactive zone were dry cells, too. Otherwise, these inactive cells were not involved in the computations, except for passing recharge water to lower layers.

Model Calibration and Validation

Calibration of the model was done to verify that the predicted groundwater levels closely corresponded to situations that matched the historical aquifer performance for an *a pos-*

teriori validation process. Multiple computer simulations were performed to match historical groundwater levels by means of parameter modification and conceptual model adjustment. Model calibration was performed for both the predevelopment and the exploitation periods. The model was calibrated for the predevelopment period by predicting and comparing groundwater levels of 1939 using a steady-state model, representing no change in land use and keeping all boundary conditions constant throughout the time. The model was calibrated for the exploitation period by reproducing and comparing groundwater levels using a transient model including 1 initial steady-state stress period. Hydraulic conductivity and recharge were the 2 sensitive parameters modified to improve matching of model predictions to historical water levels.

Data available for the predevelopment-period model calibration are sparse. Data from 15 monitoring stations were used to calibrate the model for predevelopment period. The calibration process for the predevelopment period was performed by comparing simulations results against measured groundwater levels in 1939. This year was selected as it is the earliest time that experienced little aquifer exploitation with relatively more data from monitoring wells (Figure 3). Hydraulic conductivity was adjusted, up to 1 order of magnitude, to reduce the differences between historical and simulated water levels for those zones where there were large discrepancies.

Every calibration simulation started with the first stress period as a steady-state and output from this steady-state model was considered representative of conditions for the 1950s. Output groundwater levels for the predevelopment time were used as an input for the first stress period in the transient model. Model calibration was accomplished for the exploitation period by comparing historical water level records with results from the model for the years of 1953, 1960, 1969, 1980, 1990, and 2000, which were selected for having a large number of observational records. Monitoring data were added to the model one at a time and results were analyzed before adding the next data series to the subsequent year in the analysis. This made 131 data points available for comparison. Data for the following year were added to the previous simulation after checking satisfactory results from the previous year. The parameters selected to improve matching results from the model to historical water levels were hydraulic conductivity and recharge as expected.

Model validation was performed by 1 simulation with no modification to the conceptual model or to the parameters by comparing results from the model with registered groundwater levels for the period 2001–2007. The year 2007 was the last year with available data during this study's simulation. Registered historical data from 22 monitoring stations located in the 4-county study area were used to validate the model. The model was validated for each year in the period of 2001–2007, and performance of the groundwater model was evaluated by comparing the predicted groundwater levels with the annually observed water table data. Statistics used for this purpose were the coefficient of determination (r^2), root mean square error, and normalized root mean square error, with a 95% confidence interval.

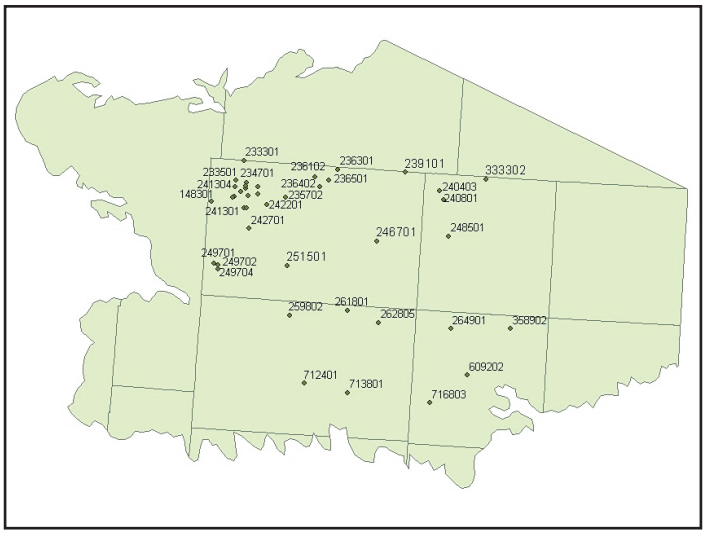

Figure 3. Locations of monitoring stations in the study area.

Modeling Current Agricultural Management Practices

The existing agricultural management practices were modeled to evaluate their impacts on groundwater levels by 2060, while assuming that future conditions are kept the same as current conditions. Future water demand was input to the validated model for simulating future groundwater levels based on a 50-year span projection. In order to simulate current practice, pumping rates were assumed constant during the period 2008–2060. Rates of groundwater withdrawal were computed for year 2008 by adding up pumping rates for each county for irrigation, municipal and public water supply, industry, manufacturing, and domestic and stock, totaling 3.3 million cubic meters per day for the 4-county area (Dutton et al. 2001). Water-use survey summary estimates (TWDB 2007a) were not used for this purpose as they are subject to continued revision. However, water demands used in this modeling effort corresponded to drought demands currently used by the TWDB for projection purposes. Water demand was spatially distributed using county average rates obtained from the same study (Dutton et al. 2001), and demand was distributed among the existing 5,881 registered wells. It was assumed that there would be no increment or reduction on the number of wells for establishing this baseline. The pumping rates were the only parameters added to validate the model for predictions.

RESULTS AND DISCUSSION

Artificial boundaries were minimized in length resulting in natural boundary conditions prevailing for the model. The grid size of 800 meters x 800 meters used for the entire area is the finest uniform resolution ever used for groundwater modeling in Texas to date. Model calibration and validation results are presented for both the predevelopment and the exploitation periods.

Calibration for the Predevelopment Period (1939–1950)

Groundwater levels for predevelopment time were reproduced by the model satisfactorily by simulating the groundwater levels in the Ogallala Aquifer in the 1950s, with a coefficient of determination of 0.99. Predevelopment, historical groundwater levels ranged from 955 to 1,405 meters above the mean sea level, and simulated groundwater levels for the same period ranged from 930 to 1,410 meters above the mean sea level in the 4-county study area (Figure 4). The model underestimated groundwater levels for some areas in Hartley, Moore, and south Dallam counties. By the contrary, the model overestimated groundwater levels for the north-west and north-east corners of Dallam and northern Sherman counties. In general, trends in the computed groundwater levels closely followed those in the measured historical groundwater levels.

A statistical analysis was performed to quantify differences between computed and historical groundwater levels by comparing the results found for the predevelopment period (Figure 5). The root mean square error was 10.5 meters, which corresponds to a normalized root mean square area of 3%. All compared values were located within the 95% confidence interval, and these results are indicative of good matching for the model.

Calibration for the Exploitation Period (1951–2000)

Comparison of predicted groundwater levels against historical data for the exploitation period (Figure 6A) produced a coefficient of determination of 0.97, and 28 data points were outside of the 95% confidence interval. Sixteen outliers were below the 95% lower limit (underestimation), and 12 data points were above the 95% upper limit (overestimation). Year 1953 presented a set of outliers of underestimated groundwater levels (14 out of 16) and none for the overestimated outliers. The period of 1952–1956 was a sequence of dry years (Dutton et al. 2001). Year 1960 presented half of the total number of overestimated outliers and none of the underestimated groundwater levels. Consequently, predicted trends in the groundwater levels for 1960 highly deviated from that in the measured data presenting differences up to 150 meters between observed and computed groundwater levels for stations 239101 and 246701 (see the 2 most left points for year 1960 in Figure 6B). The period 1956–1960 registered a consistent increase in precipitation through the time that peaked in 1960 in the 4-county area, which partially explains the overestimation of groundwater levels for 1960. Dutton et al. (2000) reported overestimation of registered groundwater levels by more than 45 meters while calibrating a regional model that included eastern Dallam County between 1959 and 1967. Outcomes from this study confirmed that groundwater levels for this period and for stations 239101 and 246701 should be

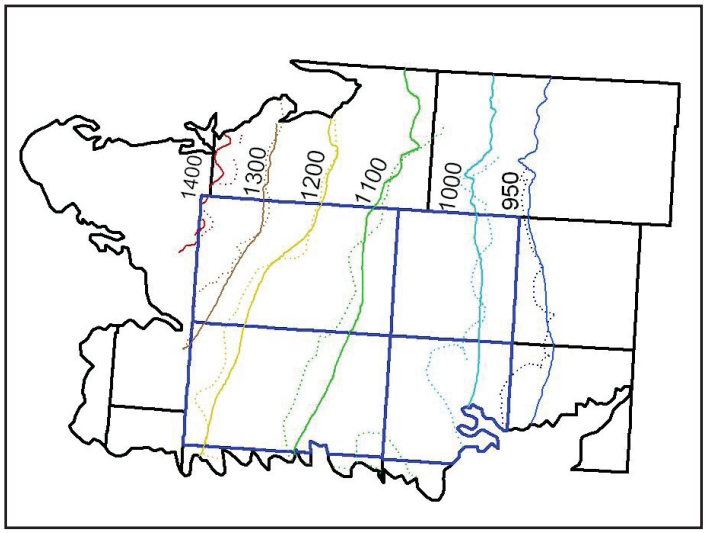

Figure 4. Historical (continuous lines) and simulated (dotted lines) groundwater levels (meters above the mean seal level) after calibrating for the predevelopment period.

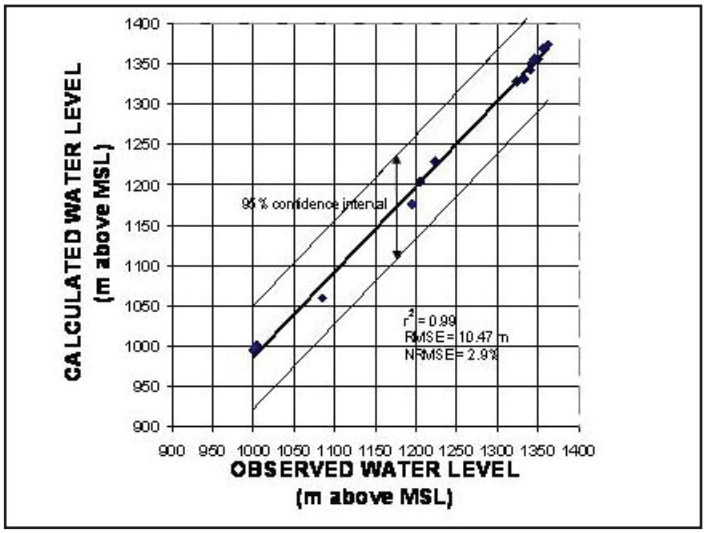

Figure 5. Calibration results for the predevelopment period (before 1950) showing 95% confidence interval and main statistics.

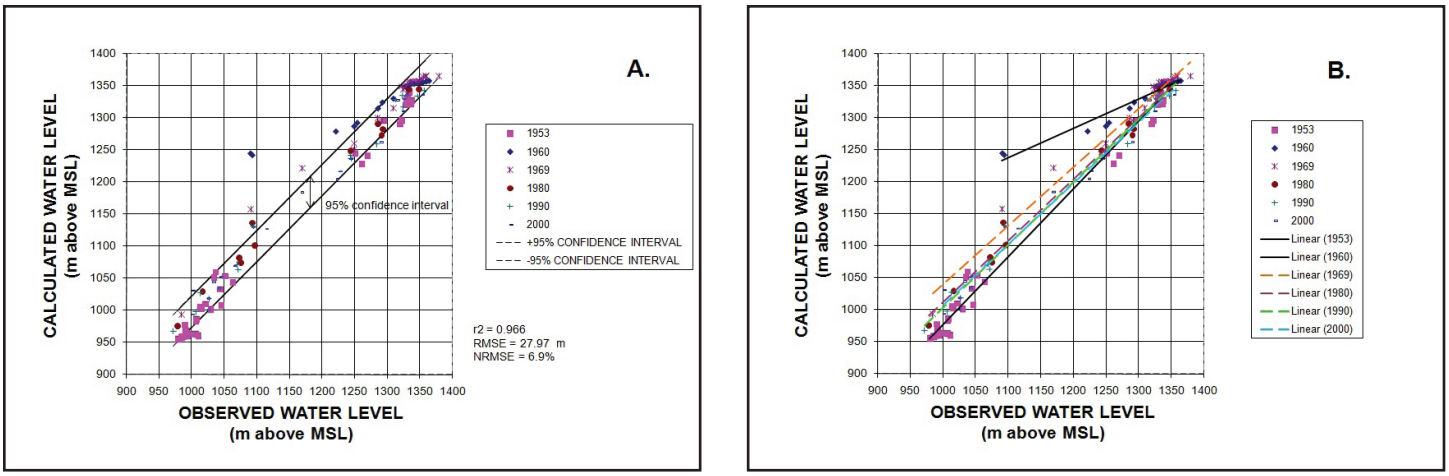

Figure 6. Calibration results for the exploitation period showing correlation between observed and calculated water levels. **A.** 95% confidence interval and statistics. **B.** Trend by year.

used with precaution for calibration of future models.

Other overestimation outlier values from stations 246701 and 251501, both located in Dallam County, belonged to year 1969 (Figure 3). Station 239101, located in Dallam County, produced overestimation outliers for years 1960, 1980, 1990, and 2000. It is noteworthy that all stations listed are located in Dallam County. Station 333302, located in Sherman County, produced 1 overestimation outlier for the year 2000. Overall performance for calibration yielded a root mean square error of 28.0 meters and normalized root mean square error of 7% for the exploitation period, indicating that calibration results are acceptable for this study. Table 2 presents a summary for the multiple-year statistics.

Validation for the Exploitation Period (2001–2007)

Validation results demonstrated a strong correlation between calculated groundwater levels and observed levels with a coefficient of determination of 0.98 for the period of 2001–2007, as shown in Figure 7. A root mean square error of 15.5 meters and a normalized root mean square error of 4.3% were computed by comparing predicted groundwater levels with historically registered levels for the same period. The result in the time series with the lowest normalized root mean square error was year 2004 with 4.2%, and the highest magnitude was 5.0% for the year 2003.

Outliers were identified as resulting from 3 specific monitoring stations out of 22 stations used for analysis. Two stations (239101 in Dallam County and 333302 in Sherman County) are located close to the Texas-Oklahoma state boundary, and station 609202 is in central Moore County (Figure 3). The model over-predicted groundwater levels for 2 stations close to the state borderline and under-predicted the groundwater level for the station in Moore County. Station 239101 corresponded to the area located in eastern Dallam County with registration inconsistency for the period of 1959–1967.

Differences between estimated and calculated groundwater levels for over-prediction outliers ranged between 29 meters (station 333302) and 40 meters (station 239101) and between 23 meters and 26 meters for under-prediction outliers (both at

Table 2. Calibration period evaluation showing statistics for correlation coefficient and standard errors for multiple years: Predevelopment Period.

Year	Total Observations	r^2	RMSE (m)	NRMSE (%)
1953	41	0.99	23.5	6.3
1960	20	0.95	53.4	19.5
1969	22	0.97	22.7	5.8
1980	12	0.99	15.5	4.2
1990	16	0.99	14.2	3.7
2000	20	0.98	16.5	4.7
All years	131	0.97	28.0	6.9

Table 3. Validation period evaluation showing statistics for correlation coefficient and standard errors for multiple years; Exploitation Period.

Year	Total Observations	r^2	RMSE (m)	NRMSE (%)
2001	19	0.98	15.6	4.8
2002	16	0.98	14.8	4.5
2003	16	0.98	16.4	5.0
2004	16	0.99	13.9	4.2
2005	14	0.98	16.8	4.8
2006	13	0.98	14.6	4.9
2007	17	0.98	16.2	4.6
All years	111	0.98	15.5	4.3

station 609202). Presence of these outliers at specific locations is indicative of low performance of the model in these particular areas. Table 3 presents statistics for the validation period. The correlation coefficients were high showing strong correlation between model results and historical data. In addition, normalized root mean square errors were less than or equal to 5% for each of the validation years, which are indicators of satisfactory model performance.

Impacts of Existing Agricultural Management Practices on Future Groundwater Levels

Simulated groundwater levels in the Ogallala Aquifer were depicted for year 2060 (Figure 8) by calculating groundwater drawdown for a 50-year period (2010–2060) in the future. Groundwater drawdown was computed as the difference between 2010 and 2060 groundwater levels to represent conditions for 2060 relative to 2010. Additionally, a grid image was created using the Kriging interpolation technique for visualizing groundwater drawdown to show the relative change in groundwater levels in the study area (Figure 9). If aquifer exploitation continues constantly at the current rate during the next 50 years, about 9% of the 4-county study area would experience groundwater depletion greater than 30 meters, and 2% of the area would experience groundwater depletion greater than 50 meters in 2060. Most of these areas are located in Hartley County. Of that area, 22% will experience depletion greater than 30 meters, and 5% of the county will experience depletion greater than 50 meters. Consequently, over the next 50 years, groundwater levels are predicted to deplete a maximum of 75 meters and 80 meters in the eastern and northwestern parts of Hartley County, respectively. In Dallam County, 7% of its area will experience depletion greater than 30 meters. Bright areas in Figure 9 are indicative of areas with larger potential for groundwater depletion.

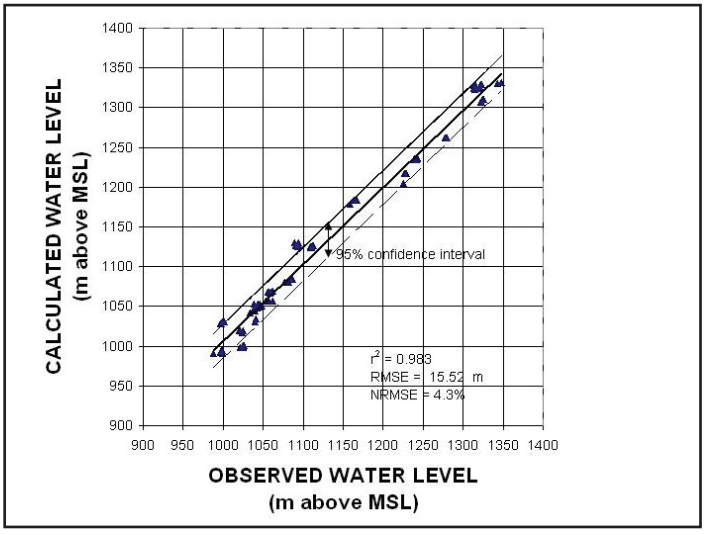

Figure 7. Validation results showing correlation between observed and calculated water levels, 95% confidence interval, and statistics.

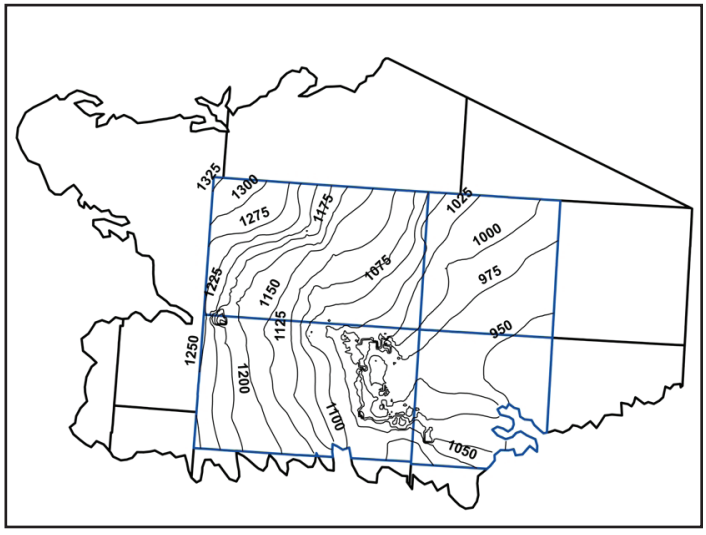

Figure 8. Predicted groundwater levels for 2060 (meters above the mean sea level).

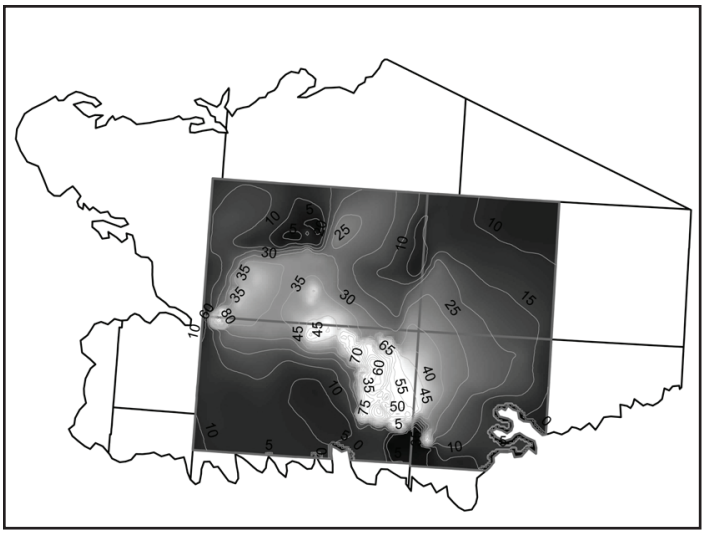

Figure 9. Simulated groundwater drawdown (meters) for applying current aquifer exploitation during the period 2010–2060.

SUMMARY AND CONCLUSION

A groundwater model for the 4-county study area (Dallam, Sherman, Hartley, and Moore counties) in the northwestern Texas High Plains underlying the Ogallala Aquifer region was developed, calibrated, and validated using observed groundwater-level data. The conceptual groundwater model was developed for this purpose. Hydraulic conductivity and recharge rates were most sensitive to predicted groundwater levels and were adjusted in calibrating the model. Performance statistics indicated that trends in the simulated groundwater levels closely followed those in the observed historical groundwater levels in the underlying Ogallala Aquifer.

The model was validated by comparing predictions against historical groundwater levels for the period 2001–2007. The conceptual model and the parameters obtained from the calibrated model were not modified during the validation period. Validation results yielded coefficients of determination greater than 0.97 and normalized root mean square values lower than and equal to 5.0%, indicating excellent agreement between the predicted and observed groundwater levels.

Two zones in the study area were identified as future drying-out zones if the current aquifer exploitation continues at the same rate during the next 50 years. These areas are located in the eastern and northwest portions of Hartley County. This calibrated groundwater model is expected to be used for evaluating the different agricultural management policy scenarios being debated (Amosson et al. 2008) for groundwater levels in the period 2010–2060.

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Commentary: A New Day? Two interpretations of the Texas Supreme Court's ruling in *Edwards Aquifer Authority v. Day and McDaniel*

Russell S. Johnson[1], Gregory M. Ellis[2]

Editors' Note: Many in Texas waited patiently for the Texas Supreme Court decision on *Edwards Aquifer Authority v. Day and McDaniel*, arguably the most important decision on Texas groundwater law in a generation. Regardless of which way the decision went, it undoubtedly would have a big impact on the management of groundwater resources in the state. We were not disappointed. The decision is complicated and, in places, seemingly contradictory. By opening groundwater management to regulatory takings, a door to another complicated area of law has been opened. Although the *Day* case answers some questions, others remain unanswered. And there are strong opinions on what *Day* means and doesn't mean.

While the Texas Supreme Court considered the *Day* case, Russ Johnson and Greg Ellis regaled audiences at multiple venues on their views on the case and what the court would or should do. Johnson's arguments leaned toward the landowner perspective while Ellis's arguments leaned toward the groundwater conservation district perspective. With the *Day* case decided, we thought it would be informative to ask Johnson and Ellis what they thought *Day* meant. Given the topic and nature of the contributions, only the editorial board reviewed the papers before accepting them for publication. As expected, the papers are interesting and informative—and help set the stage for the path forward.

Keywords: Texas water law, Texas groundwater law, Edwards Aquifer Authority, day case

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A New Day? Landowner perspective

By Russell S. Johnson

NATURE OF THE GROUNDWATER OWNERSHIP RIGHT

Although the rule of capture has been the law in Texas since 1904 and has been consistently described as a property right incident to ownership, the courts were never required to define the exact nature of the right until recently. Beginning with the *Houston & T.C. Ry. Co. v. East* case, the courts described the rule of capture as a real property right but never clearly defined when or if the right is vested. This is particularly important in the context of regulating the exercise of that right, as discussed later. In *East*, the Texas Supreme Court, citing New York law, said:

> An owner of soil may divert percolating water, consume or cut it off, with impunity. It is the same as land, and cannot be distinguished in law from land. So the owner of land is the absolute owner of the soil and of percolating water, which is a part of, and not different from, the soil.

Houston & T.C. Ry. Co. v. East, 81 S.W. 279, 281 (Tex. 1904) (quoting *Pixley v. Clark*, 35 N.Y. 520 (1866)). Similarly, in *Pecos County*, the El Paso Court of Appeals stated:

> It seems clear to us that percolating or diffused and percolating waters belong to the landowner, and may be used by him at his will...These cases seem to hold that the landowner owns the percolating water under his land and that he can make a non-wasteful use thereof, and such is based on a concept of property ownership.

Pecos County Water Control & Improvement District No. 1 v. Williams, 271 S.W.2d 503, 505 (Tex. Civ. App.—El Paso 1954, writ ref'd n.r.e.).

The Texas Supreme Court in *Friendswood Development Co. v. Smith-Southwest Industries, Inc.* refused to abandon the rule of capture, noting that it had become "an established rule of property law in this State, under which many citizens own land and water rights." 576 S.W.2d 21, 29 (Tex. 1978).

In spite of these statements, which imply that groundwater is owned by the landowner, the Texas Supreme Court had not, prior to its recent decision in *Edwards Aquifer Authority v. Day and McDaniel*, provided a description of the nature of the ownership right embraced by the absolute ownership rule. In *Sipriano v. Great Spring Waters of America, Inc.*, 1 S.W.3d 75 (Tex. 1999), the Supreme Court deftly avoided a discussion of the nature of the ownership right and instead held that it was inappropriate for the Court, given the Legislature's efforts to expand the powers of groundwater conservation districts, to insert itself into the regulatory mix by substituting the rule of reasonable use for the rule of capture. *Sipriano*, 1 S.W.3d at 80. The Court noted that any modification of the law would have to be guided by constitutional and statutory considerations, implying that ownership of groundwater is a property right and protected by the Constitution.

In the 1 case where the issue was argued to be directly relevant, *Barshop v. Medina County Underground Water Conservation District*, the Supreme Court avoided making a definitive decision on the issue. 925 S.W.2d 618 (Tex. 1996). In *Barshop*, landowner plaintiffs filed suit prior to the implementation of the Edwards Aquifer Authority Act (EAAA or Act), claiming that the Act violated the Texas Constitution by taking their rights to use Edwards Aquifer groundwater. The plaintiffs claimed that the Act deprived landowners within the jurisdiction of the Edwards Aquifer Authority (the Authority) jurisdiction of their vested property right in groundwater in violation of the Constitution. Plaintiffs conceded that the State has the right to regulate the use of groundwater but maintained that they had a vested property right in the water, which the Act took away. The State countered that groundwater under the rule of capture, while an ownership right in real property, was not vested until the water was actually reduced to possession and therefore the Act, which provided for regulation of use, could not result in a taking. *Id.* Without resolving these conflicting arguments or deciding the nature of the ownership right, the Supreme Court held that the Act was not unconstitutional on its face, ruling that the plaintiffs had failed to establish that, under all circumstances, the Act would deprive landowners of their property rights. Therefore, the Supreme Court did not have to resolve definitively the clash between property rights in water and regulation of water—that is whether the Act, as it might be applied, could result in an unconstitutional taking.

> While our prior decisions recognize both the property ownership rights of landowners in underground water and the need for legislative regulation of water, we have not previously considered this point at which water regulation unconstitutionally invades the property rights of landowners. The issue of when a particular regulation becomes an invasion of property rights in underground water is complex and multi-faceted. The problem is further complicated in this case because Plaintiffs have brought this challenge to the Act before the Authority has even had an opportunity to begin regulating the [Edwards] Aquifer.

> Despite these problems and competing interests, this case involves only a facial challenge to the Act. Because Plaintiffs have not established that the Act is unconstitutional on its face, it is not necessary to the disposition of this case to definitively resolve the clash between property rights in water and regulation of water.

Id. at 626.

Recently, the issue of the nature of the groundwater right was squarely before the Fourth Court of Appeals of Texas in 2 cases. In both cases, the Court was confronted with questions of law requiring analysis of the ownership interest in groundwater. In both decisions, the Court concluded that groundwater was owned as real property.

In *City of Del Rio v. Clayton Sam Colt Hamilton Trust*, the issue was whether a seller's reservation in the conveyance of "all water rights associated with said tract" prevented the buyer from drilling a well and producing groundwater on the tract conveyed. 269 S.W.3d 613, 614 (Tex. App.—San Antonio 2008, pet. denied). Litigation was initiated after the buyer, the City of Del Rio, drilled a water well on the purchased tract. The city argued that the Trust's reservation of water rights could not be effective and that under the rule of capture, the corpus of groundwater cannot be owned until it is reduced to possession. *Id*. at 616. The Court reviewed the Supreme Court's authority holding that percolating water is part of and not different from the soil, that the landowner is the absolute owner of it, and that it is subject to barter and sale like any other species of property. *Id*. at 617 (*et. al*). The Court distinguished the absolute ownership rule from the rule of capture, holding that the rule of capture is a tort rule denying a landowner any judicial remedy and was developed as a doctrine of nonliability for damage, not a rule of property. *Id*. at 617-18. The Court concluded that "under the absolute ownership theory, the Trust was entitled to sever the groundwater from the surface estate by reservation when it conveyed the surface estate to the City of Del Rio." *Id*. at 617. The city's petition to the Texas Supreme Court was denied.

Shortly thereafter, in *Edwards Aquifer Authority v. Day*, 274 S.W.3d 742 (Tex. App.—San Antonio 2008), the Fourth Court of Appeals reviewed a summary judgment in favor of the Authority on Day's and McDaniel's claim that the operation of the EAAA and the Authority's decision to deny Day and McDaniel a permit to produce groundwater constituted a taking under the Texas Constitution. The Authority petitioned the Texas Supreme Court to review this decision, and Day and McDaniel sought review of the decision denying them a permit. The Supreme Court granted the petitions for review.

FACTS OF THE *DAY* CASE

Under the EAAA, landowners who had historically used Edwards Aquifer groundwater for irrigation purposes were assured by the legislation of a minimum permit amount of 2 acre-feet of production per year per acre irrigated. Mr. Day and Mr. McDaniel (Day) jointly owned a tract of land located within the Authority's jurisdiction that had a well that flowed under artesian pressure. Day's predecessor in title irrigated a portion of the property directly from the well and a much larger portion of the property from an impoundment on a creek to which the artesian flow had been directed by a ditch constructed by the landowners. The Authority granted Day a permit for 14 acre-feet of groundwater based upon irrigation of land directly from the well but denied the request for a permit for land irrigated from the impoundment. The Authority determined that the water pumped from the impoundment on the property was surface water and therefore owned by the State and did not constitute historical use of groundwater from the Edwards Aquifer.

PROCEDURAL HISTORY

Day appealed the decision to state District Court, claiming error by the Authority. In the alternative, they argued that the actions of the Authority constituted a constitutional taking and an inverse condemnation of their groundwater rights and sought damages. The Authority then sued the State in the same proceeding, alleging that the State should be liable in the event the Court found there was a taking.

The trial court granted the Authority's and the State's motions for summary judgment on the constitutional takings claims, finding that the plaintiffs had no vested right to groundwater under their property and granted a take-nothing summary judgment on all of Day's constitutional claims. The trial court disagreed with the Authority's decision to deny Day a permit.

The parties appealed to the Fourth Court of Appeals. The Court agreed with the Authority's conclusion that the water used from the lake was state water and not groundwater and reversed the trial court's judgment granting a permit for acres irrigated with water from the impoundment. The Court reversed the take-nothing judgment granted on summary pleadings on the takings claim and remanded to the trial court for further proceedings on the constitutional claims. The Court of Appeals concluded that landowners have ownership rights in groundwater, that those rights are vested and are therefore constitutionally protected, and reversed the trial court's grant of summary judgment on these issues. The Court held that the landowners' "vested right in the groundwater beneath their property is entitled to constitutional protection." *Id*. at 756.

Both the State and the Authority filed petitions for review of the Court of Appeal's decision that plaintiffs have a vested and constitutionally protected interest in groundwater beneath their property. Day filed a petition for review, claiming error by the Court of Appeals in denying a permit for acres irrigated with water from the impoundment. The Texas Supreme Court granted all petitions for review.

While the case was still awaiting a decision, the 82nd Texas Legislature passed legislation addressing the ownership issue. Senate Bill 332 amended section 36.002 of the Texas Water Code to clarify the Legislature's view of the nature of the ownership interest and rights of landowners while recognizing that regulation and management of groundwater resources under the Conservation Amendment is a matter of public interest. Section 36.002 now provides that landowners own the groundwater below the surface as real property, which entitles the landowner to drill for and produce the groundwater below the surface, subject to the common law limitations against waste, malice, or negligent subsidence and the regulatory authority outlined by the Legislature in chapter 36.

Specifically, within amended section 36.002, subsection (c) provides that nothing in chapter 36 should be construed as granting authority to deprive or divest a landowner of the ownership and rights described by section 36.002. Subsection (d) states that the section does not prohibit a district from limiting or prohibiting the drilling of a well not in compliance with district rules for spacing or tract size or affect the ability of a district to regulate groundwater production authorized by chapter 36. Subsection (d)(3) clarifies that districts are not required to allocate to a landowner a proportionate share of available groundwater based on acreage owned, in effect stating that the ownership right does not require the application of a correlative rights rule to groundwater. Subsection (e) exempts certain water management entities from the section. Specifically, it provides that the section does not affect the ability to regulate groundwater as authorized by the laws creating and governing the Edwards Aquifer Authority, the Harris-Galveston Subsidence District, or the Fort Bend Subsidence District.

THE ARGUMENT AT THE SUPREME COURT

At the Supreme Court, Day and numerous Amici argued that the ownership right of landowners in groundwater beneath their land is a vested real property right protected by the U.S. and Texas Constitutions from taking without compensation. Several Amici argued that the absolute ownership rule as applied to minerals had created a vested property right protected from uncompensated taking, finding that the minerals were owned in place.

The Authority argued that the rule lacked attributes essential to the ownership of property: the right to exclude others and enforce those rights. The Authority also argued that groundwater should be treated differently because the law recognizes correlative rights in oil and gas but not in groundwater. Finally, it argued that groundwater is so fundamentally different from oil and gas that ownership rights in oil and gas should not bind the Court to apply those rights to groundwater. The State argued that while landowners do have some ownership rights in groundwater, they were not, in this case, sufficient to support a takings claim.

THE SUPREME COURT ANSWERS THE QUESTION OF THE NATURE OF LANDOWNER GROUNDWATER RIGHTS

On February 24, 2012, the Texas Supreme Court issued a 50-page, unanimous opinion in *Edwards Aquifer Authority v. Day* affirming the Fourth Court of Appeals and confronting and answering for the first time the question of whether a landowner's groundwater rights are a vested real property right protected by the Texas and U.S. Constitutions' prohibitions against uncompensated taking. 369 S.W.3d 814 (Tex. 2012). The opinion, written by Justice Hecht, begins with a succinct summary of the issue presented in the decision:

> We decide in this case whether land ownership includes an interest in groundwater in place that cannot be taken for public use without adequate compensation guaranteed by Article 1, § 17(a) of the Texas Constitution. We hold that it does.

Id. at 817. The opinion reviews the history of the EAAA and its key provisions and summarizes the facts leading up to the Authority's decision to deny Day a permit for groundwater use from an impoundment on a water course. The Authority found that the water used from the impoundment had become surface waters of the State and that Day were therefore not entitled to a groundwater production permit for water withdrawn from the impoundment and used for irrigation.

The Supreme Court affirmed the Authority's decision, finding that Day had failed to prove that their use of water was groundwater and not state water. This statement of the law has profound implications for any landowner using groundwater to supplement water in an impoundment on a water course. As stated by the Court:

> We do not suggest that a lake can never be used to store or transport groundwater for use by its owner. We conclude only that the Authority could find from the evidence before it that that was not what had occurred on Day's property.

Id. at 823. The Supreme Court then provided a detailed summary of the history of the rule of capture from its adoption in

East to the decision in *Sipriano*, finally concluding that ownership of groundwater in place had never been decided by the Court. The Court noted that while it had never addressed the issue with regard to groundwater, it had done so long ago with respect to oil and gas, to which the rule of capture also applies. The Court noted that while ownership of gas in place did not entitle the owner to specific molecules of gas, which could be diminished through drainage, with proper diligence they could be replenished or obtained. The Court stated that while the molecules are in the ground, they constitute a property interest. The Court, quoting its previous decisions, noted that the right to the oil and gas beneath a landowner's property is an exclusive and private property right inherent in land ownership, which may not be deprived without a taking of private property.

The Supreme Court found that there was no basis in the differences cited between groundwater and oil and gas to conclude that the common law allows ownership of oil and gas in place but not groundwater. Specifically, the Court quoted itself regarding the ownership of oil and gas in place, before affirming this was its holding:

> In our state the landowner is regarded as having absolute title and severalty to the oil and gas in place beneath his land. The only qualification of that rule of ownership is that it must be considered in connection with the law of capture and is subject to police regulations. The oil and gas beneath the soil are considered a part of the realty. Each owner of land owns separately, distinctly and exclusively all the oil and gas under his land and is accorded the usual remedies against trespassers who appropriate the minerals or destroy their market value.
>
> We now hold that this correctly states the common law regarding the ownership of groundwater in place.

Id. at 831-32. The Court cited the legislative revisions to section 36.002 described above as demonstrating the Legislature's understanding of the interplay between groundwater ownership and groundwater regulation.

The Supreme Court then analyzed whether Day had stated a viable takings claim. In so doing, the Court rejected the argument that the Authority's regulatory action could be considered a *per se* taking for Fifth Amendment purposes and instead applied the regulatory takings analysis originally adopted by the U.S. Supreme Court in *Penn Central Transportation Co. v. New York City*, 438 U.S. 104 (1978). In *Penn Central*, the Court identified several factors that have particular significance in determining whether the regulation rises to the level of a taking under the Constitution. Primary among those factors are the economic impact of the regulation on the claimant and the extent to which the regulation has interfered with distinct investment-backed expectations. In addition, the character of the governmental action—in essence an analysis of the reasonableness of the regulation in light of the goals to be achieved and the impacts reasonably expected—must be considered.

Because this factual inquiry was not developed in the summary judgment proceeding, the Texas Supreme Court agreed with the Fourth Court of Appeals of Texas that summary judgment against Day's taking claim should be reversed and the issue remanded to the trial court.

As a side note, the Supreme Court rejected Day's complaint that section 36.066(g) of the Texas Water Code, which authorizes an award of attorneys' fees and expenses to a groundwater conservation district that prevails in a suit like the underlying action, violated equal protection. The Court found the State has a legitimate interest in discouraging suits against groundwater districts to protect them from costs and burdens associated with such suits and that a cost-shifting statute is rationally related to advancing that interest. Landowners who file takings claims should be aware of this provision.

IMPACTS ON SURFACE AND GROUNDWATER MANAGEMENT AND REGULATION

The opinion in *Edwards Aquifer Authority vs. Day* resolved decades of conflict concerning the nature of the ownership right held by landowners in groundwater in Texas. By applying the case law applicable to oil and gas, the Texas Supreme Court has determined that groundwater is "owned in place" by the landowner and that this ownership right can support a claim for uncompensated taking under the state and federal constitutions. The Court's decision profoundly affects the interface between groundwater and surface water law on the landowner's property and outlines the current Court's view on the law that should be applied when a takings claim is brought by a landowner against a groundwater conservation district.

First, the Supreme Court concluded that the groundwater produced by Day from the well lost its character as groundwater and became surface water of the State of Texas when the water from the well reached and entered the intermittent creek on the Day and McDaniel property. Day had constructed a conveyance mechanism to move the groundwater from the well to the creek and assumed that they could withdraw their "groundwater" from an impoundment on their property without obtaining a permit from the State. The Supreme Court found that the Authority correctly determined that the groundwater became surface water when it entered the creek, therefore losing its character as groundwater and extinguishing the ownership interest of Day in the groundwater.

By so finding, the Supreme Court has likely inadvertently converted what many landowners assumed was their lawful

use of groundwater into unlawful diversions of state water without a permit. Many rural properties have groundwater wells and facilities constructed so that the groundwater can be used from an impoundment on the landowners' property. If the impoundment is on a watercourse, or the groundwater is withdrawn and used by the landowner after entering a watercourse, the Supreme Court's opinion implies that this will be viewed as an unlawful diversion of state water, even though the water diverted would not have been there but for the actions of the landowner. The Court made mention of the fact that Day had not measured the amount of water flowing from the well to the lake or the amount pumped from the lake into the irrigation system, that there was no direct transportation from source to use, and that the withdrawal was only periodic, as needed, to irrigate the adjacent acreage. The Court made much of the fact that the lake was apparently not used to store water for irrigation but was primarily used for recreation. However, landowners should be aware of this decision and the potential impact it may have on their ongoing water use on their property.

THE TAKINGS ANALYSIS

After determining that landowners do have a constitutionally compensable interest in groundwater, the Texas Supreme Court could, and probably should, have simply reversed and remanded to the trial court for consideration of Day's taking claim. Instead, the Court wrote on whether the Authority's regulatory scheme had resulted in a taking of that ownership interest. Given the procedural history of the case (a takings claims denied on Motion for Summary Judgment by the Authority), the Court was not obligated to address this issue; the issue was not directly before it.

Despite this, the Court engaged in an extensive analysis of regulatory takings claims. As described by the Court, 3 analytical categories of takings have been developed under Texas and federal law. Two categories of regulatory action generally deemed to be *per se* takings are (1) situations where the government requires owners to suffer a permanent physical invasion of their property and (2) regulations that completely deprive owners of all economically beneficial use of their property. The Court noted that outside of these 2 relatively narrow categories, regulatory takings challenges are governed by the standards set forth by the U.S. Supreme Court in *Penn Central*. *Penn Central* holds that there is not a set formula for evaluating regulatory takings claims but identified several factors that had particular significance. Primary among those factors are the economic impact of the regulation on the claimant and the extent to which the regulation interferes with distinct investment-backed expectations. In addition, the Supreme Court indicated that the character of the government action may be relevant in discerning whether a taking has occurred. Quoting its own decision in *Sheffield Development Co. vs. City of Glenn Heights*, the Court noted that all the surrounding circumstances must be considered in applying a reasonableness test so that, in the end, whether the facts are sufficient to constitute a taking is a question of law. *Day* at 839 (quoting *Sheffield Dev. Co. v. City of Glenn Heights*, 140 S.W.3d 600 (Tex. 2004)).

Noting that the case was before it on summary judgment, the Supreme Court examined the evidence and concluded that the 3 *Penn Central* factors did not support summary judgment for the Authority and the State and that a full development of the record may demonstrate that the Authority's actions were too restrictive of Day's groundwater rights and without justification in the overall regulatory scheme. *Id*. at 838-43. The Court rejected the Authority's argument that if groundwater regulation can result in compensable takings, the consequences will be disastrous. *Id*. at 843-44.

WHAT CONSTITUTES A TAKING?

The *Day* Court did not answer the question of what actions will or will not be considered a taking under the *Penn Central* analysis. In fact, the Court could hardly pronounce such an absolute rule given that all takings analyses are fact dependent. So, what is a groundwater conservation district to do?

The short answer is that groundwater conservation districts must consider the goals they seek to accomplish by regulation in comparison to the economic impact on landowners within their jurisdiction. Specifically, groundwater districts should consider the impact on investment-backed expectations of subsequent regulation and the economic impact to landowners of the application of these regulations. This analysis has particular application to groundwater users who have made investments based upon their ability to produce groundwater, which are interfered with by the regulations. Interference alone, or negative economic consequences alone, are not sufficient, by themselves, to support a takings claim. A deciding court must measure the regulatory goals against the economic impacts.

Despite claims to the contrary, the *Day* decision does not mandate a correlative rights approach to be used by groundwater conservation districts to avoid takings claims. A strict correlative rights system would inevitably have negative economic consequences for those already using groundwater inconsistent with whatever correlative rules are developed by the district. This is particularly true if the district assumes that all correlative rights will be exercised since these situations do not and have not occurred historically.

Groundwater conservation districts should be particularly concerned about the basis for their decision establish-

ing a desired future condition. Specifically, absent findings of adverse consequences associated with less restrictive desired conditions, districts will be challenged if the restrictions levied cause severe economic dislocation and are designed to meet a laudable goal—one that, if not met, would not result in catastrophic consequences.

CONCLUSION

Prior to the decision in *Edwards Aquifer Authority v. Day and McDaniel*, many groundwater conservation districts in Texas were advised that regulations restricting access to groundwater could not support a takings claim. After the decision, these groundwater districts will need to reconsider their approach to establishing limits and, in particular, examine and justify the reasons for those limits. Absent such justification, proof of economic dislocation or loss of investment-backed expectations will undoubtedly result in takings claims that could be successfully pursued.

A New Day? District perspective

By Gregory M. Ellis

THE DAY CASE

The Texas Supreme Court issued its opinion in *Edwards Aquifer Authority v. Day and McDaniel*, 55 Tex. Sup. Ct. J. 343, 369 S.W.3d 814 (Tex. 2012) holding that there is a vested property right in groundwater prior to capture, and the Courts must now consider whether a particular government action rises to the level of a regulatory taking. This paper discusses the background of the *Day* case, the Court's opinion, and the impact the opinion will have on future litigation and groundwater regulation generally.

Synopsis[1]

Farmers Day and McDaniel applied for an Initial Regular Permit (IRP) from the Edwards Aquifer Authority (the Authority) claiming 700 acre-feet of water rights. They presented evidence of having an Edwards Aquifer well and that they irrigated 150 acres of pasture from a lake on the property and an additional 7 acres directly from the well. The lake was filled by artesian flow from the well that discharged to a ditch and included intermittent surface water flows. The Authority issued a permit for 14 acre-feet based on the 7 acres irrigated directly from the well; Day and McDaniel appealed the permit decision and filed multiple constitutional claims, including a takings claim for the groundwater lost. The Texas Supreme Court upheld all the permitting decisions made by the Authority, including limiting the permit to 14 acre-feet for the land irrigated directly from the well, but also held that landowners have a vested property right in groundwater prior to capture and Day and McDaniel were therefore entitled to have the Court consider whether any of their property was taken through this permitting action.

Facts

The Authority conducted a contested case hearing on the application by Day and McDaniel. During the contested case hearing, the evidence concerning when and how many acres were irrigated was disputed. Testimony ranged from a low of 150 acres to a high of 300 acres irrigated plus recreational use of 50 acre-feet in a lake on the property that was an impoundment on the creek. In addition, the evidence demonstrated that Day and McDaniel had diverted water directly from the well to irrigate 7 acres of property adjacent to the well site.

The Authority does not regulate any formation other than the Edwards Aquifer, and the record does not indicate if Day and McDaniel attempted to access any formations other than the Edwards Aquifer. Day and McDaniel have not applied for a Term Permit as provided by Section 1.19 of the Authority's enabling Act[2].

Procedural History and Claims

At the conclusion of the contested case hearing, the Authority determined that the water pumped from the impoundment on the property was surface water and therefore owned by the State and did not constitute historical use of groundwater from the Edwards Aquifer. Thus, the Authority denied the permit application for the acres of property irrigated from the impoundment of the property. The Authority found that Day and McDaniel had shown historical use of groundwater on the 7 acres adjacent to the well and issued a permit to withdraw 14 acre-feet of water per year from the aquifer.

Day and McDaniel appealed to state District Court claiming error by the Authority. In addition and in the alternative, they argued that the actions of the Authority constituted a constitutional taking and an inverse condemnation of their groundwater rights and sought damages. The Authority interplead the State as a third-party defendant seeking contribution and indemnity from the State on the takings claims made by Day and McDaniel.

[1] Parts of this paper were taken from a December 2010 paper co-authored by Gregory M. Ellis and Russell S. Johnson presented at the University of Texas School of Law 2010 Texas Water Law Institute (December 2–3, 2010, Austin, Texas).

[2] Act of May 30, 1993, 73d Leg., R.S., ch. 626, 1993 Tex. Gen. Laws 2350, amended by Act of May 16, 1995, 74th Leg., R.S., ch. 524, 1995 Tex. Gen. Laws 3280; Act of May 29, 1995, 74th Leg., R.S., ch. 261, 1995 Tex. Gen. Laws 2505; Act of May 6, 1999, 76th Leg., R.S., ch. 163, 1999 Tex. Gen. Laws 634; Act of May 25, 2001, 77th Leg., R.S., ch. 1192, 2001 Tex. Gen. Laws 2696; Act of May 28, 2001, 77th Leg., R.S., ch. 966, §§ 2.60-.62 and 6.01-.05, 2001 Tex. Gen. Laws 1991, 2021-2022, 2075-2076; Act of May 25, 2001, 77th Leg., R.S., ch. 1192, 2001 Tex. Gen. Laws 2696; Act of June 1, 2003, 78th Leg., R.S., ch. 1112, § 6.01(4), 2003 Tex. Gen. Laws 3188, 3193; Act of May 23, 2007, 80th Leg., R.S., ch. 510, 2007 Tex. Gen. Laws 900; Act of May 28, 2007, 80th Leg., R.S., ch. 1351, §§ 2.01-2.12, 2007 Tex. Gen Laws 4612, 4627-4634; Act of May 28, 2007, 80th Leg. R.S., ch. 1430, §§ 12.01-12.12, 2007 Tex. Gen. Laws 5848, 5901-5909; Act of May 21, 2009, 81st Leg., R.S., ch. 1080, 2009 Tex. Gen. Laws 2818 [hereinafter "EAA Act"]. Citations are to the EAA Act's current sections, without separate references to amending enactments. A compilation of the EAA Act including all amendments can be found on the Authority's website, at http://www.edwardsaquifer.org/files/EAAact.pdf.

The District Court held that the water pumped from the impoundment on the Day and McDaniel property was not state surface water. The Court found that the water used was groundwater from the aquifer and found, based on the record, that this water had been used to irrigate a 150 acres of the Day and McDaniel property, and that Day and McDaniel were entitled to a permit to withdraw 300 acre-feet of aquifer groundwater per year in addition to the 14 acre-feet authorized by the Authority. The Court granted the Authority's and State's motions for summary judgment on the constitutional takings claims finding that the plaintiffs had no vested right to groundwater under their property, and granted a take nothing summary judgment on all of Day's and McDaniel's constitutional claims.

Both parties appealed to the Fourth Court of Appeals in San Antonio. The Court of Appeals agreed with the Authority's conclusion that the water used from lake was state water and not groundwater and reversed the District Court's judgment granting a permit for acres irrigated with water from the impoundment. The Court of Appeals affirmed the Authority's decision granting plaintiffs' permit only for the 7-acre tract that was irrigated with groundwater directly from the well. The Court of Appeals reversed the take nothing judgment granted on summary pleadings on the takings claim and remanded to the District Court for further proceedings on the constitutional claims. The Court of Appeals concluded that landowners have some ownership rights in groundwater, that those rights are vested and are therefore constitutionally protected, and reversed the District Court's grant of summary judgment on these issues.

Both the State and the Authority filed petitions for review of the Court of Appeal's finding that plaintiffs have a vested and constitutionally protected interest in groundwater beneath their property. Day and McDaniel filed a petition for review claiming error by the Court of Appeals to deny a permit for acres irrigated with water from the impoundment and making several constitutional claims. Eventually all 3 petitions were granted and answered by the Texas Supreme Court.

The Texas Supreme Court's opinion, issued February 24, 2012, affirmed the opinion of the Fourth Court of Appeals on the primary issues and remanded the case back to the District Court for a full hearing on the takings issues raised by the plaintiffs. The opinion covers a number of issues and includes a comprehensive discussion of Texas groundwater and property law. Both sides filed motions for rehearing that were denied on June 8, 2012.

The first 8 pages of the opinion provide a recitation of the facts and procedural history of the case, including the findings of the administrative law judge during the original permit hearings, the decision of the Authority's Board of Directors, the holdings of the District Court judge on appeal from the Board decision, and finally the opinion of the Court of Appeals. Of course, the biggest question was the nature of the property right in groundwater prior to capture, to which the Supreme Court devotes most of its discussion.

Before reaching the discussion of the property right, however, the Supreme Court reviewed the Authority's permit decision. Because the Authority held that the water allowed to flow into the creek bed became state water, the Board denied that portion of the application based on acres irrigated out of the creek-fed lake. First the Supreme Court determined that groundwater flowing into a surface-water course loses its nature as groundwater and becomes surface water owned by the State, citing the definition of state water as any "water of ordinary flow, underflow, and tides of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico, and the storm water, floodwater, and rainwater of every river, natural stream, canyon, ravine, depression, and watershed in the state" (citing § 11.021(a), Water Code). The Supreme Court also noted that the Legislature specifically declared surface water "when put or allowed to sink into the ground, . . . loses its character and classification . . . and is considered percolating groundwater.'" (citing § 35.002(5), Water Code). The lone exception it cited is a situation where the owner of the groundwater obtains a "bed and banks" permit to use the water course as a conduit for privately owned water (citing § 11.042(b), Water Code). However, there is no mention of the Chapter 36 definition of "waste," which includes "willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well unless such discharge is authorized by [a wastewater discharge] permit . . .". § 36.001(8)(E), Water Code. That definition should require the Supreme Court to find that the groundwater discharge to the creek was wasteful, and therefore could not form the basis of a permit.[3] Either way, the Supreme Court held the Board reached the correct decision on the permit.

Having determined the permit decision was correct, the Supreme Court turned its attention to the takings issue. The District Court decided that Day and McDaniel failed to meet the threshold issue of having a vested property right that could be taken. The Supreme Court held that groundwater should be "owned in place" the same as oil and gas property. The Supreme Court then inexplicably spends 10 pages of the opinion discussing prior groundwater cases and how the Supreme Court

[3] "To the extent water is available for permitting, the board shall issue the existing user a permit for withdrawal of an amount of water equal to the user's maximum beneficial use of water **without waste** during any 1 calendar year of the historical period." § 1.16(e), Edwards Aquifer Authority Act (emphasis added).

had never before held that groundwater was owned in place. It cited the original groundwater case, *Houston & T.C. Railway v. East*, saying, "No issue of ownership of groundwater *in place* was presented in *East*, and our decision implies no view of that issue." (emphasis in original). The opinion then discusses 4 cases decided since *East* (*City of Corpus Christi v. City of Pleasanton*, Friendswood *Development Co. v. Smith-Southwest Industries, Inc.*, *City of Sherman v. Public Utility Commission*, and *Sipriano v. Great Spring Waters of America, Inc.*), finding that "[i]n none of them did we determine whether the water was owned in place."

The discussion on ownership ends with comparisons to oil and gas cases and early holdings that oil and gas is owned in place. An important statement that appears to be dicta is that the ownership interest is based on "volumes that, while they could be diminished through drainage, with 'proper diligence', could also be replenished through drainage." This statement ignores one of the major differences between oil and gas formations and aquifers; almost all the aquifers in the state are replenished through recharge from the surface. Any drainage that occurs may be fully replaced during the next rain event (especially true for the Edwards Aquifer, which measures well levels on a daily basis[4]). The "volumes" of oil and gas formations may be determined by measuring the formation; the same cannot be said for rechargeable groundwater formations. (*See* discussion of these differences on page 24 of the *Day* opinion.)

The opinion also addresses a recent Supreme Court decision in *Coastal Oil & Gas Corp. v. Garza Energy Trust*, where the Court denied an action for trespass liability based on "fracing" operations that may have extended onto the plaintiff's land. The majority opinion in that case was that the plaintiff failed to state a claim for damages:

> In this case, actionable trespass requires injury, and Salinas's only claim of injury—that Coastal's fracing operation made it possible for gas to flow from beneath Share 13 to the Share 12 wells—**is precluded by the rule of capture**. That rule gives a mineral rights owner title to the oil and gas produced from a lawful well bottomed on the property, even if the oil and gas flowed to the well from beneath another owner's tract. The rule of capture is a cornerstone of the oil and gas industry and is fundamental both to property rights and to state regulation. Salinas does not claim that the Coastal Fee No. 1 violates any statute or regulation. Thus, **the gas he claims to have lost simply does not belong to him.**

Coastal Oil 268 S.W.3d 1, 9 (Tex. 2008) (citations omitted; emphasis added).

The majority re-iterates this reasoning a few pages later in the same opinion:

> [A]llowing recovery for the value of gas drained by hydraulic fracturing usurps to courts and juries the lawful and preferable authority of the Railroad Commission to regulate oil and gas production. Such recovery assumes that the gas belongs to the owner of the minerals in the drained property, contrary to the rule of capture. While a mineral rights owner has a real interest in oil and gas in place, "this right does not extend to *specific* oil and gas beneath the property"; ownership must be "considered in connection with the law of capture, which is recognized as a property right" as well. The minerals owner is entitled, not to the molecules actually residing below the surface, but to "a fair chance to recover the oil and gas in or under his land, *or* their equivalents in kind."

Coastal Oil 268 S.W.3d 1, 9 (Tex. 2008) (citations omitted; emphasis in original).

The Day opinion makes all of this applicable to groundwater.

Finally, the comparison to oil and gas is concluded with a reference to *Elliff v. Texon Drilling Co.* and the following quote, in which the phrase "oil and gas" has been replaced with "groundwater":

> In our state the landowner is regarded as having absolute title in severalty to the [groundwater] in place beneath his land. The only qualification of that rule of ownership is that it must be considered in connection with the law of capture and is subject to police regulations. The [groundwater] beneath the soil [is] considered a part of the realty. Each owner of land owns separately, distinctly and exclusively all the [groundwater] under his land and is accorded the usual remedies against trespassers who appropriate the [groundwater] or destroy [its] market value.

210 S.W.2d 558, 561 (internal citations omitted in original).

Section IV of Justice Hecht's opinion discusses whether Day and McDaniel had properly stated a takings claim, in light of the Court's decision that groundwater represents a constitutionally protected, vested property right. That discussion begins with a lengthy recitation of the history of groundwater regulation and the powers and duties of groundwater conservation districts. Then the Supreme Court held that facts in the record could not support a "physical invasion" taking; specifically, having been granted a permit for 14 acre-feet and could potentially drill a well for exempt uses up to 25,000 gallons per day[5], Day and McDaniel could not claim a permanent physical invasion of their property. Justice Hecht added some interesting dicta by stating, "It is an interesting question, and one we need not decide here, whether regulations depriving

[4] See http://data.edwardsaquifer.org/display_technical_m.php?pg=j17_live

[5] The opinion assumes each landowner may only drill 1 well for exempt uses, but there is no such limitation in either the Edwards Aquifer Authority Act, the Authority's Rules, or Chapter 36 of the Water Code.

a landowner of all access to groundwater—confiscating it, in effect—would fall into the category." Presumably that would require district rules (or perhaps permit decisions) deny any possible permit for any amount of groundwater, along with a prohibition on wells even for exempt use. Until an actual case arises, however, this issue remains just "an interesting question."

The Supreme Court then held that the "summary judgment record" was inconclusive on the issue of whether the permit decision denied Day and McDaniel "of all economically beneficial use" of their property. In reviewing the 3 *Penn Central* factors (see discussion *infra*), the Supreme Court held the record was incomplete on the first factor (the regulation's economic impact on the property) and the second factor (the owner's investment-backed expectations) but concentrated most of its effort on the third factor: the character of the governmental action.

The discussion of groundwater regulation in terms of takings analysis began with a strong endorsement of the need for regulation. Citing both *East* and the "Conservation Amendment[6]" the court said, "Groundwater provides 60% of the 16.1 million acre-feet of water used in Texas each year. In many areas of the state, and certainly in the Edwards Aquifer, demand exceeds supply. **Regulation is essential to its conservation and use**" (emphasis added).

The opinion then differentiates between the goals and methods of regulating groundwater and regulating oil and gas, concluding that while oil and gas regulation may generally be based on surface acreage, groundwater regulation "that affords an owner a fair share of subsurface water must take into account factors other than surface area." Reviewing the Authority's statutory regulatory scheme and its emphasis on historic use, Justice Hecht made a comparison to surface-water statutes that also awarded permits based on historical use and found that there are fundamental differences. Specifically he said that riparian surface water rights are usufructuary and did not represent an ownership interest. "Furthermore, non-use of groundwater conserves the resource, 'whereas[] the non-use of appropriated waters is equivalent to waste.' To forfeit a landowner's right to groundwater for non-use would encourage waste." (citing *In re Adjudication of the Water Rights of the Upper Guadalupe Segment of the Guadalupe River Basin*). This argument ignores the fact that groundwater in the Edwards Aquifer flows from property to property and eventually out 1 of many springs[7]. Just as water flowing down a river is lost either to the next landowner or to the sea, groundwater in the Edwards Aquifer cannot be "conserved" through non-use. If landowners could conserve all their groundwater by not producing it, no regulation would be necessary. The Justice also argues that historical use regulations "would have been perversely incentivized to pump as much water as possible" had they known the historic use regulations were imminent. Of course that is exactly why the Legislature set the historic period from June 1, 1972, to May 31, 1993—to prevent people from "gaming the system" by pumping groundwater to inflate their historical claims. Sec. 1.16(a), EAA Act. It is also why the Legislature required the permits be based on "user's maximum beneficial use of water **without waste**." Sec. 1.16(e), EAA Act, emphasis added. Pumping groundwater without putting it to a beneficial use would accomplish nothing. Although there may be incentives to overproduce, there are adequate safeguards to prevent it.

It is at this point in the opinion the Supreme Court attempts to interpret the meaning and intent of the recent amendments to Section 36.002 (S.B. No. 332 from the 82nd Legislature), a task made difficult by the compromises afforded to pass the legislation. The Supreme Court concluded that "deprive" and "divest" as used in subsection (c) of Section 36.002 "does not include a taking of property rights for which adequate compensation is constitutionally guaranteed." The constitutional protection for taking private property is adequate compensation; there is no prohibition against the government taking property for public uses. Therefore, the prohibition in Sec. 36.002 (c) against depriving or divesting someone of their property goes beyond the constitutional protection. One could easily argue that a groundwater conservation district (other than the Authority, the Harris-Galveston Subsidence District, or the Fort Bend Subsidence District) is prohibited from denying a landowner permission to drill at least 1 well for some beneficial purpose. The Supreme Court's interpretation seems to be that even if that 1 well is allowed, there must still be a complete takings analysis to see if that regulation goes too far. Indeed the Court goes on to say, "a landowner cannot be deprived of all beneficial use of the groundwater below his property merely because he did not use it during an historical period and supply is limited."[8] The Supreme Court affirmed the opinion of the Fourth Court of Appeals that the case must be remanded to fully explore the takings claims.

The Supreme Court then addressed various other constitutional issues raised by the plaintiffs. First, an administrative body has no authority to decide constitutional issues, so it is improper to raise them as part of an administrative hearing process. Second, there is no constitutional requirement that the Board of Directors personally conduct hearings as opposed to referring them to a hearings examiner. Third, the Court

[6] Art. XVI, Section 59, Texas Constitution.

[7] The opinion cites the Amicus brief filed by the Canadian River Municipal Water Authority, which is located in the Texas Panhandle over the Ogallala Aquifer, a very different aquifer.

[8] It is interesting to note that the Court did not address Term Permits as authorized by Sec.1.19, EAA Act, as a means of allowing some beneficial use of the groundwater.

did not need to address the "open courts" and "due process" arguments against the provision in the Administrative Procedures Act that allows ex parte communications between the administrative law judge and agency staff not involved in the contested case because Day and McDaniel did not claim any such contact occurred. Fourth, the plaintiffs' other due process claim against the substantial evidence rule is dismissed because they did not present any evidence that they were prevented from presenting at the hearing. The Court also pointed out that the substantial evidence rule does not "operate to restrict Day's evidence on his takings claim." The only interpretation of that statement must be that a party to an appeal of an administrative decision is allowed to present new evidence regarding constitutional takings claims without being bound by the substantial evidence rule.

Finally, the Supreme Court dismissed the plaintiffs' equal protection argument against application of Sec. 36.066(g), Water Code, which requires payment to a groundwater conservation district all attorneys' fees and court cost in a suit in which that district substantially prevails without affording the same consideration to any other party to that suit. The Court upheld the Fourth Court of Appeals decision on that issue because the State's interest in discouraging lawsuits against groundwater conservation districts is rationally related to the cost-shifting provision in the statute.

This unanimous decision by the Supreme Court may open the door to any number of suits against any number of groundwater conservation districts. The immediate impact may be that districts shy away from protection for historical uses and more toward either a correlative rights or reasonable-use regulatory plan, both of which will likely prove to be very expensive for cities and others with high demand. The most interesting aspect of the decision is its derision for protecting historical uses. Because takings litigation is generally centered around investment-backed expectations, one would think historical users would deserve the most protection, and any regulation that is aimed at protecting those investments would be the most likely to pass constitutional muster. Instead, the Court turned that analysis on its ear by deriding protection of historical uses to the potential detriment of landowners who have yet to invest a dime (beyond the purchase price of their property). Mr. A. Dan Tarlock, in his well-known reference "Law of Water Rights and Resources, 2012 ed.," discussed the *Day and McDaniel* decision in §4:29 as follows:

> [T]he Texas Supreme Court . . . adopted the oil and gas rule of ownership in place for groundwater which inverts the usual objective of takings law—the protection of investment backed expectations—because the regulation of future uses may be more likely to be a taking compared to the restriction of existing uses!

Tarlock provides further analysis of the decision in **§4:36:**

> Lower Texas appellate courts rendered a series of decisions suggesting that the [EAA] Act was not a taking. However, the Texas Supreme Court opened the door to taking claims by unnecessarily hardening the state's doctrine of capture by adopting the oil and gas rule of ownership in place for groundwater and thus inverting the usual objective of takings law—the protection of investment backed expectations. The oil and gas rule is a fiction to allow landowners to lease the right to extract oil and gas, and no other state has applied it to groundwater.

A. Dan Tarlock, *Law of Water Rights and Resources* **§§4.29, 4.36 (2012 ed.).**

The Supreme Court's decision would allow several parties to raise takings claims in future permitting decisions: the applicant, an existing well owner, and a landowner with a desire to "conserve" his groundwater through non-use. Once an aquifer has reached its limit (meaning the aggregate of all withdrawals meets or exceeds the amount the aquifer can sustain or the amount that will achieve the chosen desired future condition for that aquifer), what decision should a groundwater conservation district make? If the district denies an application because all available groundwater supply has already been permitted and is being produced by others, the applicant will surely sue. If the district grants the application but then reduces the permits for all other existing users, the existing users will certainly sue. If the district grants the application and does not reduce any other permitted uses thereby allowing aquifer levels to decline, surely the landowner, in attempting to "conserve" his water, will sue because the district's actions are allowing his vested property rights to be confiscated by others.

It may well turn out that after all the litigation is said and done very few plaintiffs will have prevailed. An "inverse condemnation" or "regulatory taking" is difficult to prove, and even if the plaintiff prevails he must pass the additional hurdle of proving up damages. Until these issues are settled through multiple lawsuits over multiple aquifers testing multiple regulatory methodologies, groundwater conservation districts will be diverting resources towards litigation defense and away from where they are most sorely needed: data collection and aquifer modeling. Although Sec. 36.066(g), Water Code allows districts to recoup their costs in suits where they prevail, that does not mean they will actually recover any funds.

When these suits are filed, how they will be prosecuted and what arguments may be raised are complicated issues. Regulatory takings are fact-dependent and addressed on an ad hoc basis, even though they are ultimately considered as legal matters to be decided by a court. Each new suit will require a complete analysis. The next section of this paper reviews the current state of regulatory takings law in Texas.

REGULATORY TAKINGS

Regulatory Takings from *Pennsylvania Coal* to *Lucas* and *Dolan*

Both the United States and Texas constitutions provide protection against the State taking private property without compensation. *See* Tex. Const. art. I, § 17 ("No person's property shall be taken, damaged or destroyed for or applied to public use without adequate compensation being made, unless by the consent of such person; and, when taken, except for the use of the State, such compensation shall be first made, or secured by a deposit of money; and no irrevocable or uncontrollable grant of special privileges or immunities, shall be made; but all privileges and franchises granted by the Legislature, or created under its authority shall be subject to the control thereof.") *and* U.S. Const. amend. V. ". . . nor shall private property be taken for public use without just compensation." Although the provisions are a little different, Texas courts have always applied the federal analysis to cases brought under the Texas Constitution. *Sheffield Development Co., Inc. v. City of Glenn Heights*, 140 S.W.3d 660 (Tex. 2004).

Historical Takings Analysis

The courts rejected the idea of regulatory takings until 1922 when the U.S. Supreme Court decided *Pennsylvania Coal Co. v. Mahan*, 260 U.S. 393 (1922). As a means to control surface subsidence, the State required coal companies to leave subsurface columns of coal in place. Up to 98% of the coal could be removed, but the coal companies claimed the State had taken the remaining 2%. The State argued the regulation was a legitimate use of the State's police powers. The U.S. Supreme Court held that regulations *can* reach the level of a takings if they go "too far" and interfere with the rights of property owners.

Over the next 50 years, the concept moved very little. In the 1960s, the U.S. Supreme Court began to address the question of where to draw the line, or "how far is too far." Because no bright line presented itself, the Court turned to equity and fairness. The Court ruled that the police powers could affect a taking both if it caused a physical occupation of property and if it burdened a few individuals with costs that should be shared by the whole. The Takings Clause is there to "bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole." *Armstrong v. United States*, 364 U.S. 40 (1960). Without the bright line, each regulatory endeavor became an ad hoc analysis of who benefited and how much.

In the late 1970s and early 1980s, the Court found regulatory takings could occur along a continuum, beginning with physical invasions (per se taking), categorical takings, and regulatory takings. A categorical taking occurs if the regulation does not substantially advance a legitimate state interest or if it denies an owner all economic use of the property. *Agins v. City of Tiburon*, 447 U.S. 255 (1980). A regulatory taking occurs if the property is unfairly burdened; fairness is determined by considering the regulation's economic impact on the property, the owner's investment-backed expectations, and the character of the governmental action. *Penn Central Transportation Co. V. City of New York*, 483 U.S. 104 (1978). Again, the lack of a bright line led to ad hoc decisions based on the facts of each individual case.

Of particular interest to the various parties considering Texas groundwater issues are a pair of cases dealing with certain fundamental aspects of property ownership. The first case was *Hodel v. Irving* where the U.S. Supreme Court held that being able to pass property in a will was so fundamental to ownership that removing that right would be a taking. 481 U.S. 704 (1987). The Court ruled that although property rights did represent a bundle of sticks, and removing only 1 stick from the bundle did not generally reach the level of a taking, there are some sticks in the bundle so fundamental to the ownership interest that they could not be removed without affecting the entire property right. The second case involved another "fundamental right:". . . the right to exclude others from the property." The U.S. Army Corps of Engineers required the owners of Kuapa Pond in Hawaii to allow the public access to their pond. The Corps concluded that improvements to the pond made it a navigable stream and therefore waters of the United States. The Court said:

> In this case, we hold that the "right to exclude," so universally held to be a fundamental element of the property right, falls within this category of interests that the Government cannot take without compensation. *Kaiser Aetna v. United States*, 444 U.S. 164, 179 (1979).

Some argue that *Kaiser Aetna* should have been decided as a physical invasion case because the government claimed the waters of the pond as waters of the United States. The difference is that the government would not be occupying the land but would require the landowners to allow access to the public. That debate is purely academic because the result is the same: the owner is entitled to compensation.

Although property rights had been described as a "bundle of rights," and that removing 1 or more "sticks" from the bundle would not devalue the entire interest so much that compensation must be paid, clearly some of the "sticks" weigh more than others. Where the regulations affected 1 of the "fundamental" sticks in the bundle, or excessively burdened the entire bundle, the government has taken the property. One of those sticks so fundamental to property ownership is the right to exclude—

the right to build a fence around that property and protect it. That raises the question that if the owner never had that right to begin with, what value can be applied to that particular stick in the property bundle? The rule of capture prevents a landowner from building that fence—any adjacent landowner may lower water levels or even dry up wells with impunity. *Sipriano v. Great Spring Waters of Am., Inc.*, 1 S.W.3d 75 (Tex. 1999). If the landowner cannot prevent a neighbor from capturing that property just how much can it be worth?

The Current Takings Analysis

The primary impediment to completing a takings suit has been the ripeness issue. Most cases involved "as applied" challenges rather than facial challenges. This is true for 2 simple reasons: (1) No one complains until the regulation keeps them from doing something and (2) facial challenges are extremely difficult because the plaintiff has to show *no* possible constitutional application of the regulation can exist. The typical takings case begins with an application to develop land or enhance a building. Once refused by the administrative body, the applicant sues for the value of the land, usually hoping the State will relent and allow the development. When the State does not relent, the plaintiff must first prove that the claim is ripe for adjudication.

In a variety of cases, and a variety of jurisdictions, the courts have required the plaintiff to return to the administrative body seeking another possible solution or possible use for the property. First, the property owner must file a "meaningful" application, meaning they cannot apply for uses clearly not permissible. In *MacDonald, Sommer & Frates v. Yolo County*, 477 U.S. 340 (1986), the Court complained that the property owner's plans were "exceedingly grandiose." The Court held that the plaintiff should have filed a more reasonable application, which would likely have been approved, and therefore the claim was not ripe for consideration.

The basic ripeness question revolves around the question of finality. In *Williamson County Regional Planning Comm'n v. Hamilton Bank*, 473 U.S. 172 (1985), the Court held that the claim was not ripe because the plaintiff never obtained a final determination. This is different from the exhaustion of remedies requirement. Exhaustion of all administrative remedies simply means completion of the administrative appeal process. Finality is achieved by obtaining a determination of what *will* be allowed on the property. In *Williamson* the Court also required the property owner to seek a variance to the offending ordinance.

A number of cases have now been turned aside for lacking ripeness. Cases have been dismissed for failure to make formal application (*Eide v. Sarasota County*, 908 F.2d 529 (11th Cir. 1990)), failure to file for a variance (*Amwest Investments v. City of Aurora*, 701 F.Supp. 1508 (D. Colo. 1988)), and failure to have a final decision (*Kinzli v. City of Santa Cruz* 818 F.2d 1449 (9th Cir. 1987). Some courts have even ruled that the property owner must file an application even if doing so is futile. *See Kinzli*, *Shelter Creek Dev. Corp. V. City of Oxnard*, 838 F.2d 375 (9th Cir. 1988). State courts are following suit. *See City of Jacksonville v. Wynn*, 650 So.2d 182 (Fla. App. 1995); *Ventures Northwest Ltd. Part. V. State*, 896 P.2d 70 (Wash. App. 1995); and *City of Iowa City v. Hagen Electronics, Inc.*, 545 N.W.2d 530 (Iowa 1996). However, a property owner is "not required to resort to piecemeal litigation or otherwise unfair procedures in order to obtain [a final] determination." *MacDonald, Sommer & Frates v. Yolo County,* 477 U.S. 340, 352 n. 7 (1986). In *Mayhew v. Town of Sunnyvale*, 964 S.W.2d 922 (Tex.1998) the Texas Supreme Court ruled the plaintiff's claims were ripe even though an application that met the new ordinances standards was never filed. The Court concluded that, "under the circumstances of this case, the Mayhews were not required to submit additional alternative proposals, after a year of negotiations and $500,000 in expenditures, to ripen this complaint." *Mayhew,* 964 S.W.2d at 932.

The U.S. Supreme Court addressed some of the confusion created by the ad hoc analysis required by decisions in the late 1980s in a pair of cases in the early 1990s. The first was the landmark decision of *Lucas v. South Carolina Coastal Council*, 505 U.S. 103 (1992). Mr. Lucas was a developer who owned property along the South Carolina coast, and as such had to submit development plans to the Council. After successfully developing a number of lots along the waterfront, Lucas purchased 2 remaining lots for his personal use. In the meantime the Council increased the size of the "construction-free zone" to include the 2 Lucas-owned lots. Following the Council's decision, Lucas was prohibited from building on his property, or as 1 Justice put it, he could only use the property for camping. Lucas sued for compensation, and the Supreme Court ruled in his favor.

The Court specifically held that the government takes property when its regulations leave the landowner with no economically beneficial use of the land. There was no balancing test against the police powers and no need to inquire into the purpose for the regulation or the legitimate state interest being advanced therein. The regulation had gone so far that the government may as well have physically occupied the property. The Court allowed only 2 exceptions to this new per se takings rule: (1) the regulation prevented a nuisance that could have been prevented under the common law and (2) the regulation was part of a state's background principles of real property.

In *Dolan v. City of Tigard*, 512 U.S. 374 (1994), the Court defined the rules that must be followed when analyzing exaction cases. An exaction is when the government requires dedication of some portion of the subject property as a condition

to receive a development permit. In Dolan, the City required a plumbing supply store to dedicate a bike path and greenway as a condition to a building permit. In reviewing the City's actions, the Court set out a 3-part test:

1. Does the permit condition seek to promote a legitimate state interest?
2. Does an essential nexus exist between the legitimate state interest and the permit condition?
3. Does a required degree of connection exist between the exactions and the projected impact of the development?

After determining the City met both of the first 2 conditions, the Court held that the exactions required of the Dolans were not "roughly proportional" to the impact. This "rough proportionality" test was described as an individualized determination that the exaction was related both in the nature and extent of the development's impact. As a disjunctive test, if the government fails any of the 3 prongs, the property owner is due compensation. The Court also pointed out that the exaction required public access to the greenway, meant as a floodplain easement. The public access was once again a government trespass, stepping on the "fundamental" right to exclude others.

While these cases provided some structure to takings cases, a large number of the cases still come down to an ad hoc, "I know it when I see it" analysis. Because government agencies are smart enough to create legislative history sufficient to pass the legitimate state interest test, and most can create the essential nexus necessary to pass the second test, that leaves only the rough proportionality question. Just as the *Pennsylvania Coal* decision left courts little guidance as to when a regulation went "too far," the courts have little guidance as to when a regulation is "roughly proportional." In addressing any takings claim, we now seem to have a several step process to follow. First, determine what property interest was taken. If the property interest is 1 of the fundamental sticks in the bundle or if the property is so burdened that the entire bundle loses all economically viable use, the case is a per se taking. One measure of whether the affected property right is fundamental is whether the State could have taken the same action under nuisance law or based on the background principles of property law. The next step is to determine whether the State's action promotes a legitimate state interest and if the regulation has the essential nexus to that state interest. Finally, the Court must do an ad hoc analysis of whether the regulation is roughly proportional to impact of the activity.

So the "current takings analysis" reverts back to 1978 where the U.S. Supreme Court set out a 3-prong test in *Penn Central*, a case involving the owners of Grand Central Station in New York City and the City's ordinance prohibiting substantial alteration of "historic structures." Penn Central Transportation Company wanted to further develop the Grand Central Station property by constructing office space above it. The City's Landmarks Preservation Commission prohibited any such development, thereby requiring the property continue to be used as a railroad station with the existing commercial spaces. Before the U.S. Supreme Court, the landowners argued that their development rights for the air space above the terminal had been taken by the City's decision. The Court articulated a 3-part test for determining regulatory takings (that do not fall into either the physical occupation or categorical takings):

1. the "economic impact" of the government action,
2. the extent to which the action "interferes with distinct investment-backed expectations," and
3. the "character" of the action.

Measuring the economic impact of a government regulation should be fairly straightforward, especially in light of the facts of the *Penn Central* case itself. Penn Central Transportation Company (and its predecessor owners of Grand Central Station) had operated the railroad terminal for 65 years, and nothing in the regulation prevented or restrained those operations in any way. In essence, the company could always do what it had always done, so could not thereby claim any economic impact of the regulation. Where the regulation does have an economic impact, that impact must be measured against the investment-backed expectations of the landowner. One of the key considerations is whether the landowner had notice of the regulation when the property was purchased. Although such notice is not a bar to a takings claim (See *Palazzolo v. Rhode Island* 535 U.S. 606 (2001)), it is a strong factor in determining if the landowner could have reasonably "expected" a different result given the nature of the regulation. Finally, the *Penn Central* opinion requires a review the "character" of the governmental action, a term that has been difficult to define and utilize.

Discussion of the "character" of the government action has taken several turns and followed multiple definitions. In *Lucas* the Court characterized the government action to be tantamount to a physical invasion of the property, leading to "categorical" takings as opposed to regulatory takings. In fact, if the government action is so burdensome as to prevent all economically viable use of the property, the rest of the *Penn Central* analysis becomes irrelevant. Other courts have reviewed the purpose of the regulations as a balancing test against the private interests, in essence determining if the costs of the regulation are best borne by individual landowners or by the public at large. *Agins v. City of Tiburon* 447 U.S. 255 (1980) (overruled by Lingle v. Chevron U.S.A. Inc., 544 U.S. 528 (2005)). Another interpretation is found in Keystone Bituminous Coal Assn. v. DeBenedictis, 480 U.S. 470 (1987), where the Court reviewed the regulation in terms of reciprocity of advantage: that the regulated community both benefits from and is bur-

dened by a regulation. This may be a particularly useful way to view groundwater regulation, where a landowner may not be allowed to withdraw as much water as desired, but neither will his neighbor. The overall regulation should ensure all landowners are protected in exchange for their acceptance of the limitations in their permits.

In 2005 the U.S. Supreme Court handed down its opinion in Lingle, overruling the earlier decision in Agins and providing some clarification regarding the character question in takings litigation. In Lingle the Court specifically repudiated the "substantially advances a legitimate government purpose" as a test better brought under due process arguments instead of takings litigation where the primary purpose is to determine if a regulation is so burdensome as to require compensation be paid. Any regulation that does not advance a legitimate government purpose should be invalid on its face, thereby removing the regulation and any need for a takings analysis. Further, Lingle appears to have limited the "character" part of the Penn Central analysis (at least as far as it applies to groundwater regulation) to the reciprocity of advantage question. If the regulation is targeted to a small number of landowners who will ultimately benefit very little from the regulation's impact on the entire community, then a court should be more likely to find there has been a taking. If, however, the regulation is applied broadly and helps benefit the entire regulated community (as well as the public at large), then the government will have met the burden imposed by the third prong of the Penn Central test.

The Texas Supreme Court has always followed the *Penn Central* analysis to review regulatory takings suits, and the 2 seminal cases for Texas are *Mayhew v. Town of Sunnyvale*, 964 S.W.2d 922 (Tex.1998) and *Sheffield Development Co., Inc. v. City of Glenn Heights*, 140 S.W.3d 660 (Tex. 2004) (both decided before *Lingle*).

The standard for compensable regulatory takings in Texas is set forth in detail by the Texas Supreme Court in *Mayhew v. Town of Sunnyvale*. Following the *Penn Central* takings analysis, *Mayhew* found a compensable regulatory taking can occur if:

1. the regulation does not substantially advance a legitimate governmental purpose,
2. the regulation denies the owner all economically viable use of the property, or
3. the regulation unreasonably interferes with the owner's use and enjoyment of the property.

The first factor is now out of place based on the U.S. Supreme Court decision in *Lingle*; a regulation that does not advance a "legitimate governmental purpose" should be considered invalid and the Court may void such a regulation under a due process argument.[9] If the invalid regulation causes irreparable harm before it can be rectified by the Court, then certainly takings compensation would also be due, but that is a separate analysis that doesn't involve the first prong of the *Mayhew* test. The second factor reflects the decision in the *Lucas* case and would only apply to groundwater regulation where the landowner is denied access to any groundwater and either (1) the entire property loses all economic value (the plaintiff proves the land cannot be developed without access to the groundwater) or (2) the courts find that groundwater should be considered a separate estate from the land and therefore valued separately. (See discussion below regarding the problems of valuing an estate of uncertain size.)

Most regulatory takings cases center on the third factor, which the *Mayhew* opinion divides into 2 parts:

1. the economic impact of the regulation, and
2. the extent to which the regulation interferes with distinct investment-backed expectations.

In *Mayhew* the Court considered a city's decision to deny a proposed planned development and whether that denial caused a taking of the developer's property. The trial court had ruled in favor of the developer, including findings that the development's value prior to the town's zoning ordinance requiring 1 unit per acre in planned developments was greater than $15,000,000, but as a result of the town's denial the property was only worth $2,400,000 fair market value. The Court of Appeals reversed the District Court's judgment and dismissed the Mayhews' claims against the town, holding that none of the claims was ripe for adjudication. *Town of Sunnyvale v. Mayhew,* 905 S.W.2d 234 (Tex. App.—Dallas 1994) (Tex. App.—Dallas 1994), *rev'd on other grounds by Mayhew v. Town of Sunnyvale,* 964 S.W.2d 922 (Tex.1998). The Texas Supreme Court held that the claims were ripe for adjudication: "The ripeness doctrine does not require a property owner, such as the Mayhews, to seek permits for development that the property owner does not deem economically viable." *Mayhew,* 964 S.W.2d at 932. Because the claims were ripe, the Court then had to perform the takings analysis.

The Court quickly disposed of the first 2 factors, holding that the town's ordinances did advance a legitimate state interest and that the property held some economic value after the town's decision. *Mayhew,* 964 S.W.2d at 935 and 937, respectively. That left the final factor and the balancing test between the economic impact of the denial and the property owner's investment backed expectations. The Court ruled against the Mayhews because they did not have a "reasonable investment-backed expectation to build 3,600 units on their property."

[9] The Texas Supreme Court discussed this issue and recognized various critiques of the rule, but then held that Texas is bound by the U.S. Supreme Court precedent. *Sheffield*, 140 S.W.3d at 674. Presumably Texas courts must now also follow the precedent in *Lingle*.

Mayhew, 964 S.W.2d at 937. The Mayhews originally purchased the property for ranching and only later decided to offer it up for development. The historical use of the property is "critically important when determining the reasonable investment-backed expectation of the landowner." *Mayhew,* 964 S.W.2d at 937.

The 2004 case involving Sheffield Development provides some additional detail in analyzing takings claims. Just as the Mayhews wanted a higher density development, the Sheffield Development Co. investigated property that was partially developed and purchased the property relying on the ability to continue development at the same density. Days after Sheffield purchased the property, the City of Glenn Heights adopted a moratorium on accepting new plats until it could review its zoning ordinances to ensure they were consistent with the comprehensive land-use plan. Eventually the city re-zoned the Sheffield's property to only allow half the number of homes. Sheffield sued the City for takings and other constitutional claims, most of which the trial court found in Sheffield's favor, and, following a jury trial on the damages, Sheffield was awarded $485,000 in damages. The Tenth Court of Appeals ruled that the re-zoning did constitute a compensable taking, reasoning that the economic damages (a 38% reduction in the value of its property) and that the rezoning unreasonably interfered with Sheffield's investment-backed expectations. *City of Glenn Heights v. Sheffield Development Co.,* 61 S.W.3d 634 (Tex. App.—Waco 2001) *rev'd by Sheffield Development Co., Inc. v. City of Glenn Heights*, 140 S.W.3d 660 (Tex. 2004).

On appeal, the Texas Supreme Court reversed the Court of Appeals and rendered a decision in favor of the City. First, the Court said the City's rezoning effort, although perhaps flawed in intent and execution, was not significantly different than the zoning effort made by cities every day. *Sheffield*, 140 S.W.3d at 679. Further, because Sheffield could not show damages from the moratorium that were distinct from the rezoning or that the 15-month delay caused by the moratorium impacted its reasonable investment-backed expectations, the moratorium did not cause a taking. *Sheffield*, 140 S.W.3d at 680.

Perhaps because local governments and state agencies work to avoid incurring any takings liability, there are a dearth of cases where plaintiffs have successfully won takings damages. In 2006 the Fourth Court of Appeals ruled a taking had occurred in the case of *City of San Antonio v. El Dorado Amusement Co. Inc.*, 195 S.W.3d 238 (Tex. App.—San Antonio 2006, pet. denied). In that case the City zoning changed on the plaintiff's property, which had been operating for 18 years providing on-site alcohol consumption, and the new prohibition on alcohol sales changed both the profitability and sale value of that property. Damages were awarded for both lost profits until the property was sold and the loss of value at that sale. *El Dorado*195 S.W.3d at 248.

A 2011 oil and gas case from the 14th Court of Appeals held that a taking occurred when the City of Houston prevented the owner of certain mineral rights from drilling to capture those minerals and the owner's lease eventually expired. *City of Houston v. Maguire Oil Co*., 342 S.W.3d 726 (Tex. App.—Houston [14 Dist.] 2011). In that case the only estate at issue was the severed mineral rights, and the Court held a taking had occurred when city staff erroneously applied a city ordinance that prohibited oil and gas wells in the city's extraterritorial jurisdiction to the Plaintiff's property, which was located within the city limits. *Maguire*, 342 S.W.3d at 747. The damages awarded were based on the difference, if any, between the fair market value of Maguire's mineral estate immediately before and immediately after the revocation of the drilling permit by the City.

REGULATING GROUNDWATER THROUGH GROUNDWATER CONSERVATION DISTRICTS

The Texas Legislature first began creating local regulatory agencies for the purpose of conserving groundwater in 1951, long after the 1917 voter ratification of the "Conservation Amendment," Section 59, Article XVI, Texas Constitution. The agencies, now known as groundwater conservation districts, cover either an entire aquifer or some manageable portion thereof. Their only duty is to protect the resource so that those who depend on groundwater are assured of a plentiful, clean supply. Groundwater conservation districts have 3 regulatory tools at their disposal: spacing requirements, production limitations, and production fees[10]. These 3 tools are typically implemented through a permitting system, and most groundwater conservation districts require permits to drill a new well and operating or production permits for a specific term of years.

Groundwater Conservation District Jurisdiction

Spacing Requirements

Nearly all of the groundwater conservation districts above the Ogallala Aquifer in the Texas Panhandle have adopted spacing requirements that prevent new wells from being drilled within a certain distance of any other well, and in some instances within a certain distance of the property line. The Ogallala is a flat, sandy aquifer, and the primary problems are depletion

[10] Not all districts have all 3 of these tools. Nearly all groundwater conservation districts were created by special legislation and the powers and duties of each are unique.

and overlapping cones of depression. Every water well creates a cone of depression centered at the well and spreading out for some distance from the well. The distance it spreads is dependent on the hydrogeology of the aquifer. In the case of Mr. East, the railroad well's cone of depression extended onto the East property and Mr. East claimed the railroad's well operations drained all the water out of his well. Wells much deeper and more powerful than were possible in 1904 can have cones of depression that reach for great distances.

By spacing out the wells, the local district can minimize the impact of overlapping cones of depression. This helps ensure each landowner access to some amount of water. Please note that the rule of capture still applies: Whiteacre cannot sue Blackacre for allowing the cone of depression to extend onto Whiteacre. But the district's spacing regulation helps protect *both* properties and thereby increases both the land values and productivity.

Production Limitations

In other areas, such as Houston and San Antonio, spacing requirements would have little or no effect on the problems facing those particular aquifer systems. In Houston the problem is subsidence—the sinking of the land surface due to groundwater withdrawals. In San Antonio the problem is rapidly dropping aquifer levels during periods of drought, adversely affecting both well owners and surface springs. In both locations the preferred method of regulation is limiting the amount of water that can be produced from each regulated well. By reducing the overall production, the aquifer pressure and water levels can be maintained to prevent the harm.

Again, the rule of capture still applies. The Texas Supreme Court was asked to address this specific issue in 1978, 2 years after the creation of the Harris-Galveston Coastal Subsidence District when a group of landowners filed suit against an industrial group for causing its land to subside. *Friendswood v. Smith-Southwest Indus.*, 576 S.W.2d 21 (Tex. 1978). The Court held that the rule of capture still applied, so the defendant owed the plaintiff no duty of care. The Court did, however, prospectively modify the rule of capture to allow for future suits where the plaintiff could show that negligent pumping by the defendant had caused plaintiff's land to subside. Never did the Court even consider what some have argued: that inside groundwater conservation districts the rule of capture has been abolished or modified.

As aquifer depletion becomes more of a problem and as cities begin looking to rural groundwater supplies as their future water source, more and more groundwater conservation districts are adopting production limitations. The overall effect will be a safer supply for everyone.

Production Fees

Production fees, the third tool, are not available to all of the groundwater conservation districts in the state and are greatly limited by statute. Even with the statutory limits, fees can be used to help reduce production. The Harris-Galveston Subsidence District is the only district that has adopted a fee schedule designed to create an economic disincentive to pumping groundwater. In the *Beckendorff v. Harris-Galveston Coastal Subsidence Dist.*, 558 S.W.2d 75, (Tex. Civ. App.—Houston [14th Dist.] 1977), writ ref'd *per curiam*, 563 S.W.2d 239 (Tex. 1978), decision the Houston Court of Appeals specifically approved the use of fees as a regulatory tool designed to reduce production. The Austin Court of Appeals agreed 13 years later in *Creedmoor Maha Water Supply Corp. v. Barton Spring-Edwards Aquifer Conservation Dist.*, 784 S.W.2d 79 (Tex. App.—Austin 1989, writ denied). In both cases the Appellate Court said that the fees were designed to create a disincentive to pump groundwater and were thereby regulatory tools rather than taxes.

Takings Implications of Groundwater Regulations

Every aspect of groundwater regulation may be rife with takings implications and certainly potential litigation. Collectively the groundwater conservation districts must set desired future conditions for the various aquifers within a groundwater management area. § 36.108, Water Code. Once the desired future condition is set for a given aquifer, each groundwater conservation district must regulate that aquifer to achieve that goal. § 36.1071, Water Code (Management Plan requirements); § 36.1132, Water Code (permitted groundwater production will achieve an applicable desired future condition). The amount of groundwater that may be withdrawn annually (and still achieve the desired future condition) is represented by the modeled available groundwater. § 36.1132(b)(1), Water Code. Taken together these legislative mandates create a perfect storm for litigation. If the district continues to issue permits without limitation, the district is subject to enforcement action by the Texas Commission on Environmental Quality. § 36.1082(b)(7), Water Code. That district may also be the target of a suit by a landowner whose groundwater levels are steadily dropping because of the production authorized by the district. If the district sets a limit on production and stops issuing permits, an existing landowner that cannot get a permit to drill a well is likely to file a takings claim (see discussion of the *Bragg* case *supra*). The only other option is for the district to continue issuing permits for new wells, and then require reductions in all permits to assure achieving the desired future condition. Of course, permittees

forced to reduce their pumping are likely to sue based on their investment-backed expectations.

Whether any of the claims will succeed depends entirely upon an analysis under *Mayhew* and *Day and McDaniel*, and whether a landowner has been denied a "fair share" of the groundwater. Each case will be judged on its own facts, including the district's management plan, regulations and permit decisions, and the plaintiff's property interests and investment-backed expectations.

FUTURE CASES

Bragg v EAA

Bragg v. Edwards Aquifer Authority, No. 06-11-18170-CV (38th Jud. Dist., Medina County, Tex., filed Nov. 21, 2006)

Glenn and Jolynn Bragg ("Braggs") applied to the Edwards Aquifer Authority for Initial Regular Permits to irrigate 2 pecan orchards: the "D'Hanis" orchard and the "Home Place" orchard. In both cases the Braggs requested 6 acre-feet of groundwater per acre, citing the higher water demand for pecan trees, although neither well had ever produced that amount of groundwater either during the historical use period or during any year prior to filing the litigation. However, under the Edwards Aquifer Authority Act permits may only be granted for the amount of water withdrawn and beneficially used during an historical use period (1971–1992). The well at the Home Place orchard had historical use, but the D'Hanis Orchard well was drilled in 1995 and did not qualify for an Initial Regular Permit. As a result, the Authority denied the D'Hanis permit application on the basis that there was no irrigation during the historical use period. The Authority granted the Home Place permit application at the statutory minimum for agricultural irrigation wells of 2 acre-feet of water per acre (which is more than the amount ever actually produced from that well) for each acre of land actually irrigated during any 1 year of the historical use period. The Braggs claimed a constitutional taking of their common law water rights and sought compensation from the Authority. The Braggs originally sued the Authority for federal civil rights violations as well, but all of those claims were denied in federal court and the state takings claim was remanded to state court.

Following a bench trial, the Court ruled that Edwards Aquifer Authority Act's enactment and implementation did not deprive plaintiffs of all economically viable use of their property and concluded that

- the Act's enactment and implementation "substantially advance the government's legitimate interest" in protecting the Edwards Aquifer and the associated springs;
- no statute of limitations bar actions brought for takings claims raised as part of the permitting process;
- the Authority's denial of the D'Hanis Initial Regular Permit application "unreasonably impeded the Plaintiff's [sic] use of the D'Hanis Orchard as a pecan farm, causing them a severe economic impact; interfered with their investment-backed expectations, and constituted a regulatory taking of the Plaintiff's [sic] property" under the *Penn Central* and *Sheffield* (Texas) cases for which the compensation owed the Braggs is $134,918.40 (calculated from the difference, per acre, in the value of dry land farm land and Edwards Aquifer-irrigated farm land in Medina County); and
- the Authority's granting of the Home Place Initial Regular Permit for less than the amount requested "unreasonably impeded the Plaintiff's [sic] use of the Home Place Orchard as a pecan farm, causing them a severe economic impact; interfered with their investment-backed expectations, and constituted a regulatory taking of the Plaintiff's [sic] property" under the *Penn Central* and *Sheffield* (Texas) cases for which the compensation owed the Braggs is $597,575 (current market value of $5,500 for the 108.65 acre-feet of EAA permitted rights that were requested, but not granted).

The total amount of compensation found owed was $732,493.40.

The judge's findings of fact and conclusions of law found, among other things, that

- "the Authority acted solely as mandated by the Act and without discretion in denying the D'Hanis Application and in granting a permit on the Home Place Property for 120.2 acre-feet of annual Edwards Aquifer water withdrawals" in an Initial Regular Permit and
- the Authority's requested attorney's fees were reasonable.

Notably, the Bragg court considered whether the relevant parcel for a takings could be limited to the groundwater estate in the regulated Edwards Aquifer and accepted such an approach with respect to the Home Place Property, though that same calculus was rejected for the D'Hanis Property. Further, the Court determined that the Braggs should be compensated for the Home Place Property not based on the value of their groundwater rights but based on the groundwater rights the Braggs requested from the Authority but did not receive.

The Authority and the Braggs each filed notices of appeal, and the parties' briefs have all been filed with the Fourth Court of Appeals in San Antonio. In addition, 3 amicus briefs were filed, 1 by the San Antonio Water System in support of the Authority and 2 filed in support of the Braggs by the Pacific

Legal Foundation and the Texas Farm Bureau, et al[11] (other amicus briefs are likely to be filed in the near future). The Court of Appeals heard oral argument on March 28, 2013.

The Medina County District Court held that the Authority took the Bragg's property through 2 actions:

1. denying a permit to withdraw non-exempt groundwater from a well and
2. granting a permit for an amount less than the landowners requested.

Neither approach considered alternative groundwater supplies still available to the Braggs, thereby creating law that grants a vested property right in each and every aquifer formation beneath a property as a severable estate. Neither approach considered the Edwards Aquifer groundwater still available to the Braggs through exempt-use domestic and livestock wells or Section 1.19 term permits, thereby creating law that grants a vested property right in each and every type of permit offered by a district. The Fourth Court of Appeals must clarify just how takings analysis should be applied to groundwater regulation, and provide a regulatory path that groundwater conservation districts may follow to avoid taking private property in the future.

As groundwater conservation districts approach the limits on the amount of groundwater that may be produced and still achieve that aquifer's desired future condition each Board of Directors will be faced with a choice of denying new applications (highly unlikely in light of the *Day* decision) or reducing existing permits. Under this District Court's analysis, every groundwater conservation district would be potentially liable for money damages for every denied application *and* for every reduced permit. There is no path to nonliability other than foregoing any regulation.

Other Potential Lawsuits

The potential for takings lawsuits filed against groundwater conservation districts is virtually limitless. Because each aquifer is different the regulations addressing who gets permits and for how much is different. Potential plaintiffs includes those who are denied permits, those whose permits are reduced and any landowner who watches aquifer levels decline over time. Not only will production limitations be challenged, but spacing limitations as well.

Key questions include:

1. Does this mean every urban and suburban lot owner is entitled to a water well and some amount of groundwater (or compensation)? What is the "fair-share" due to a small-lot landowner?
2. Can a landowner file suit against a groundwater conservation district for allowing groundwater beneath his property to decline (caused by permits for withdrawal on other properties)?
3. Are municipalities that prohibit or restrict water wells now also facing takings liability?
4. Is there a potential for federal takings claims in addition to state takings claims?
5. Can groundwater conservation districts say "no permit this year" without takings liability, or would they face liability for a temporary takings? How will this affect water conservation requirements and drought restrictions?
6. Do historical users, who have investment-backed expectations, have the best claim for a takings?
7. Is domestic and livestock use enough of a "fair share" or is that going to depend on how many acres the landowner controls?
8. Is there a vested property right to each aquifer or formation, or as long as the landowner has access to some reasonable amount of groundwater can restrictions on tapping other formations avoid takings liability?

CONCLUSION

The argument over groundwater regulation in Texas will be settled as groundwater conservation districts all over the state continue to tighten controls on groundwater production and landowners begin filing takings claims. Cities will continue to look for plentiful, affordable water supplies for their growing populations, and rural areas will continue to worry about their long-term supplies as aquifer production increases. People who are looking to protect future supplies often speak of aquifers as "our water," while those who are seeking to sell water supplies only refer to "my water." In fact, groundwater is neither "ours" nor anybody's "mine," which is exactly why reasonable regulation is so necessary. Landowners cannot fence their groundwater, cannot quantify the water that flows past their property underground, and cannot prevent anyone from drying up their well. Landowners' only "fence" is a strong groundwater conservation district permit quantifying their ability to capture groundwater and the requirement that their neighbors obtain permits. Fighting against that regulation through takings lawsuits will only weaken everyone's claim to ownership of groundwater.

[11] Other Amici on the Texas Farm Bureau brief: Texas and Southwest Cattle Raisers Association, Texas Forestry Association, Texas Association of Dairymen, Texas Wildlife Association, and Texas Cattle Feeders Association.

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Groundwater Conservation District Finance in Texas: Results of a Preliminary Study

Charles R. Porter, Jr.[1,2]

Abstract: The preferred method of groundwater management in Texas is by locally formed groundwater conservation districts (GCDs). However, not all of Texas groundwater is managed by a district; some areas have not voted to form a GCD. There are 99 GCDs in Texas with 2 pending; only 174 of the 254 counties are covered by a GCD. GCDs are financed by ad valorem taxes, fees, and grants. Not all GCDs have ad valorem tax support. Revenues from the responding GCDs in this study range from $20,000 annually to $2,632,982. Some cannot open their offices daily. All need money for research to determine the actual amount of groundwater in their district, its sources, and its characteristics. Tax rates for the GCDs with ad valorem tax authority in this study run from $.005/$100 valuation to $.035/$100 valuation, meaning a $200,000 home in these districts would pay from $10 to $70 annually, not as much as a few cups of Starbucks coffee cost annually. All Texans agree water is life, and groundwater is one of our most precious resources, therefore GCDs deserve more financial resources. The Texas Water Code provides a number of tools for GCDs to finance their operations including ad valorem taxation levies, issuance of bonds, notes, and promulgation of fees to name a few. However, in many of the GCDs who responded to the study, these tools are not practical to use. Since ad valorem taxation and bond authority must be granted by local voter approval, these tools are unavailable in some GCDs as well.

Keywords: groundwater management, groundwater conservation district finance

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[2] Author's Note: I was assisted by my summer intern at St. Edward's University, Emily Caudill, in compiling the charts and data. I greatly appreciate her able assistance.

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Terms used in paper

Short name or acronym	Descriptive name
DFC(s)	desired future condition(s)
GCD(s)	groundwater conservation district(s)
GMA(s)	groundwater management area(s)
MAG	managed (or modeled) available groundwater
PGMAs	priority groundwater management areas
TWDB	Texas Water Development Board
TCEQ	Texas Commission on Environmental Quality

Groundwater conservation districts (GCDs) manage a large portion of the groundwater produced in Texas though not all; some areas are not covered by a GCD.[1] The Texas Legislature has asserted on a recurring basis that it prefers groundwater be managed by GCDs.[2] Yet of the 35 voluntary GCD respondents to this brief study, only High Plains Underground Water Conservation District No. 1 ($2,632,982)[3], Barton Springs/Edwards Aquifer GCD ($1,420,170)[4], and Upper Trinity GCD ($1,337,750)[5] had annual gross revenue greater than the average Starbucks coffee shop ($1,078,000); only High Plains had more revenue than the average McDonald's ($2,565,000)[6] or even The Finish Line, a tennis shoe shop located in many malls ($1,807,548)[7]. Of the GCDs that responded to this preliminary study with ad valorem tax support, in 14 of the 35 participants, the highest tax rate reported was $.035/$100 valuation[8] meaning the tax paid annually for the local GCD on an individual property valued at $200,000 is only $70, for many, not even the cost of 1 tank of gasoline, 2 cups of Starbucks coffee a month for a year, or 2 bags of groceries. Not all of Texas is covered by a GCD; the groundwater in only 174 of the state's 254 counties is managed.[9] The future success in Texas is directly linked to groundwater resources—of that, few disagree. No one disagrees either that water is life.

To date the citizens of Texas, however, seem reluctant to adequately finance the costs of the preferred management method of groundwater, that is GCDs. The Legislature is responsible for setting up the process to fund GCDs. Texas citizens do not set the budgets for state agencies and, other than the ballot box, have less than timely and, at best, indirect control over political subdivision revenues from ad valorem taxes and fee structures. GCDs have the opportunity, with the consent of their local voters, to become ad valorem tax-based entities. However the Legislature, by requiring these local confirmation elections, have made it a difficult challenge for GCDs to generate revenue as ad valorem tax-based entities.

GCD LOCATIONS AND BASIC STATISTICS

The map in Figure 1 depicts the locations of the individual Texas GCDs. The areas in white have no GCD at this time.

The Texas Water Development Board (TWDB) offers these facts about GCDs in Texas:

- There are 99 GCDs in Texas: 97 are confirmed by voters (note: this estimate includes several districts that do not require confirmation), and 2 have yet to be confirmed by voters through local elections.
- The first district (High Plains Underground Water Conservation District No. 1) was created in the Texas Panhandle in 1951.
- The smallest district covers an area of about 31 square miles (Red Sands Groundwater Conservation District in Hidalgo County), and the largest district (High Plains Underground Water Conservation District No. 1) covers an area of approximately 12,000 square miles.
- A total of 174 counties are either fully or partially within a GCD.
- There are 62 single-county districts in Texas and 37 that cover more than 1 county.
- While 96 of the 99 existing districts overlie a major aquifer, only 64 of these districts overlie a minor aquifer.
- The total reported groundwater usage in the entire state in the year 2008 was approximately 9.7 million acre-feet.
- In the same year, the total reported groundwater usage in all the districts (confirmed and unconfirmed) in the state was approximately 8.3 million acre-feet.
- Districts over the Ogallala Aquifer accounted for approximately 5.6 million acre-feet of this usage.
- In 2008, Throckmorton County had the lowest amount of reported groundwater usage (28 acre-feet) and Hale County the highest (540,886 acre-feet).
- The first groundwater management plan to be approved was the Gonzales County Underground Water Conservation District's plan in 1998.

Texas GCDs are almost infinitely variable; drawing "across-the-board" conclusions about them can be problematic. The same is true for water wells in Texas—their use, depth, and production volume varies widely. The TWDB maintains an inventoried database of 135,000 water wells in Texas. According to the TWDB, "This database, thanks in part to the cooperation from private well owners and public agencies, is one of the most comprehensive statewide groundwater databases

[1] According to the Texas Water Development Board (TWDB) currently 174 of Texas' 254 counties are covered or partially covered by a GCD.

[2] Texas Water Code 36.0015. The Texas Supreme Court has also emphasized the importance of GCDs, most recently in the opinion by Justice Nathan Hecht in T*he Edwards Aquifer Authority and the State of Texas, Petitioners, v. Burrell Day and Joel McDaniel*, Respondents, in the Supreme Court of Texas No. 08-0964.

[3] Appendix 1 to this article.

[4] Ibid.

[5] Ibid.

[6] http://www.retailsails.com.

[7] The Finish Line Annual Report 2012 Annual Report, 16.

[8] Appendix 1. The maximum tax rate allowed by statute is $.50 per $100 valuation.

[9] http://www.twdb.state.tx.us/groundwater/conservation_districts/facts.asp

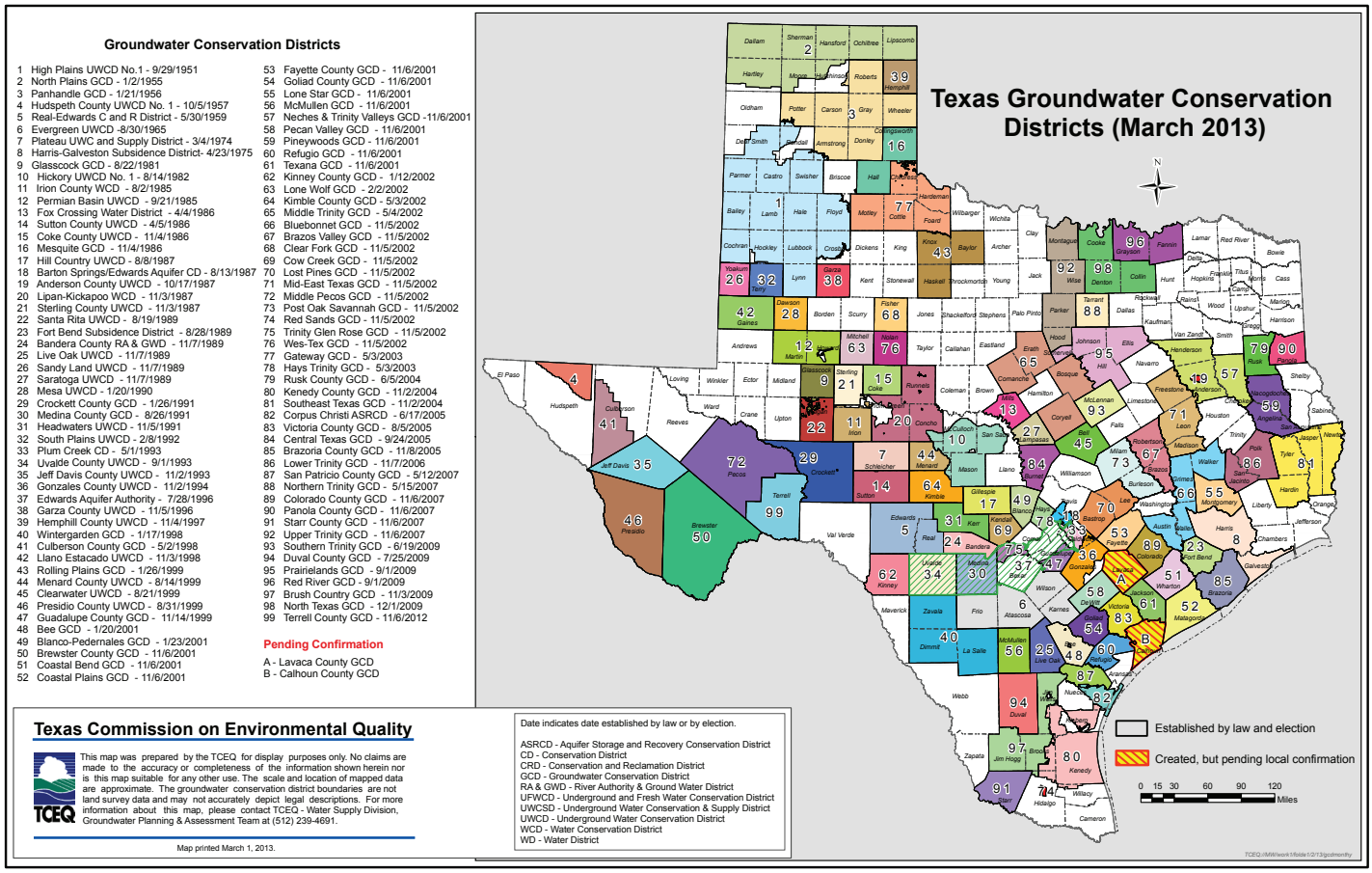

Figure 1. March, 2013 Map of groundwater conservation districts.

in the entire United States."[10] The database certainly does not include all the water wells in Texas, yet by its sheer size it indicates the critical role groundwater plays in the everyday lives of Texans.[11] We simply fail to put our money where no doubt we would all agree our treasure is—into the support of prudent water management and conservation.

BASIC SOURCES OF GCD REVENUE

While there are 3 basic sources of revenue for GCDs: local ad valorem taxes, permit and other fees, and grants, there is a wide variation in revenues across the 35 GCDs that responded to the questionnaire.[12] As mentioned, the study respondents had annual revenues that ranged from $20,000 to $2,632,982.[13] Some respondents have hundreds of permitted

[10] http://www.twdb.state.tx.us/groundwater/data/; for a county-by-county compilation of water wells, see http://www.twdb.state.tx.us/groundwater/data/gwdbrpt.asp. Other substantial well data can be found at the Texas Department of Licensing and Regulation, the Railroad Commission of Texas, and at the United States Geological Service Texas Water Science Center in San Antonio.

[11] Many domestic and livestock wells are not required to be registered anywhere. The TWDB is required by statute to estimate all exempt use. The TWDB defined its methodology for accounting exempt use in this statement found on page 4 of "GAM Run 10-050 MAG" February 1, 2011: "Since exempt uses are not available for permitting, it is necessary to account for them when determining managed [now referred to as modeled] available groundwater. To do this, the TWDB developed a standardized method for estimating exempt use for domestic and livestock wells in the area. Because other exempt uses can vary significantly from district to district and there is much higher uncertainty associated with estimating use due to oil and gas exploration, estimates exempt pumping outside domestic and livestock uses have not been included. If the district believes it has a more appropriate estimate of exempt pumping, it may submit it, along with a description of how it was developed, to the TWDB for consideration. Once established, the estimates of exempt pumping are subtracted from the total pumping output from the groundwater availability model to yield the estimated managed [now referred to as modeled] available groundwater for permitting purposes."

[12] There are 97 GCDs currently; 77 were selected for the questionnaire (the members of the Texas Alliance of Groundwater Districts).

[13] See Appendix 1. The Texas State Auditor is a source for further information about revenue sources of GCDs. For the purposes of this preliminary study, only voluntary respondents' information was used.

irrigation wells; others such as the Crockett County Groundwater District have only 3.[14] Though a GCD has a small amount of revenue, that does not necessarily indicate a need for more funding. Some GCDs do not have much demand for non-exempt water wells—irrigation, municipal, or industrial use wells—hence, due to lack or demand, the impact of any production, user, or export fees would be insignificant. Many district water wells drilled are only used for and classified as domestic and livestock wells, which are generally exempt from permit.[15] Some GCDs are located in oil and gas shale boom areas where hydraulic fracturing is using millions of gallons of groundwater to extract the oil and gas. This use of groundwater is also exempt from permit during exploration activities, but during production, it requires a permit.[16] According to The Railroad Commission of Texas[17]:

> The amount of water needed to perform hydraulic fracturing on a well is highly variable and depends on the formation that is undergoing hydraulic fracturing and whether the well being fractured is a vertical well or a horizontal well.
>
> In the Barnett Shale, hydraulic fracturing of a vertical well completion can use 1.2 million gallons (28,000 barrels) of water, while the fracturing of a horizontal well completion can use 3.5 million gallons (over 83,000 barrels) of water.
>
> In the Eagle Ford Shale, industry has reported an average use of approximately 11 acre-feet of water used to complete each well, down from the approximately 15 acre-feet previously used.
>
> The amount of water used in hydraulic fracturing is relatively small when compared to other water uses such as agriculture, manufacturing and municipal water supply.
>
> According to the TWDB, irrigation accounts for the largest share of the state's total current water demand, roughly 60 percent, and projected water needs are expected to increase most in the area of municipal water use in the coming decades. In comparison, hydraulic fracturing and total mining water use continue to represent less than one percent of statewide water use, although percentages can be larger in some localized areas.

Before going into a detailed commentary about the results of the study, an overview of GCD characteristics and current issues is helpful.

THE NEED FOR GCDS; RISK IN AREAS WITHOUT GCDS

According to Kirk Holland, general manager of the Barton Springs-Edwards Aquifer Groundwater Conservation District, "every square inch of ground in Texas should be in a groundwater conservation district."[18] In the areas where no GCD exists, there is no management or protection of groundwater. Some cities and counties regulate groundwater use and some "home-rule" cities exercise their police power to regulate groundwater well drilling and production. Without a GCD, landowners risk a loss of their groundwater, not only to adjacent landowners with the same rights for local use but also to those who would transfer large amounts of groundwater to other areas of the state. This fact should cause a great deal of alarm and consternation for people living in those unprotected areas. For example, 1 area without a GCD is Val Verde County, the home county of the City of Del Rio. Del Rio was warned by its own consulting engineer of the city's impending risks in not being covered by a GCD due to the concept of the "rule of capture" in Texas groundwater law.[19] The local people personally interviewed believe creation of a GCD in their area by local election is not probable in the near future—maybe

[14] Interview with Slate Williams, general manager of the Crockett County Groundwater Conservation District in Ozona, Texas July 17, 2012.

[15] The typical domestic and livestock well does not have to be permitted as long as it is incapable of producing more than 25,000 gallons per day on a 10-acre tract. 25,000 gallons per day is the equivalent of 336 inches of rain a year (1 inch of rain per acre equals 27,154 gallons of water), the equivalent to a very wet rainforest. While it is unimaginable that someone would use that much water in a beneficial way, since there is no permit required, no meter required, and no accounting of the amount of water drawn for most domestic and livestock wells meeting the exempt rules, we simply do not know how much water exempt domestic and livestock wells are using across the state or in any GCD. Most GCDs now at least require registration of domestic and livestock wells, generally for statistical purposes only. How well this is enforced is unknown. The question is not so much the number of wells drilled in the past few years, but the wells that were drilled in the recent past or prior to the formation of the local GCD.

[16] The Texas Water Code 36.111 requires those fracturing to report their groundwater use if required by local GCD rule.

[17] http://www.rrc.state.tx.us/about/faqs/hydraulicfracturing.php

[18] Phone interview with Kirk Holland, January 4, 2012.

[19] Charles Porter. "The History of *W.A. East v. Houston and Texas Central Railway Company, 1904*: Establishment of the Rule of Capture in Texas Water Law or "He Who Has the Biggest Pump Gets the Water." East Texas Historical Journal, 50th Anniversary Edition, Fall, 2012. The rule of capture declared there is no liability for 1 neighbor's water well taking enough water to deplete a neighbor's water well. It has been confirmed for more than 100 years by all the Texas courts, including the Texas Supreme Court. In areas without a GCD, the rule of capture can be a formidable threat to the future of the area's groundwater.

ever.[20] Groundwater is owned in place according to the ruling of the Texas Supreme Court in the Day case[21]; however determining precisely the amount of groundwater owned is very difficult and expensive as groundwater is "fugitive" in nature or moving constantly from place to place.

An example of a different anomaly in groundwater management in Texas with potentially negative consequences on both the aquifer and public attitude towards conservation is the City of Austin. Austin's groundwater north of the Colorado River is not covered by a GCD. The imposition of watering restrictions during drought and the increasingly high cost of lawn irrigation have spurred the installation of more than 200 private water wells within the city's service area since 2006, with essentially no restrictions on their spacing or the amount of water produced by each, in an area already adequately served by centralized water supplies.[22] The impact on the aquifer of these new wells and their interference with each other, especially during prolonged drought, are unknown at this time. The sense of a reduced need for conservation among those generally well-heeled private well owners and the inequity perceived by other landowners without such wells make sorely needed water conservation, regardless of water source, more difficult and of concern to water managers.

Garrett Hardin, an ecologist, wrote in the "The Tragedy of the Commons" about the depletion of a shared resource by individuals, acting independently and rationally according to each one's self-interest, despite their understanding that depleting the common resource is contrary to the group's long-term best interests.[23] Groundwater in Texas is one of our most precious common resources. The tension maintaining the delicate balance between the common good and personal interest is building in Texas especially due to the serious prospect of extended drought in our future, yet again.

[20] Interview with Bill Nixon an ex Del Rio City Councilman, in Del Rio, July 27, 2010. Their family has the oldest and largest ranch inside the city limits dating to just after the Civil War.

[21] The Edwards Aquifer Authority and the State of Texas, Petitioners, v. Burrell Day and Joel McDaniel, Respondents, in the Supreme Court of Texas No. 08-0964.

[22] Austin American-Statesman. "Drought spurs more to drill private wells" June 3, 2012, front page. It is estimated there were 156 private water wells in the City of Austin at that time; latest estimates exceed 200. The City of Austin passed Ordinance 20121011-005 on October 11, 2012. In this ordinance, the City has authority to require registration of private water wells along with other authority to avoid water quality impairment. However, there is no limitation as to the amount of water drawn other than the court ruled limitations on the "rule of capture."

[23] Hardin, G. (1968). "The Tragedy of the Commons". *Science* 162 (3859): 1243–1248

HOW GROUNDWATER CONSERVATION DISTRICTS ARE CREATED

The Groundwater Conservation District Act of 1949 provided for conservation and development of groundwater with GCDs as managers.[24] In 1951, the High Plains Underground Water Conservation District No. 1 became the first GCD created in Texas. Chapters 35 and 36 of the Texas Water Code describe the specific legal authority granted GCDs relating to the management of groundwater and the administrative governance and oversight of GCDs by state agencies. The TWDB administrative rules review the desired future conditions (DFCs) of the groundwater management areas (GMAs). Member GCDs propose DFCs working through their GMA but do not have the authority to change the GMA-determined DFCs at the GCD level. The Texas Commission on Environmental Quality (TCEQ) also has limited oversight over GCDs under the Texas Water Code. GCDs are political subdivisions in Texas and as such, they are additionally obligated to abide by all state laws relating to political subdivisions, including laws related to open government and public information, ethics, and voting.

There are currently 99 GCDs covering all or part of 174 counties.[25] There are also 2 unconfirmed GCDs that have full statutory authority to regulate although confirmation will be required to keep those powers. These GCDs have broad statutory authority but their activities remain ultimately under the electorate's supervision. Each district presides over a territory described at its creation. GCDs strive to protect property owners' rights while at the same time preserving groundwater resources. Landowners may petition to create a GCD or petition an existing GCD for annexation of their land. Generally voters approve the formation of the district and elect the governing board of directors, but in some areas, county commissioners appoint the board of directors. All GCDs must develop a groundwater management plan every 5 years to address water supply needs, management goals, and estimates of water usage. The GCD submits the plan to the TWDB for administrative approval and implementation of the plan is subject to review by the State Auditor's Office. Since 2005, all GCDs participate in joint planning within GMAs.

Authority Granted to GCDs

According to Chapter 36 of the Texas Water Code, "[GCDs] created as provided by this chapter are the state's preferred method of groundwater management through rules devel-

[24] See also The Texas Constitution Article XVI, section 59.

[25] www.twdb.state.tx.us/mapping/doc/maps/gcd_only_8x11.pdf, as of March, 2013.

oped, adopted, and promulgated by a district in accordance with the provisions of this chapter."[26] Section 36.113 provides that GCDs must "require a permit for the drilling, equipping, operating, or completing of wells or for substantially altering the size of wells or well pumps."[27] When acting on permit applications, a district must consider whether "the proposed use of water unreasonably affects existing groundwater and surface water resources or existing permit holders," whether "the proposed use of water is consistent with the district's approved management plan," and whether "the proposed use of water is dedicated to any beneficial use. [28]" GCDs formulate and are guided by groundwater management plans that:

- provide for the most efficient use of groundwater,
- control and prevent waste of groundwater,
- control and prevent subsidence,
- address conjunctive surface water issues,
- address natural resource issues,
- address drought conditions, and
- address conservation.

The rules of most GCDs include the registration of all water wells, even those exempted from permitting by the Texas Water Code. The basic exemptions[29] are 1) domestic and livestock use of water from a well on tracts larger than 10 acres and that is capable of producing no more than 25,000 gallons per day[30] and 2) water wells used in oil and gas exploration (excluding production)[31].

Section 36.116 (a) of the Texas Water Code further outlines the broad regulatory authority of GCDs:

> In order to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, to control subsidence, to prevent interference between wells, to prevent degradation of water quality, or to prevent waste, a district may regulate:
>
> (1) the spacing of water wells by:
>
> (A) requiring all water wells to be spaced a certain distance from property or adjoining wells;
>
> (B) requiring wells with a certain production capacity, pump size, or other characteristic related to the construction or operation of and production from a well to be spaced a certain distance from property lines or adjoining wells; or
>
> (C) imposing spacing requirements adopted by the board; and
>
> (2) the production of groundwater by:
>
> (A) setting production limits on wells;
>
> (B) limiting the amount of water produced based on acreage or tract size;
>
> (C) limiting the amount of water that may be produced from a defined number of acres assigned to an authorized well site;
>
> (D) limiting the maximum amount of water that may be produced on the basis of acre-feet per acre or gallons per minute per well site per acre;
>
> (E) managed depletion; or
>
> (F) any combination of the methods listed above in Paragraphs (A) through (E).32

VOLUNTARY METERING OF WATER WELLS

The Texas Water Code allows GCDs to consider how granting new permits will affect existing permit holders and surface water resources. The rights of historical users may be protected in considering permitting of new users. Since there is a real possibility that drought or other scarcity may force GCDs and other Texas agencies to enact increased limitations on groundwater withdrawals, it may be wise policy for landowners to meter all their wells and document the amount of water used historically. I have discussed the idea of metering exempt domestic and livestock wells and all wells in areas without a GCD with many farmers and ranchers across Texas in the last 2 years. While I meet resistance to the idea of metering at first, many of my interviewees understand the value of a meter and good recordkeeping to someday prove their historic use.

[26] Texas Water Code 36.0015.

[27] Ibid. 36.113.

[28] Ibid.

[29] Note that there are exemptions to the exemptions also but are outside the scope of this paper.

[30] The domestic and livestock exemption is set by the individual GCDs and varies across the state. The specification provided by the statute is a minimum standard for exemption.

[31] There is discussion underway in the field about oil and gas exemptions for fracturing older wells or reworked wells and exempt status. Some GCD managers I talked to expressed concern over what activity constitutes exploration and what is production. Recently private landowners are selling water to oil and gas drillers through "private water stations." The water wells supplying these water stations are not exempt under the Texas Water Code 36.117.

[32] Texas Water Code 36.116 (a).

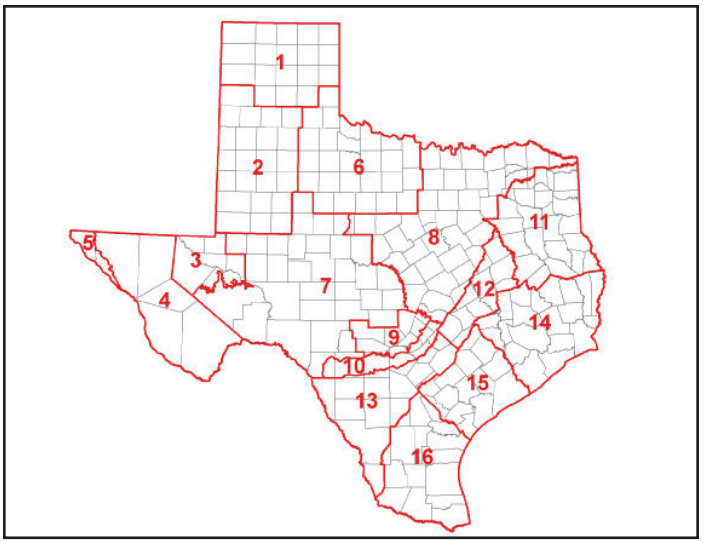

Figure 2. Groundwater management areas (GMAs).

CONTROVERSIAL RULES

The most controversial GCD rules involve restrictions on withdrawals. Historically, districts have sought to protect groundwater by regulating the spacing of wells, limiting the rate of pumping, limiting the amount of pumping each year, or a combination of these measures. There are high limits to the fines associated with violation of GCD rules, up to $10,000 per day for each violation. Those neighbors who own land adjacent to a well in violation of GCD rules may sue the well owner for damages to stop the violation and to recover damages.[33] Outside a GCD, the chances of a successful lawsuit such as this are exceedingly slim, as the rule of capture prevails.

Can GCDs generally prohibit landowners from access to water under their own land? GCDs are barred from prohibiting landowners from drilling wells that meet exempt criteria. GCDs, however, can regulate amounts of water withdrawn for municipal, industrial, and agricultural irrigation use. GCDs often regulate spacing between wells. Will most districts eventually require meters on existing wells? Considering the forecasts for Texas growth and future droughts, it may be a prudent practice of GCDs to require meters on all wells since more accurately determining the actual amounts of groundwater used protects not only the resource but all users in the district. Metering also greatly helps the science of groundwater since accurate pumping numbers are needed to have accurate models.

[33] See Texas Water Code 36.119 and particularly 36.119(g) for preconditions for filing this type of lawsuit.

GROUNDWATER MANAGEMENT AREAS AND DESIRED FUTURE CONDITIONS

The GMAs are shown in Figure 2. The logic behind their formation was simple. Since many of the 99 GCDs are defined more or less by county boundaries and many share the same aquifer and underground water sources, the GMAs give long-term water planners a chance to consider on a more regional basis the impact the GCDs have in total over an aquifer or underground water source. Section 35.004 (a) of the Texas Water Code provides that, "to the extent feasible, the groundwater management area shall coincide with the boundaries of a groundwater reservoir or a subdivision of a groundwater reservoir." According to the TWDB, "Section 35.004 provides that the TWDB may alter the boundaries of designated management areas as required by future conditions and as justified by factual data."[34]

As required by statutes adopted between 2005 and 2010, the GCD members of the GMAs used a defined joint planning process to develop DFCs for their aquifers and delivered them to the TWDB. According to a memorandum to TWDB board members dated September 9, 2009, "a desired future condition is essentially a management goal that defines the philosophy and policy of groundwater management in a defined area."[35] In other words, DFCs are a policy statement of what the GMAs would like their groundwater conditions to be in 50 years, so each of its member GCDs can begin to establish its own mandatory groundwater management objectives. To establish the DFC for the GMA, the member districts must adopt their DFCs by at least a two-thirds majority vote. The DFCs are submitted to the TWDB for review; the TWDB can recommend changes[36] but not mandate the districts or GMAs to make the changes. (I have heard some attorneys recently speak of a movement to give the TWDB the authority to force its recommended changes. However, both the TWDB and the Sunset Commission recommended the opposite; they recommended removing the TWDB from the process except for technical assistance.)

DFCs may be revised at any time and must be updated at least every 5 years. After the DFCs are generated, each GMA presents its decision in local hearings for the second round[37]

[34] Letter to Board Members, December 7, 2011, RE: Proposed Amendment to 31 Tex. Administrative Code Chapter 356 Groundwater Management. See Texas Water Code 35.004.

[35] For further detail, please refer to the Texas Water Code 36.001 and 36.108.

[36] The TWDB only has this ability if a petition challenging the reasonableness of the DFC is filed and only then if the board finds the DFC not reasonable.

[37] The process changed during the 82nd Legislative session. The first round hearing is no longer required.

to receive public comments. A few of these hearings have been thorny, as members of the public have disagreed with the DFCs in some areas. The public has the right to administrative appeal.

DFCs are critical for planning in each GCD. GMAs were created for the same reason as the answer to my favorite question for my water classes, "What does water ignore?" The correct answer is, "Political boundaries." Yet, political boundaries were a significant basis for setting GMA boundaries; some say more so than outlining the pool of groundwater in the overall area. The GMAs were formed to help generate groundwater policies considering shared groundwater sources among the GCDs.

MOST RECENT LEGISLATION

SB 660 was passed by the 82nd Texas Legislature, which added a definition for DFCs to Chapter 36 and now requires districts to ensure that management plan goals and objectives are consistent with achieving applicable DFCs. The bill added 9 new factors that districts must consider when renewing or establishing DFCs:

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from 1 geographic area to another
2. The water supply needs and water management strategies included in the state water plan
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water
5. The impact on subsidence
6. Socioeconomic impacts reasonably expected to occur
7. The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees, and assigns in groundwater
8. The feasibility of achieving the DFC
9. Any other information relevant to the specific DFCs

Pursuant to the act, DFCs must also "provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area."[38]

In addition to GMAs, Texas has currently designated 6 priority groundwater management areas (PGMAs). These are areas in which critical issues associated with quantity or quality of groundwater either already are occurring or may reasonably be expected to occur in the next 50 years.[39] For areas not covered by GCD protections inside any of these PGMAs, if the local population has not created a GCD on its own, the TCEQ has an obligation to create one even without local voters' approval, although any new tax rate associated with the new GCD must be voter-approved.[40] Counties in PGMAs and all other counties in Texas may "impose groundwater availability requirements on new developments dependent on groundwater."

MODELED AVAILABLE GROUNDWATER

After the GMAs delivered the DFCs to the TWDB, the board generated the then termed managed available groundwater (MAG) reports for each DFC on the basis of groundwater models and the best science available. In 2011, under SB 737 of the 82nd Legislature, the term managed available groundwater was changed to modeled available groundwater, and its definition modified for clarity.[41] A MAG is now defined as "the amount of water that the [TWDB] executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under [the joint planning process of] Section 36.108."[42] The MAG includes water produced from both exempt and non-exempt wells. The TWDB then apportions the MAG among the individual districts and also as warranted among the relevant regional water planning areas.

The MAGs, where available, are used as the mandatory basis for groundwater availability in regional water planning. They

[38] http://www.texasgroundwater.org/pdfs/2011legeupdate.pdf.

[39] Originally the PGMAs were based on a shorter time period. The 50-year time period changed in the 82nd Legislative session.

[40] The TCEQ has an "out" in the statute if it believes a GCD would not be viable.

[41] Since the groundwater model parameters are so critical to prudent planning of groundwater and the consequences of unrealistic models is significant, it is my opinion that the change in name is appropriate. Planning based on modeling is only as good as the model parameters. The Texas Alliance of Groundwater Districts published these comments about legislative changes made by the 82nd Legislature in 2011: "SB 660 also requires Regional Water Plans (RWPs) to be consistent with applicable desired future conditions (DFCs) and adds additional informational requirements for the state water plan. Notably, the bill requires TWDB and the TCEQ, in consultation with the Water Conservation Advisory Council (WCAC), to develop a uniform water use calculation system. These changes are consistent with the changes made by SB 181. Consistent with SB 737, SB 660 changes the term "managed available groundwater" to "modeled available groundwater" in order to better reflect the meaning of the term. SB 660 also makes comprehensive changes to the process for establishing and adopting DFCs in the various GMAs and filing petitions for inquiry at TCEQ. Though two separate proposals for amending the DFC appeals process were introduced during the Legislative Session, neither version passed. As a result, the DFC appeals process at TWDB remains substantively unchanged."

[42] SB 737, 82nd Legislature.

are also a major consideration in permitting decisions and other groundwater management activities by individual districts. Their use and significance are best judged at the individual district level. For example, I reviewed the Hays-Trinity Groundwater Conservation District MAG for the Trinity Aquifer before my speech to the International Right of Way Association in San Antonio in the fall of 2011. What does this particular MAG mean for the future of Hays County? Under current domestic and livestock well exemptions (no permit required for a well that is incapable of producing more than 25,000 gallons per day on a 10-acre tract), it appears to me that in a decade or so, the groundwater in the Hays-Trinity GCD may become fully allocated.[43] Does it follow then that the district will not allow any new water wells? What if a new crop is economically feasible and requires irrigation? Does this indicate that no new irrigation permits can be issued? If an existing landowner wants to change the use of the property to some use requiring irrigation, is that landowner going to be denied the request? Will the existing landowner have priority over the new landowner if they request irrigation permits at the same time? Did this create 2 classes of landowners? I do not have the answers, but assuming that the model accurately considers the consequence of growth in its jurisdiction and the GCD maintains its current definition of exempt wells, the district's ability to "manage" its groundwater production with the large number of exempt wells is effectively eliminated.[44]

The TWDB website publishes the MAGs for all of the districts in the state.[45] They are interesting to review for the various areas of the state. What will land values do in the future in the case that the full effect of exempt domestic and livestock use is considered?

Having presented a broad overview of GCDs, the following results of the study found in Appendix 1 indicate the vast differences in the revenues, budgets, and other financial structure of GCDs across the state. It bears repeating that smaller revenues and expenditures do not necessarily indicate a crisis in financial needs for the district. Geography, population density, socio-economic conditions, and groundwater demand more appropriately dictate financial decisions per GCD along with other factors that require more or less funding, including most importantly available studies and data.

Yet with the "sword-of-Damocles" statement made by the TWDB in the State Water Plan for 2012 cover letter, ("The primary message of the 2012 State Water Plan is a simple one: In serious drought conditions, Texas does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises.") maybe the state should begin assisting every GCD in planning a regulatory program to avoid the worst-case scenario, with periodic adjustments to the program to ensure the DFCs are achieved. Regional Water Planning Groups[46] are mandated by state law to use the groundwater availability information generated by GCDs and the TWDB (MAGs and DFCs) in an effort to plan, considering all aspects of water that recognizes the "conjunctive"[47] relationship between all kinds of water. One of the most prudent things the state can do is to set up or provide the resources to ensure that a key "weapon" to combat the predicted extreme aridity will be there when needed; that weapon is money. An equally important "weapon" is conservation-oriented practices, which include incentives to conserve and a dedicated campaign to educate Texans as to the value and essential need to conserve water in their daily lives.

It was encouraging for water planning statewide that the citizens of Texas passed Proposition 2 in the fall of 2011.[48] Proposition 2 authorized the state to provide access to state credit up to $6 billion to help finance water infrastructure needs in the future. While this is far short of the $53 billion needed according to the 2012 State Water Plan, Proposition 2 indicated a majority of Texans recognized the significance of water to our future quality of life. State Senator Troy Fraser and House Representative Allan Ritter presented bills in the ongoing current session of the Legislature to extract $2 billion in funding for the 2012 State Water Plan from the "Rainy Day Fund," and the House bill met resistance and was generally killed in the House of Representatives in early May. However, a compromise was reached Friday, May 17, which brought back the possibility of funding the $2 billion to the House floor. (At press time, the Legislature was still in session.)

[43] Of course, it would be exceedingly rare to find any domestic and livestock well using 25,000 gallons per day. Using the 25,000 gallons per day to evaluate the actual availability of groundwater is problematic since it seems impossible to imagine anyone using that much water daily. However, my point here is that the 25,000 gallons per day is a ridiculous amount to use anywhere in a regulatory formula to determine whether a domestic and livestock well could be drilled without a permit.

[44] The Legislature changed the Texas Water Code 36.1132 in 2011 to be clear that a MAG is not a permit cap, but rather 1 of several considerations and criteria that the GCD Board should consider under 36.113 and 36.122.

[45] http://www.twdb.state.tx.us/groundwater/

[46] Regional Water Planning Groups are designed as an attempt to address the conjunction relationship of groundwater to surface water over the state through a joint planning process.

[47] All water exists in a conjunctive relationship; groundwater feeds surface water, surface water and diffused surface water (rain) feed groundwater. Planning regulatory support for either type of water without consideration for the other is a mistake the state is trying to avoid with the regional planning groups.

[48] Proposition 2 results were 347,614 for (51.52%), 327,076 against (48.47%).

FINANCING GCDS – WIDE VARIATIONS IN NEEDS AND BUDGETS

Some GCDs in Texas face significant funding challenges, as they have statutorily restricted water use fee rates and low ad valorem taxation rates.[49] Some GCDs cannot afford to open their offices more than a few days a week or even a month.[50] Many times voters express their keen desire to establish a GCD but are not willing to vote any amount of additional taxes for adequately funding the GCD. GCD revenue can also be generated from water use fees on production from larger, non-exempt wells and from miscellaneous other fees, such as new well permit fees. However, in some GCDs there is not enough groundwater production from larger wells and not enough applications for new well permits or other fee-based activities to generate adequate revenue from such fees for full-time operations.

Yet, is more money needed in all the GCDs? Every GCD manager I talked to when asked if more money was needed, of course, said more money would be helpful. However, they all said more funding is not necessarily needed. In some ways my question was unfair; if a GCD manager says no money was needed, the tendency for their constituents will naturally be to move to reduce ad valorem taxes and fees. Along the same lines, if a GCD manager says a great deal of new money is needed, then the tendency for the public will naturally be to resist. The dire worldwide economic conditions certainly lead all prudently thinking people to be reticent about any commitment to higher fees or taxes. Some of the managers mentioned a need for more support, such as money for sample meters for irrigation and other wells. Every manager mentioned a desire for more detailed research to better determine as closely as possible the amount of groundwater existing in the district, its sources, and its characteristics. The Crockett County Groundwater Conservation District manager told me they discovered/accessed a "new" aquifer last summer, the Santa Rosa, introducing the idea that we may have groundwater resources heretofore undiscovered or unused, a very encouraging development.[51]

[49] As mentioned before, a GCD may set an ad valorem tax equal to $.50 per $100 valuation and it may also set $1 per acre-foot annually for agricultural use or $10 per acre-foot annually for water used for any other purpose. The key word here is "may." It is up to the local board of the GCD, where a GCD exists, to make these decisions with the support of local voters.

[50] A GCD manager in West Texas told me in 2009 that his entire annual budget was only $13,000; it has since increased to $20,000. Many GCDs simply cannot afford to keep their offices open to the public 5 days a week, yet in several cases, the demand is such that the offices need not open daily.

[51] Interview with Slate Williams.

THE STUDY

Appendix 1 shows the results from 35 respondents to these questions I submitted on basic financial aspects of Texas GCDs:

- What is your budget for the current year or most recent year?
- What is your total revenue (if possible separated by type and source)?
- What are your total expenses?
- How many wells are permitted and what type are they?
- How many exempt wells are in your district?
- How many permanent employees do you have?
- What are the hours and days of the week your office is open?

While all the GCDs in Texas are public agencies and subject to public information request regulations, I sought only volunteer responses; I did not modify the raw results. If a respondent did not answer a question, the box in the Appendix is filled with the comment "no response." Some districts are fee-based only without ad valorem tax support. Some gain almost all their revenue from ad valorem taxes: rates range from $.005/$100 valuation to $.03/$100 valuation. For example, if a property is valued at $100,000 and the ad valorem tax collected for the GCD is $.03/$100 valuation, then the amount that property owner pays to the GCD is $30 per year. For context, school district tax rates are usually $1.50/$100 valuation, which equates to $1,500 in our example. While many certainly may consider GCDs an ad valorem tax, which is significant, it is fair to say those GCDs ad valorem tax rates are usually the lowest in any county.[52]

ISSUANCE OF BONDS AND NOTES

GCDs generally have the ability to issue bonds and notes for capital improvements with the approval of the voters in

[52] The Texas Water Code section 36.201 caps the ad valorem tax rate a GCD may charge at $.50 per $100 of assessed valuation. There are GCDs that assess more than the voluntary participants in this preliminary survey do. Please see the State Auditor's schedules. According to the August 31, 2011 Texas Bond Review Board Local Government Annual Report, "State law sets limitations on certain local government debt issuers by setting maximum ad valorem tax rates per $100 of assessed property valuation. These rates vary by government type, but all must generate sufficient funds based on annual ad valorem tax collections to provide for the payment of the debt service on outstanding and projected ad valorem tax (GO) debt. Additionally, all public securities issued by local debt issuers must be approved by the Office of the Attorney General – Public Finance Division (OAG) and registered with the Texas Comptroller of Public Accounts. For reporting purposes issuances that combine both tax-supported and revenue bonds are categorized as tax-supported debt."

their jurisdiction, the TCEQ, and the Attorney General.[53] Section 36.020 of the Water Code provides this authority for the GCDs:

> BOND AND TAX PROPOSAL. (a) At an election to create a district, the temporary directors may include a proposition for the issuance of bonds or notes, the levy of taxes to retire all or part of the bonds or notes, and the levy of a maintenance tax. The maintenance tax rate may not exceed 50 cents on each $100 of assessed valuation.
>
> (b) The board shall include in any bond and tax proposition the maximum amount of bonds or notes to be issued and their maximum maturity date.

Section 36.201 further outlines this authority:

> LEVY OF TAXES. (a) The board may annually levy taxes to pay the bonds issued by the district that are payable in whole or in part by taxes.
>
> (b) The board may annually levy taxes to pay the maintenance and operating expenses of the district at a rate not to exceed 50 cents on each $100 of assessed valuation.
>
> (c) The board may not levy a tax to pay the maintenance and operating expenses of the district under this section until the tax is approved by a majority of the electors voting at an election in the district held for that purpose. The district may:
>
> (1) hold an election for approval of the tax at the same time and in conjunction with an election to authorize bonds, following the procedures applicable to a bond election; or
>
> (2) hold a separate election for approval of the tax in accordance with Subsection (d).
>
> (d) An order calling a separate election for approval of a tax under this section must be issued at least 15 days before the date of the election, and the election notice must be published at least twice in a newspaper of general circulation in the district. The first publication of the notice must be at least 14 days before the date of the election.

[53] It is noted that section 36.171 of the Texas Water Code provides that the TWDB may issue and sell bonds and notes in the name of the GCD for any lawful purpose of the GCD. TCEQ approval is not required for refunding bonds. A bond election is required only if the bonds are secured in whole or in part by taxes. Bonds issued in the name of the GCD would be tax exempt, which may make them attractive to investors.

PROMULGATION OF FEES

Section 36.205 of the Water Code provides this authority for the GCDs:

> AUTHORITY TO SET FEES. (a) A district may set fees for administrative acts of the district, such as filing applications. Fees set by a district may not unreasonably exceed the cost to the district of performing the administrative function for which the fee is charged.
>
> (b) A district shall set and collect fees for all services provided outside the boundaries of the district. The fees may not unreasonably exceed the cost to the district of providing the services outside the district.
>
> (c) A district may assess production fees based on the amount of water authorized by permit to be withdrawn from a well or the amount actually withdrawn. A district may assess the fees in lieu of, or in conjunction with, any taxes otherwise levied by the district. A district may use revenues generated by the fees for any lawful purpose. Production fees shall not exceed:
>
> (1) $1 per acre-foot payable annually for water used for agricultural use; or
>
> (2) $10 per acre-foot payable annually for water used for any other purpose.
>
> (d) The Lone Star Groundwater Conservation District and the Guadalupe County Groundwater Conservation District may not charge production fees for an annual period greater than $1 per acre-foot for water used for agricultural use or 17 cents per thousand gallons for water used for any other purpose. This subsection shall take precedence over all prior enactments.
>
> (e) Subsection (c) does not apply to the following districts:
>
> (1) the Edwards Aquifer Authority;
>
> (2) the Fort Bend Subsidence District;
>
> (3) the Harris-Galveston Coastal Subsidence District;
>
> (4) the Barton Springs-Edwards Aquifer Conservation District; or
>
> (5) any district that collects a property tax and that was created before September 1, 1999, unless otherwise authorized by special law.
>
> (f) A district, including a district described under Subsection (d), may assess a production fee under

Subsection (c) for any water produced under an exemption under Section 36.117 if that water is subsequently sold to another person.

(g) A district may assess a transportation fee under Section 36.122.

PERSPECTIVES ON FINANCE TOOLS AVAILABLE TO GCDS FROM THE RESULTS OF INITIAL STUDY

Chapter 36 provides the GCDs with a number of funding mechanisms or tools. But are these practical? Are they being used by the GCDs?

Perspective on the Issuance of Bonds

First, as to bonds, the survey results show none of the participants in our survey mentioned any bonded indebtedness. The lack of interest by GCDs to use the tool of issuing bonds for finance purposes is confirmed by searching the Texas Bond Review Board site. The Texas Bond Review Board was created by the Legislature in 1987 to:

> … ensure that debt financing is used prudently to meet Texas' infrastructure needs and other public purposes, to support and enhance the debt issuance and debt management functions of state and local entities, and to administer the state's private activity bond allocation.[54]

Assuming GCDs would be considered local government entities by the Bond Review Board, the August 31, 2011 Texas Bond Review Board Local Government Annual Report does not even include anywhere in the 82-page report the words "groundwater conservation district."[55] Surely the concern about voter rejection of a bond proposal for a GCD is valid; my interviews with GCD managers confirm this concern. However, there are other reasons, such as the inability to amortize or retire a proposed bond. Why?

For current open market terms for bond sales, I interviewed a municipal bond broker. According to him[56], today's interest rate for a non-rated local government entity bond would probably be around 3.5% to 3.75% annually. The near-perfect credit-rated State of Texas bond interest rates range from 3% to 3.5% today. The maturities of non-rated local bonds generally run 20 to 25 years.

It is difficult to imagine, for example, considering the level of annual gross revenues of most of our survey participants, that many could afford to service a bond. Assume a $500,000 bond maturing in 25 years at 3.75%, the annual payment in interest alone would be $18,750. If the same bond was $1 million, then the annual interest payment would be $37,500. A $5 million bond would require an annual interest payment of $93,750. The annual interest payable on the $1 million bond exceeds the total annual gross revenues of some of the participants in our study; the $5 million bond interest service would heavily burden most of our survey participants.

Would local voters approve a new ad valorem tax to cover their GCD's bond? It is safe to assume those GCDs that do not now have approval of their voters for an ad valorem levy would likely not approve a new tax for a bond. Would they consider it for a special project that benefits the entire GCD? Some may, most would not. (Keep in mind that the "not to exceed" limitation of 50 cents per $100 valuation is only applied to maintenance and operating expenses and not to bonded indebtedness. There is no statutory limitation mentioned in the water code as to bonded indebtedness tax levies.) Voter approval requires an expensive advertising and information campaign, again expenses most of our study participants would be hard pressed to cover.

According to a study done by Texas Comptroller of Public Accounts Susan Combs, the November 2011 voter turnout for bond elections in select counties across the state ranged from 5.8% in Montgomery County to 12.6% in Mitchell County. Per page 7 in the study, "There is no minimum voter participation required to approve debt issues, and typically few voters cast ballots in bond elections." Weak voter turnout may impact the election results at times; at times it may not. Some counties such as Travis County in the Combs study had an 8.5% turnout and voters approved its 2 proposals with a 3 to 2 majority. Conversely, a $200 million bond proposal for roads was defeated in Montgomery County.[57]

None of our participants has ad valorem taxation authority to levy at the full limitation of 50 cents per $100 valuation. Take for example those participants who have been authorized to levy an ad valorem tax of one-half cent per $100 (.005/100), then a $1,000,000 bond requiring $37,500 annual interest payments indicates that the total GCD ad valorem tax base (the district-wide total assessed value of all property in the GCD) would have to be at least $750 million. The total ad valorem tax base of some Texas counties does not equal $750 million.[58]

[54] http://www.brb.state.tx.us/agency/overview.aspx

[55] August 31, 2011 Texas Bond Review Board Local Government Report found at http://www.brb.state.tx.us/pub/lgs/fy2011/2011LocalARFinal.pdf

[56] March 20, 2013 phone interview with David S. Brollier, RBC Dain Rauscher in Houston.

[57] Susan Combs. "Your Money and Local Debt." Texas Comptroller of Public Accounts, September 2012, 7.

[58] See the State Comptroller's website for county-by-county total ad valorem tax base valuations at http://www.window.state.tx.us/propertytax/administration/pvs/findings/2012p/

The results also show that not all of the participants had approval[59] from their voters to levy ad valorem taxes. The nature of the Texas electorate many times in the past has been to limit new ad valorem taxes. In 2012, new school district bond elections were successful in 71% of the bond proposals.[60] When the statute repeats the phrase "not to exceed 50 cents per $100 dollar valuation, to me it generally means that the Legislature meant this limitation to be fully understood by all. The maintenance and operating tax must be approved by the voters "at the same time and in conjunction with an election to authorize bonds."

If a GCD decided to propose a bond proposal without state support for the underwriting of the bond, it may find little interest in the investor marketplace for a locally guaranteed solely by the local GCD at this time. This would be in contrast to the statewide voter-approved Proposition 2 in the fall 2012l that provided up to $6 billion in state-issued bonds for water infrastructure projects. There are several major cities around the country that have filed for well-publicized bankruptcy proceedings and others may follow; therefore, the likelihood that a smaller local government entity like a GCD could find investors would be limited if not impossible.

The bottom line is that the "not to exceed" limitations on the GCDs authority to raise revenue plus the approval required by the voters may be the reason no participant in our study has issued any bonds. The tool of bond issuance is not a practical one for the GCDs in their real-life financing plans.

Yet, the issuance of bonds remains a possibility in the future for finance of GCDs. The TWDB Loan Assistance Fund is an additional source of support for GCDs.[61]

Perspective on the Issuance of Notes (Borrowing)

The water code allows GCDs to issue notes. If a GCD chooses this path to finance a project and seeks an institutional lender, the typical underwriting standard in determining the loan amount is 70% of cost or value, whichever is the lesser. In other words, a water project costing $1 million, if qualified in all other ways such as the creditworthiness of the GCD and the reliability of its gross revenue stream, would at most qualify for a $700,000 loan. This means the GCD would have to make a "down payment" of $300,000 cash to build the project. Many of our participating GCDs do not have this amount of cash available, and this amount again exceeds many of our participants' gross annual reported revenues. Issuance of notes is another tool available by statute, but impractical and rarely if ever used by our participants except in minor amounts for very short terms. Qualifying for a typical institutional loan may prove elusive for the GCDs.

Another requirement of an institutional lender would be collateral for the loan, which is usually provided by a deed of trust on the water project itself. The reluctance of a lender to foreclose on a defaulted water project is an obvious hurdle to a prudent lender's decision to make a loan. What do they do with the asset after foreclosure? Who could possibly run it without incurring losses? The State of Texas would likely be asked to guarantee the loan.

Perspective on Establishing Fees

GCDs have a variety of options available to them for fees as outlined in the Texas Water Code section 36.102. A GCD may set fees for administrative acts of the district such as filing applications.[62] A district shall set and collect fees for all services provided outside the boundaries of the district. A district may assess production fees based on the amount of water authorized by the permit to be withdrawn from a well or the amount actually withdrawn not to exceed $1 per acre-foot annually for agricultural use or $10 per acre-foot for water used for any other purpose.[63] A district may assess a production fee under Subsection (c) for any water produced under an exemption under 36.117 if that water is subsequently sold to another person. A district may assess a transportation fee under 36.122. Section 36.206 allows temporary boards to set user fees for the creation and initial operation of a district. Section 36.122 allows a district to impose a reasonable fee or surcharge for an export fee. Of course, civil penalties under 36.102 are a potentially significant source of revenues for GCDs.[64]

The obviously most significant fee structure would be the per acre-foot fees of $1 for agricultural use and $10 for any other use. Yet, these limitations are couched in "not to exceed" language, another restriction on financing possibilities for GCDs. The same political problems exist with these usage fees. Surely some GCD board of directors would come under heavy siege from users in their jurisdiction for any fee structure. A future study will analyze in detail the fee structure of all the GCDs, but participants in our study who volunteered

[59] The GCDs were not asked if they had sought past approval to levy ad valorem taxes nor if they had sought approval and such approval was rejected by the voters. It will be an interesting question to include in a future update of this paper.

[60] http://www.tspra.org/news-and-reports/tspra-newsroom/bond-tax-rate-elections/453-texas-school-bond-election-results-from-november-6-2012

[61] See Texas Water Code Subchapter F.

[62] Fees set by a district may not unreasonably exceed the cost to the district of performing the administrative function for which the fee is charged.

[63] This section does not apply to the Edwards Aquifer Authority and certain other districts (see subsection C part iv. and v.).

[64] The GCD may rule a penalty of up to $10,000 per day per violation. Penalties may be enforced in court, and if the GCD prevails, there is a mandatory award of court costs, attorney fees, and expert fees.

fee information did not charge the allowed amounts.

GCDs may also make or accept grants, gratuities, advances, or loans in any form to or from any source approved by the board, including any governmental entity, and may enter into contracts, agreements, and covenants in connections with grants, gratuities, advances, or loans that the board considers appropriate.[65]

Other revenues available to a GCD are allowed to come from ownership or operation of a GCD's works, improvements and facilities and from the sale, transportation and distribution of water.[66] A GCD may sell, transport, and distribute surface water or groundwater. A future update of this study will seek detailed information of these other revenue sources that are not mentioned in any of the documents provided us by the participants in this preliminary study.

OTHER OPTIONS FOR SUPPORT OF GCDS

There are ways to accomplish GCDs' core duties without any funding, such as securing research information from the TWDB and third party sources. The TWDB provides groundwater availability models; the TCEQ must budget for water availability models. GCDs can rely upon TWDB-funded groundwater availability models and technical information supplied by applicants and third parties. The TWDB, on request, shall make technical staff available to serve in a non-voting advisory capacity to assist with the development of DFCs. GCDs may require permit applicants to provide hydrogeological reports and other technical information to prove up applications during the permitting process. GCDs have the authority to require permit holders to maintain and provide reports of "drilling, equipping, and completing of water wells and of production and use of groundwater." Third parties often provide modeling and technical information, especially those wishing to obtain export permits. Well driller's logs are available and existing data as well from many state agencies.

Some GCDs participate in weather modification programs, which is best described as cloud seeding. The Crockett County Groundwater District, for example, allocated $80,500 of its $215,826 total 2011–2012 budget or 37% of the budget to weather modification.[67] Several GCDs have participated in this program for a number of years and all told me they thought the program was very helpful and that their constituents see cloud seeding as a true benefit of the GCD.

Correlations between total expenses and permitted irrigation wells, general permit registrations, households in the district, and other demographic characteristics were not indicative of any usable trend or ratios. The GCDs are simply too diverse in size, local rule structures, fees, and geography to draw any overall conclusions. What is indicated is that GCDs must be studied individually as self-supporting local entities, keeping in mind that the local boards of directors know best the needs of their jurisdictions. One echo across the GCD managers I personally interviewed was clear—they want no unfunded state mandates. Another indication from my interviews is that the GCDs could use help from accurate research as to the groundwater actually in place in their district along with help in getting an accurate count of the exempt domestic and livestock wells and their water volumes drawn. The amount of groundwater actually being used and the amount actually available seem to be the critical need and one of the only things all the GCDs have in common.

A WORD ABOUT OIL AND GAS WATER USE

In the areas of our state, the most significant financial impact in groundwater is the shale oil and gas drilling boom. Oil and gas exploration water wells are exempt from exploration permits; therefore, there is almost no impact to the revenues of GCDs from this activity. However, the impact on local economies is, temporarily at least, very positive. In the end, the impact on groundwater supplies could be less positive as some of the groundwater used may never be replaced by nature.[68]

SALES OF GROUNDWATER TO OIL AND GAS EXPLORERS

Fracturing in exploration for oil and gas from deep shale formations uses huge amounts of water, almost all of which comes from groundwater. The sale of this water to the oil and gas explorers has been very helpful to struggling farmers and ranchers in these boom areas. Prices for water run from $.42 per 42-gallon barrel to $.80 and beyond. Considering some wells require up to 155,000 barrels of water to successfully conduct the fracturing, the range of payment to a farmer or rancher for groundwater for 1 well can be from $65,100 to $124,000, a sorely needed source of revenue especially considering the devastation of agribusiness still lingering since the

[65] Texas Water Code 36.158. 36.160 gives approval to other agencies to allocate funds to carry out the objectives of Chapter 36. 36.161 allows the TWDB to provide funds under 36.159 and 36.160 , Chapters 15, 16, 17, and Subchapter L to a district if the TWDB determines such funding will allow the district to comply or continue to comply with provisions of Chapter 36.

[66] Texas Water Code 36.172.

[67] 2011–2012 Budget for the Crockett County Groundwater District.

[68] Of course, this is true of any use of the aquifer.

terrible statewide drought of 2011.[69]

There are some unconsidered negative consequences for the individual farmer/rancher and the community as a whole. One rancher I interviewed on his place took me to 1 of the many 50 acre-foot above-ground holding tanks that oil and gas explorers have built to store water, which is then hauled or piped in all manner of ways to the wells being drilled and completed.

The 50 acre-foot tank in Figure 3 located in the Crockett Groundwater Conservation District holds 387,918 42-gallon barrels or 16,292,550 gallons. Assuming the price range paid by oil and gas explorers in this area is $.42 to $.80 per 42-gallon barrel, then this 1 tank represents water worth from $162,926 to $310,334. There are 16 of these in the district as of July 17, 2012. These 16 tanks together represent water worth from $2,606,816 to $4,965,344. Keep in mind that these tanks are being drained then refilled as needed, so the aggregate total paid by the oil companies is certainly much more. The water sales to oil and gas explorers alone in this district have dramatically impacted the local economy.

The rancher told me that the money from groundwater sales was very helpful to his family, but he noticed his windmills, the only water sources for his cattle, were beginning to "clank" and not bring up as much water as before. He said he thought his groundwater source was not an aquifer, but from individual underground pools of water, which he worries may not recharge, or at best, recharge only very slowly. Keep in mind that his underground pool of water is groundwater nonetheless. Yet he cannot in all good prudence pass up the money that so greatly helps his family and pays the relentlessly increasing ad valorem taxes and other carrying costs to hold his land. If the shallow wells dry up on his place, he has to either drill deeper wells (very expensive considering the expense of drilling and especially the heavy casing needed at deeper depths) or sell his cattle.

[69] "Exploration" for oil and gas is exempt from permitting, however, "production" of oil and gas is nonexempt (see the Texas Water Code 36.117(b)(2).

Figure 3. Oil and gas 50 acre-foot holding tank.

AN UNINTENDED CONSEQUENCE OF GROUNDWATER SALES

I did not bring up to him the question that immediately came to my mind so as not to cause him further consternation: what is he going to do to keep his agricultural exemption on his land? The land is not farmable without irrigation. There is not enough groundwater available in adequate amounts to farm with irrigation in the heat and aridity of this area in Texas. Without livestock or farming there is potentially no more agricultural valuation for his property; the agriculture valuation reduces ad valorem taxes paid as much as 77% or more in some counties.[70] Not only could he lose the benefits of the exemption, which are substantial, but once lost, he will be required to pay a 5-year "rollback" tax immediately. On several thousand acres, the "rollback" alone could wipe out much of the benefit of the groundwater sales; the new tax due without the agricultural exemption could pressure him into a forced sale of long-held family property or he could face losing the land to tax foreclosure in the worst case. Once a property loses the agricultural exemption, it can only be regained after 5 consecutive years of agribusiness activities. All of the less obvious consequences of depleting groundwater by selling it to oil and gas operations must be considered prior to deciding to sell.

THE FUTURE OF GCDS

GCDs protect everyone's interests in groundwater. The Legislature continues to confirm that GCDs are Texas' preferred method of groundwater management. Yet not all of Texas is protected by a GCD. The GCDs surveyed operate efficiently and honor tight budgets. This study indicates a need for more research money from grants or the state to determine more accurately the amount of groundwater actually in the districts, the source of the groundwater, and its physical characteristics. I agree with Kirk Holland—every square inch of Texas should have a GCD as manager of the groundwater. Across the board, Texans profess to the vital importance of groundwater in their lives, but seem more willing to buy new tennis shoes and Starbucks coffee than give the proper support to the preferred

[70] There is another exemption available, a wildlife agriculture valuation (commonly misnamed as an exemption; it is not an exemption from tax but a contingent valuation reduction), which has to be approved, implemented annually, and reported annually. This could be a possible alternative for water sellers finding themselves in this predicament.

managers of groundwater, GCDs.

Education of the local electorate about available groundwater supplies, the nature of groundwater formations, and current groundwater demands could garner support for better funding of local GCDs. Because of my work in the field and my classes to countless members of the public around the state educating them about the benefits of well monitoring, data collection, and research as to the true groundwater available in their area, I have confidence that the local electorates might support higher fees or taxes to fund fair and accountable groundwater conservation district regulatory programs.

The local electorate should remember GCDs hold public hearings often; all Texans should take the time to attend and offer their opinions. Each GCD manager interviewed strongly encourages comments and opinions from their constituents to help the GCD leadership make better decisions for everyone.

SUMMARY

While the Texas Water Code provides a number of tools for GCDs to finance their operations, most are impractical or, in reality, unavailable to use for many GCDs due to fee restrictions, ad valorem tax rate restrictions, local voter approval, and bond/note market requirements and conditions. The Legislature is making strides towards the funding of at least $2 billion to the 2012 State Water Plan and the people have approved the $6 billion in state credit to be used to support water infrastructure projects.

GCDs, if they continue to be the preferred method of groundwater management in our state, simply must be adequately funded to be effective and protect our most precious natural resource.

APPENDIX 1 — RESULTS

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
Barton Springs/ Edwards Aquifer Conservation District	2012 total projected income: $1,420,170	2012 projected expenses: $1,419,892	No response	995 exempt (but altogether produce less than about 4% total groundwater withdrawn in district)	9 staff members	8–5 M–F
Brewster County Groundwater Conservation District	Per phone conversation	$20,400; Most recent data available from website – 2008 approved budget; January 7, 2008 Board of Director's Meeting Minutes	No response	No response	1 permanent employee	No response
Brush Country Groundwater Conservation District	Only revenue received is from tax levy at $.03/100 valuation; Collected for 2010 was about $594,000	2009–2011: $189,187.05; 2012 budget: $465,297	"District has not developed rules so they have yet to issue a water permit for non-exempt well. Our guess is that there are between 6 to 7 thousand exempt wells in the district. The exact number will not be known until all wells are located and registered in the water well registry database that I am currently working on. District has not yet written their first annual report."	No response	1 (and plans of hiring part-time secretary within next 4 months)	8–5 M–F
Central Texas Groundwater Conservation District	Total income: $496,076.00 (from ad valorem tax at $.01/100 valuation was $457,076.00)	$495,137.50	Total well registrations as of June 6, 2012: 3414; Rules require registration only for wells drilled after September 1, 2009	Exempt well drilling auth.: 445	3 employees (general manager, hydrologist, and administrative assistant)	8–5 M–F
Cow Creek Groundwater Conservation District	Total revenue: $347,635 (Tax collected at $.005/100 valuation was $190,235)	Total estimated expenses: $339,230	72+ permitted	6500+ exempt	3 permanent employees	8–5 M–F
Crockett County Groundwater Conservation District	Ad valorem tax rate for 2011–2012: $.01107	Total budget for 2010–2011: $217,000; Proposed for 2011–2012: $215,826	No response	3 permitted irrigation wells	2 permanent employees	1–5 M–F; Manager on 24 hour call

APPENDIX 1 — RESULTS (CONTINUED

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
Goliad County Groundwater Conservation District	Ad valorem taxes at $.0143/100 valuation were $127,400; Permitted well fees: $500; Well registration fees: $665	Total expenses for current year: $49,100	3 RV parks; 1 pipeline construction; 2 livestock and wildlife	5 domestic wells; 10 livestock wells; 22 domestic and livestock; 3 oil and gas supply	1	8–5 M–F
Gonzales County Underground Water Conservation District	Taxes: $125,447; Export fees: $75,000; Interest earned: $3,000	$250,000	30 public supply wells; 7 irrigation wells	Unknown at this time	3 permanent employees	8–5 M–F
Hays Trinity Groundwater Conservation District	$187,287	$146,512	No response	No response		M–Th 9–4
Headwaters Groundwater Conservation District	$342,695.89 (87% from ad valorem taxes at $.0074/100 valuation)	$241,338.34	260	5,191	3 full-time employees	8–5 M–F
Hemphill County Underground Water Conservation District	Budgeted: $452,773; Received: $459,345	Budgeted: $452,762; Spent to date 2012: $274,867; Spent in 2011: $377,810	New: 14; Replacement: 3; Re-equip: 1; Total: 18	7 domestic; 6 livestock; 25 rig supply	No response	No response
Hickory Underground Water Conservation District No. 1	Property taxes at $.035/100 valuation were $356,211; Delinquent taxes: $9,752; Penalty and Interest: $7,268; Total budget $384,051.44	Balanced budget so that expenses equal revenue: $384,051.44	66 municipal/public water supply; 66 industrial; 8 commercial livestock; 1 aquaculture (fish farm) well; 311 irrigation wells	516 domestic and stock; 1,289 domestic: 950 stock	3 permanent employees	7–5 M–F
High Plains Underground Water Conservation District No. 1	Total revenue from all sources $2,632,982 (2011); Ad valorem tax rate 1011 $.007766 per $100 valuation lowered from $.007853 per $100 valuation in 2010	$2,902,703 (2011)	13,103 center pivot systems – last inventory 2009 per 2011 published annual report	No response	No response	2 offices – one in Lubbock and another in Amarillo open M–F.

APPENDIX 1 — RESULTS (CONTINUED)

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
Irion County Water Conservation District	2011–2012 budget: $129,345; Ad valorem tax based at $.01548/100 valuation; Population of district is only 1,700	Expenses not finalized until Sept. 30	Less than 20 that would need permits	about 1,800	1 full-time manager, 1 part-time secretary	No set office hours (Manager arrives about 7:30 field work and secretary is in office MTW 1–5)
Kenedy County Groundwater Conservation District	2012 budget: $248,000; Ad valorem tax rate: $.0153/100 valuation	Estimated 2012 expenses: $248,000	40 wells operated under a permit (14 for public water supply, remainder for agriculture or commercial uses)	No response	1 permanent employee	8–5 M–F
Lost Pines Groundwater Conservation District	$206,805.27	$390,691.97	Non-exempt: 82 municipal and 27 irrigation	1216 domestic; 173 livestock; 57 irrigation; 23 industrial	3 permanent employees	8–5 M–F
Lower Trinity Groundwater Conservation District	2012 budget: $99,209; Revenue from $.05/1000 gallons of groundwater utilized from permitted wells	Expense normally run +/- 5% annual budget	160 permitted (public water supply) wells	541 exempt (primarily rural)	1 permanent employee (serves as general manager), works approx. 20 hrs per week	7:30–4:30 M–F
Medina County Groundwater Conservation District	Taxes at $.0083/100 valuation 2012 to $.09/100 valuation: $189,780; Total revenue: $227,980	Total estimated 2012 expenses: $258,170	110 wells permitted for irrigation use; 10 for municipal; 6 for industrial (quarries)	Estimate between 400–500	2 full-time employees	8–5 M–F
Mid-East Texas Groundwater Conservation District	$115,570 production fee revenue; $4,000 non-compliance penalties; $2,500 interest; $500 other income	$153,570	211 total (144 public water supply; 61 comm/ industrial; 6 irrigation)	Estimate of 5,000+ (an assortment of domestic/stock/ rig supply etc)	1	M 9–12 and 1–5; T–Th 8–12 and 1–4:30; F 8–12 and 1–4
Neches & Trinity Valleys Groundwater Conservation District	2012 adopted budget: $195,850	$195,220	223 for public water supply; 32 non-agriculture irrigation; 7 pipeline company use; 175 large domestic/ agriculture wells	10,000 to 11,000 exempt wells (all domestic or small agriculture which pump less than 25,000 gallons per day capacity)	2 full-time employees	8:30 to 5 M–F (closed 12–1 for lunch)

APPENDIX 1 — RESULTS (CONTINUED)

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
North Texas Groundwater Conservation District	2012 budget: $478,597; $.10 per thousand gallons pumped on non-exempt wells to generate funds for budget; covers 3 counties: Collin, Cooke, and Denton	Personnel costs: $167,000	635 registered wells	151 exempt total	7 shared part-time employees with Red River	8–5 M–F
Panhandle Groundwater Conservation District		2011: $1,246,556.41	Well permits approved for 2011–2012: 136	No response	9 staff members	No response
Pineywoods Groundwater Conservation District	2011 budget: $193,084	2011: $137,523	Total district wells in database: 2,144	1,411 (and 200 more unregistered exempt wells)	2 permanent employees	8–5 M–F
Plateau Underground Water Conservation And Supply District	2012 budget: $125,000 (all of which was raised with ad valorem tax)		29 active irrigation permits and 8 industrial (all water sales mainly for oil and gas activity) permits	1,500 exempt	1 permanent employee	8–5 M–F
Plum Creek Conservation District	All income from ad valorem taxes; District has both flood and groundwater responsibilities; Tax rate applicable to groundwater is $0.0200. "We have no fee based income from water sales or transfers out of the District."	Budget for 2011–2012 allocable to groundwater responsibilities: $802,695	"PCCD has 54 permitted wells with 21 for irrigation, 12 for poultry, and 21 for public supply"	"We have an estimated 535 exempt wells in our District. This does not include the total exempt wells for Caldwell County. I am unable to categorize these wells, but most are for domestic and livestock. There are probably only a few exempt wells used for oil and gas."	4 permanent employees	8–5 M–F
Post Oak Savannah Groundwater Conservation District	Production fees: $314,244; Transport fees: $931,947; Interest (estimate): $25,000; Total revenue: $1,271,191	Expenses budget for 2012: $1,606,500	434 agriculture; 60 industrial; 104 municipal; 22 oil and gas	Estimated 4,500 domestic/ livestock; 63 oil and gas	3 permanent (1 general manager, 1 administrative asst., 1 water resource management specialist)	8–4 M–F

APPENDIX 1 — RESULTS (CONTINUED)

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
Red River Groundwater Conservation District	Budget of $250,999; $.06 per thousand gallons pumped on non-exempt wells to generate funds for budget	Administrative costs: $137,960	289 enrolled wells	29 exempt wells	7 shared part-time employees with North Texas	8–5 M–F
Rolling Plains Groundwater Conservation District	Tax collections at rate of $.0219/100 valuation: $137,000; Interest earned on investments: $5,000; Groundwater transport fees: $10,000; Total 2011 budget: $152,000; Proposed 2012 budget: $152,000	2011 expenditures: $131,092	No response	No response	1 permanent employee	9–5 M–F
Rusk County Groundwater Conservation District	Revenue: $240,000 (from taxes, permits, inspections, and interest income)	$250,000	3,400 registered wells	No response	3 full-time employees	8–5 M–F
South Plains Underground Water Conservation District	Tax collections at $.025/100 valuation – Terry County: $267,000.00; Tax collections – Hockley County: 475.00; Interest-checking: 100.00; Interest-CD: 4,235.00; Water depletion: 900.00; Accounts receivable – Other: 500.00; Total estimated revenues: $273,210.00	Salaries and benefits: $120,733.20; Supplies: $16,450.00; Purchased services: $59,250.00; Other expenditures: $28,750.00; Capital outlay: $27,000.00; Total appropriations: $252,183.20	No response	No response	2 full-time employees	8–5 M–F

APPENDIX 1 — RESULTS (CONTINUED)

District	Total revenue	Total expenses	Total permitted wells	# Exempt wells	# Permanent employees	Hours operation
Southeast Texas Groundwater Conservation District	Total expected revenue: $155,961.00	Total estimated expense: $117,626.44	13 total non exempt/ permitted	329 exempt for domestic; 39 exempt for other; 71 exempt from oil and gas related	1 full-time, 1 part-time bookkeeper	Open 5 days a week, manager mentioned he is available essentially 24/7 because phone calls forwarded to his cell phone
Sterling County Underground Water Conservation District	Ad valorem taxation rate is $.00966/100 valuation; total revenue all sources was $140,190	Expenses not finalized until Sept. 30	District does not have pumping limits and 99% use is D&L or oilfield (which is exempt)	About 700 exempt wells	Full-time manager and 1 part-time technician	No set office hours (manager available by cell phone, technician does work 3 days a week)
Trinity Glen Rose Groundwater Conservation District	2011 revenue: $205,000 and 2012 budget: $237,300	2011 operating expenses: $208,300; 2012 operating expenses prediction: $237,300	About 800 registered wells (majority of which drilled after 2002)	Out of the 800, about 600 exempt	3 part-time staff (work 20 hours each per week)	In office M–Th but also work outside office
Upper Trinity Groundwater Conservation District	$1,337,750	$1,047,431	Total registered wells: 363	Just May 2012 well registration break-down: 81 exempt and 5 non-exempt	6 staff members	8–12 and 1–5 M–F
Wintergarden Groundwater Conservation District	Total proposed income: $665,017.67 (subtotal from tax revenue at $.025/100 valuation: $665,017.67)	Total proposed expenses: $693,217.67	Total number wells registered in 2011: 283; Non-exempt: 50	233 exempt (140 for rig supply)	2 permanent employees	M–F 8–12 and 1–5

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Commentary: The legacy of Charlie Flagg: narratives of drought and overcoming the monster in West Texas water policy debates

Ken Baake [1]

Abstract: The 40th anniversary of the publication of Elmer Kelton's 1973 novel *The Time it Never Rained* coincides with one of the most severe droughts on record in Texas. Meanwhile, as of 2005, local groundwater conservation districts in Texas are required by law to determine how much groundwater they want to conserve for future generations. Such policy decisions have led to debates in West Texas among agricultural producers over whether pumping restrictions amount to erosion of the famous "rule of capture" and private property rights. This article presents Texas water law history, the Ogallala Aquifer, and its users as a continuing story in which producers and government policy-makers are actors. This paper first summarizes the ways in which water challenges in the American West and elsewhere have been classified according to different disciplines and then shows how each of those ways of knowing can be understood as a kind of storytelling. The author uses Kelton's drought novel and scholarly insights into how narrative works as a means of interpreting and contextualizing comments made by producers and others at several West Texas agricultural water policy hearings. The article concludes that policy-makers must consider the human instinct to translate complex and often contradictory knowledge from multiple domains into a less confusing story line.

Keywords: narrative, Elmer Kelton, groundwater management, drought, Ogallala Aquifer

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Terms used in paper

Short name or acronym	Descriptive name
groundwater management areas	GMAs
High Plains Underground Water Conservation District	HPUWCD
Production and Marketing Association	PMA

INTRODUCTION

This year (2013) is the 40th anniversary of the publication of Elmer Kelton's novel *The Time it Never Rained.* Its theme of water challenges is as timely now as when the novel was first published in 1973. The recent multi-year drought that has gripped much of Texas reminds us that the hardships faced by lead character Charlie Flagg in the scrub rangeland around San Angelo during the 1950s continue to plague Texans. Today, it is not just farmers and ranchers who endure these hardships; urban and suburban residents throughout the state face watering restrictions, encroaching wildfires, and almost unbearable summer heat.

Data bear out the severity of recent Texas drought conditions. According to State Climatologist John W. Nielsen-Gammon, the 12 months between October 2010 and September 2011 were the driest 12 consecutive months on record for the state—drier by 2.5 inches than the 12-month period set during the 1950s drought (Nielsen-Gammon 2012). Nielsen-Gammon calls the 2011 drought "unprecedented in its intensity," while regional news reports suggest that the drought is beginning to take a serious economic toll on the region. "Shaken and stirred: For many, job losses mean leaving friends, family, home" is the headline over an early 2013 article in the *Lubbock Avalanche-Journal* after an international food production and marketing company announced layoffs of 2,000 workers at a Plainview meat processing plant (Hoff 2013). Cargill, Incorporated attributed the layoffs to the multi-year drought that has reduced cattle supplies in the region.

Understanding some of the ways residents process such severe drought is the goal of this article, which asserts that *The Time It Never Rained* is essential reading for anyone in Texas involved in water and general environmental policy (Kelton 1973). While it is a good novel in its own right, the main reason for endorsing it as important background reading for policy-makers is that Kelton's plain-written prose helps us understand deep-seated suspicion of government regulation in the name of the environment—a suspicion that if anything has grown since the 1950s. In that vein, *The Time it Never Rained* can serve as a literary exemplar of traditional West Texas values, along with the challenges those values bring to attempts at fostering environmental stewardship—particularly water conservation.

A cursory survey of newspaper articles and Internet stories about recent Texas droughts reveals that Kelton's novel continues to speak to Texans. For example, James Decker writes in *Cattle Call*, a blog of the National Cattlemen's Beef Association Young Producer's Council:

> Elmer Kelton's novel "The Time It Never Rained" masterfully tells the story of the 1950s Texas drought and the bleak life in West Texas during those miserable days. And unfortunately, the year 2011 has shaped up as an unwanted sequel to that 1973 literary masterpiece (Decker 2011).

Similarly, a July 23, 2011 headline over an editorial in the *Austin-American Statesman* proclaims "The Time It Never Rained has come again." The editorial continues by reaffirming the need for stringent water conservation measures in the Austin area (Austin American Statesman Editorial Board 2011).

To understand the enduring power of Kelton's 40-year-old novel to represent rural Texan attitudes, it is necessary to consider the power of any story to encapsulate cultural values, beliefs, and even scientific knowledge. To that end, this article first summarizes the ways in which water challenges in the

American West and elsewhere have been classified according to different disciplines—such as geological and hydrological science, law, and economics—and then shows how each of those disciplinary ways of knowing (i.e. epistemologies) can be understood as a kind of storytelling. The latter part of this paper presents Kelton's drought novel and scholarly insights into how narrative works as a means of interpreting and contextualizing comments made by producers [1] and others at several West Texas agricultural water policy hearings.

NARRATIVE WAY OF KNOWING THE OGALLALA AQUIFER

The urge to tell and hear stories is intrinsic in human behavior and has been the subject of academic study through the field of literature, typically found in departments of English and other languages but also in fields such as history, anthropology, sociology, mass communications, and psychology. Science is concerned with stories to the extent that it classifies reality and posits cause and effect relationships among different aspects of that reality. These theories of cause and effect are situated in time and place, which, of course, also form the essential background or "setting" against which stories play out. For the French philosopher of language Paul Ricoeur, narrative is nothing less than a way of coping with the passage of time. That passage of time in the presence of others involves actions that lead to the formation of one's identity [2].

The passage of time both in prehistorical and historical settings underlies all of the ways we have understood water and water policy in the American West since the 19th century. We need only look at geology of the Ogallala Aquifer that provides water to Texas' High Plains region and to 7 other Great Plains states stretching north to South Dakota. Its formation as a vast underground bed of saturated sand is a story that begins prehistorically 10 to 12 million years ago during late Tertiary (Miocene/Pliocene) geologic time, when runoff of water and sediment from the Rocky Mountains splayed out in a great alluvial plain that filled the contours of the land to the East (HPUWCD 2013). Geological representations of the aquifer, like nearly all geological representations, are stratified—the story of time's passage represented like the cross section of a cake by the layers of earth, rock, saturated sand, and sediment.

Fast forward into historical time of the late 1800s when settlers moving West tapped the aquifer, first with windmills and later with centrifugal gasoline-powered pumps. Indeed the presence of such underground bounty could not help but remind the stern Protestant settlers of Old Testament accounts of Moses and his brother Aaron striking a desert rock to bring forth the water from underground. "Take the staff, and assemble the congregation, you and your brother Aaron, and command the rock before their eyes to yield its water," the Lord commanded Moses (Numbers 20: 7-8). When that water from eons past is exposed to the atmosphere through evaporation from the surface or through transpiration from plants, it becomes the main character in the hydrological cycle. This story is more often represented progressively in science visuals as water vapor rising from the ocean into the atmosphere on one side of the image, forming clouds over the center, and raining down onto the land on the other side.

Once brought to the surface from underground or already found there in streams and lakes, the water becomes part of another story—that of human societies allocating its use through laws and policies. Indeed, the old adage that "whiskey is for drinking and water is for fightin'" [3] summarizes a century's worth of water law in the American West. Countless courtroom dramas have played out in Texas over who owns the water, dating to the 1904 Texas Supreme Court ruling that established the famous "rule of capture" after a landowner sued the Houston & Texas Railroad for depletion. [4] Under this rule, "absent malice or willful waste, landowners have the right to take all the water they can capture under their land and do with it what they please, and they will not be liable to neighboring landowners even if in doing so they deprive their neighbors of the water's use" (Potter 2004 p. 1). This 1904 case established "precedent," a legal term referring to the story that everyone refers to henceforth when faced with challenges involving similar characters and settings.

How much water (or any resource or commodity) that a community uses is understood in economic theory through different types of models, which are stories of how "independent variables," such as average daily temperature and population density, affect the "dependent variable"—in this case, the "demand" for water. Economists model these relationships with formulas and data that show whether a change in any independent variable results in a change in the dependent variable, and whether that change is significant enough to indicate that something meaningful (a story of cause and effect) is happening. As economist and rhetorical scholar Deirdre McCloskey notes, the question economists often ask after being presented with a long mathematical equation is usually a simple one: What's your story? (McCloskey 1998).

[1] "Producer" is a term used to mean anyone who produces a product from agriculture, such as a crop or livestock. In West Texas it applies to farmers and ranchers. In this article I will use it synonymously with "farmer" or "cotton farmer."

[2] For a summary of how the concepts of identity, time, and narrative are theoretically linked in Ricoeur's work and others, see Ritivoi 2008.

[3] This adage is often attributed to Mark Twain, although there is no evidence that he actually said or wrote it.

[4] For a detailed history of Texas water law, see Mullican and Schwartz 2004.

In literary disciplines, the ways in which stories [5] work is the subject of narrative studies. Narrative is the mental reconstruction of a sequence of events, or as English professor David Herman and other scholars show in their research, the way in which human experiences and other aspects of reality are organized and interpreted to provide meaning (Herman 2002). Often the events confronting characters in a story are challenging, and it is the response to those challenges that makes up the plot of the story. Stories that contain plots, character types, and symbols that recur across time and cultures are commonly known as "archetypal stories," a concept based on the psychological theories of Carl Jung and their use in analysis of myth by Joseph Campbell. Such narrative patterns involve similar types of characters facing similar challenges. Archetypal stories shared across a culture preserve for that culture knowledge that "has been learned assiduously over the ages" (Ong 1982 p. 41).

CHARLIE FLAGG: ARCHETYPE OF THE RUGGED INDIVIDUALIST

Charlie Flagg's situation in *The Time it Never Rained* could be seen as archetypal, preserving the lesson of endurance found in various Old Testament stories of God testing man via various environmental stresses. For instance, in the story of Job, a pious man of ancient Palestine is afflicted by unimaginable trials—loss of his animals, his family, his home—a seeming betrayal by God. Yet, Job remains steadfast in acceptance of God's wisdom, even if he questions why He would punish a just man. In the end, he is rewarded for his patience with new wealth and offspring.

The steadfast endurance of Job replays in *The Time It Never Rained,* which revolves around Charlie's efforts to keep his ranching operation going during the tenacious 1950s drought. But the novel also addresses other timeless themes of farming and ranching life in Texas (and any semi-arid area). A strong theme throughout is that of relations between peoples, in this case Anglo and Hispanic Texans. At times, these relations are loving and respectful and at times patronizing and resentful. Other themes include relations between ranchers and oilmen, ranchers and bankers, fathers and children, illegal immigrants and the Border Patrol, and Texans and their guns.

Charlie's story could also be seen as 1 or more of 7 basic plots in story telling as identified by literature scholar Christopher Booker (2004). At a general level the plot in *The Time it Never Rained* is a kind of tragedy. But Kelton's story could also more specifically be seen as one of Booker's plots called "overcoming the monster." Booker gives various examples of famous monsters and their vanquishers in literature, from the ancient Greek Medusa and Perseus to H.G. Well's Victorian era "fungoid" Martians who are finally bested by "humble earth bacteria" (p. 23-29). Such monsters typically act either as predators stalking the earth, as guardians of a treasure, or as avengers for past human transgressions.

Kelton sets up the monster plot line in the prologue by immediately animating drought as a predatory creature. He writes: "It crept up out of Mexico, touching first along the brackish Pecos and spreading then in all directions, a cancerous blight burning a scar upon the land" (1973 p. 1). Like a dragon, this drought monster smothers the grass and even weeds "with its hot breath" (p. 1).

An equally dangerous monster in Kelton's novel, however, is the federal government, a seeming behemoth of insensitive agencies and bureaucrats that attempt to dictate West Texas agricultural policy from afar. The rural Texan's suspicion of government today, especially liberal government, had its roots in the post-New Deal era that Kelton captured in his story of Charlie Flagg. Within the first few pages Charlie runs afoul of a federal agriculture agent of the Production and Marketing Association (PMA)—one of the predecessor agencies of the U.S. Department of Agriculture's Farm Service Agency. Kelton's third person limited perspective lets us into Charlie's mind where we learn that the agent determines the amount of different kinds of crop a farmer could grow and what kind of price supports and financial aid he would receive from the government. In Charlie's mind the trade-off is akin to selling one's soul to the Devil: "Here he sold his freedom bit by bit, and was paid for it on the installment plan," Kelton writes (p. 6). Charlie's response to the agent's request for him to attend a PMA meeting is terse, dismissive, and tempered with the West Texan ideal of rugged individualism: "What I can't do for myself, I'll do without" (p. 9).

Throughout the novel as the drought tightens its grip, ranchers become more dependent on government aid. Fellow ranchers at one point ask Charlie to go to Washington on their behalf to argue for more price supports. Charlie's refusal, his stubbornness to participate in the government programs proves the prudent path, however, as the novel reaches a climax with ranchers in despair over the financial ruin brought on in part by their indebtedness to the federal agency.

Because he stubbornly resisted government assistance for ranchers and its attendant controls, Kelton's most famous character has been venerated among conservatives; the *National Review* in 2010 listed *The Time It Never Rained* as one of the 10 "great conservative novels" (Miller 2010). Indeed, in the novel, even the representatives of liberal collectivism at its most evident—federal agricultural agents—begrudgingly admire Charlie as "[o]ne of those *rugged individualists*," although they predict that his refusal to take aid will turn him

[5] Some scholars make a distinction between "narrative" and "story," whereby a story is the action that occurs and narrative is the telling of that action. This paper will use the 2 terms synonymously.

into a "*ragged* individualist" (Kelton 1973 p. 9 emphasis original) [6].

Flagg invariably is the most admired literary character in a class that the author of this article teaches on Texans and their land. Undergraduates almost all identify with Charlie, seeing in him traits that they admire in the adults in their lives, traits that before reading the novel they did not fully recognize as being part of their own values and ideology. They seem liberated, freed to identify with a character that is quintessentially West Texas, perhaps having previously suppressed such regional enthusiasm in an effort to seem more urbane and intellectually mature, or what they often call "politically correct."

Kelton has said that attitudes like Charlie Flagg's toward land ownership in part go back to feudal times in Europe and Britain (where the Anglos and Germans of Texas came from via the American South). In feudal times peasants worked for the Lords who were the landowners. So when they got to the New World, they coveted land of their own that was not controlled by anyone else; thus, no "Land Lords" (Kelton 2009 personal interview). Exploring this cultural heritage of intense individual freedom in Texas through *The Time It Never Rained* sheds light on why local attitudes make it so difficult to forge a national or international policy for dealing with environmental challenges such as drought.

The ranches around Kelton's hometown in the 1950s used wells to fill stock tanks, but depended largely on rainfall to provide grass for their livestock. Today, much of Texas, including the High Plains and Panhandle regions, rely primarily on groundwater, including that provided by the Ogallala (also known as the High Plains Aquifer); it provides nearly one-third of the irrigation groundwater in the United States (USGS 2013). At one time the Ogallala contained 20% more water than Lake Huron—the second largest of the Great Lakes (Pielou 1998). Much of that water table has been depleted, losing an average of a foot per year and approaching 5 feet per year in the Southern High Plains during the peak irrigation years of the late 1950s (HPUWCD 2013) [7]. The cause is frequent droughts (1860s, 1930s, 1950s, 1990s, 2011 to present) leading to higher irrigated agriculture use and, therefore, significant aquifer drawdown.

Despite the depletion, major voluntary reductions in irrigation demand on the Texas High Plains will be difficult. The Texas High Plains cotton industry drives the regional economy, producing an average of 3.66 million bales per year in the decade 2000–2010 on the Texas Plains (PCG 2004 [8]). Typically about half is irrigated while half is dryland, that is, totally dependent upon rain (Burns 2012) [9]. But because it takes 100 gallons of water or more to make 1 pound of cotton, the effect is that we are exporting what has become known among environmental scholars as "virtual water" in T-shirts, etc. from the Ogallala [10, 11].

A HIDDEN AND OCCULT WONDER

Given the multiple overlapping narratives that shape the ways in which we view the Ogallala Aquifer and water policy, it is not surprising that attitudes among stakeholders would both reflect the complex factors involved in knowing water, but would also attempt—if even subconsciously—to reduce those many factors to a simpler story line. In research over the past 10 years, reading reports and other texts about water in Texas, attending public meetings, and interviewing farmers and others, the author of this article has found that knowledge about water and about the environment in general, is forged out of paradoxes. Multiple stories coexist in all people.

For example, at times drought is seen as a cycle and at other times as the result of sin. In the former the story originates

[6] Yet, Charlie Flagg—like his creator Kelton—is not as smitten with God or guns as conservative rural America would seem to be today. Charlie seems at least as reverential toward the hill where the old Comanche warrior bones were said to have been found as he was toward the Judeo-Christian God. He has sympathy for illegal immigrants and is willing to turn the other way despite U.S. Border Patrol agents' efforts to prod him into being their eyes and ears.

Kelton himself has argued that cowboys are first and foremost pragmatists, concerned about affairs of the day. "He may be in church every Sunday, or he may spend the Sabbath getting past a hangover," Kelton wrote in a July, 2008 Texas Monthly article titled "True Grit" (Kelton 2008). He lamented that the term "cowboy" had taken a beating because of political uses that peaked during the administration of President George W. Bush, having become synonymous with a "shoot-from- the-hip" swagger. To wit: Charlie does not carry a gun, which is more typical than not of working cowboys, Kelton wrote in the same article

[7] The average annual decrease of stored groundwater in the entire 8-state range of the High Plains Aquifer between 2000 and 2007 was 10 million acre-feet per year, according to a report from the U.S. Geological Survey. See Stanton JS. et al. 2011.

[8] This website was created in 2004 and has data through 2010, as of June 11, 2013.

[9] Reports in late 2013 (See Musico 2013a) suggest that the amount of irrigated cotton acreage on the Texas High Plains has dropped to 37 percent, reflecting an increasing awareness of conservation needs by farmers. Of course, variations in rainfall and fuel costs for pumping also affect farmers' yearly decisions on how much to irrigate.

[10] For a detailed discussion of the concept of virtual water, see Renault D. 2002.

[11] Meantime, we are rapidly reaching the technological limits of efficiency in using that water. In the 1870s–1880s windmills dipped 30 to 40 feet into the ground. In the early 1900s, centrifugal steam pumps pulled water out of wells to feed irrigation ditches that delivered maybe 50% of the water captured to plants. Center pivot irrigation started 1950s and is 75% to 95% efficient. Buried drip irrigation is almost 100% efficient. There is not much more irrigation efficiency to be had.

from beyond human controls, while in the latter it results from human behavior. Nature can be perceived both as benevolent and, more often lately, malevolent; government can protect us from the vagaries of the environment or betray us in favor of policy that places the environment ahead of people; land and water can either be held in stewardship for God or used as resource for *homo economicus;* sustainability can be both wise conservation of the environment or slothfulness—as in the no-till farmer who may be looked down upon by some for letting his land "go to weeds."

Such binary thinking has always characterized our human view of the environment. Some early reports were overly optimistic about the potential for settlement on the Great Plains, writing that ". . . abundant columns of water would be found to gush out over this immense plain," (Marcou 1858 p. 30). They used terms for the aquifer such as the "land of underground rain," "underground river or lake," or "rainfall on demand." Conversely, other reports have been overly pessimistic, calling the land "non-irrigable" (Johnson 1900/1901).

Part of the problem with honestly assessing the environmental future of the Texas High Plains (and the Great Plains overall) has been that the water lies underground. The geological phenomenon known as an aquifer was ruled to be abstract: "secret, occult, and concealed" by the Ohio Supreme Court in 1861 [12], and despite sophisticated metering and mapping technology today, there is still room for conjecture, myth, and hope (perhaps arbitraging uncertainty to one's advantage) because the aquifer is hidden to our eyes. Most farmers on the Texas High Plains would seem to accept hydrological studies of the aquifer decline; many have experienced it first hand in their shrinking well yields. Still, the comment made by one farmer at a 2011 water hearing reveals that as with any hidden resource, it is possible there could be more bountiful, even divine, surprises: "Farmers meet me in your fields," the speaker exhorted. "Repent and He will fill the aquifer back up" (HPUWCD March 2011 hearing, author's notes).

The difficulties of understanding just what the aquifer is came clear at a 2006 panel discussion at Texas Tech University on regional water issues, which opened with the comment from 1 water official: "A lot of people do not understand the Ogallala Aquifer" (2006 author's notes). "It is not an underground lake, river, or water bottle." In our moments of childlike candor, the water must be seen as a hidden and mysterious world of wonder. It is believed to be God's bounty to give or withhold—just as in the Old Testament. In the late 19th and early 20th centuries railroad companies, newspaper editors, and other "boosters" appealed to the inner child of any potential settler who might be lured by spacious land above and underground magical realms below. These boosters oversold the potential of the region to sustain agriculture; hence, old promotional postcards of Plainview, Texas made it look like a tulip field in Holland or the Garden of Eden [13].

LEGAL RULINGS: CLEARING OR FURTHER MUDDYING THE WATERS?

One who is confused about the geology of an aquifer might be forgiven also for trying to make its complex legal aspects more manageable through strong narrative—especially after delving into the documents about Texas water law. While laws about an individual's rights to the water under his or her land would seem unambiguous at first glance, a closer look unravels too simplistic an understanding [14]. Wording from the 1904 Texas Supreme Court rule of capture opinion cites English common law precedent that a property owner may dig for water and "apply all that is there found to his own purposes at his free will and pleasure"; any depletion of a neighbor's water would be recognized as a loss, but not a legally actionable injury (*East* ruling as cited in Potter p. 1-2).

Yet, as in many complicated legal matters dealing with water, the 1904 ruling left room for debate that continues into the 21st century. Specifically, the Supreme Court did not rule out action in the case of "malice or wanton conduct" and also permitted the state legislature to regulate groundwater (Potter 2004.). The 1904 decision did not clearly define what was meant by the right to capture water, or when the property owner had a "vested interest"—that is, a consummated right that cannot be taken away without compensation. Thus, the 1904 ruling would seem to have violated a basic principle of common law, which holds that a person does not really have a right unless he or she has some means of seeking remedy when that right is threatened [15].

The first such groundwater regulation came to Texas in 1949 when the legislature passed a law allowing parts of the state to create underground water conservation districts (Green 1973). Two years later 13 regional counties formed the High Plains Underground Water Conservation District (HPUWCD) No. 1 after an election approving its creation, but not without

[12] For a history of hydrological knowledge including the Ohio Supreme Court case in 1861 known as Frazier vs. Brown and its precedence for Texas water law, see Mace et al. 2004.

[13] For this example see "Typical Irrigation Well near Plainview, Texas 1937" at Image-archeology.com http://www.image-archeology.com/Plainview_TX.htm

[14] As Eckstein and Hardberger (2009) note, even terminology that governs water law can seem inconsistent. They write, "One of the more troublesome aspects of water law can be the divergence often encountered between legal and scientific definitions, as well as among subfields of the law. Although the vocabulary used by the various communities can overlap, the meanings ascribed by each to various terms and concepts may differ significantly."

[15] The principle dates back to Roman law, often quoted as a positive assertion: Ubi Jus Ibi Remedium ("Where there is right there is a remedy").

some of the same resistance that appears in water policy narratives today, more than 60 years later [16]. While some producers asserted that local control was preferable to state control, others remained vehement against any control beyond the property owner, tossing around invectives like "socialism" or humorous quips suggesting that asking whether one preferred federal, state, or local control was tantamount to asking which hangman you would prefer (Green 1973). Charlie Flagg was not alone in 1950s Texas by any means.

Subsequent state government actions regarding groundwater management have never fully resolved the underlying philosophical tension between private property rights and the need to conserve for the common good; individualism versus collectivism beats out a powerful story line that can be heard over the seeming noise of various laws, government agencies, and scientific models. Producers or anyone looking for clarity run across conflicting messages from the Texas Legislature and the Texas Supreme Court—confusion that is seen even in the terminology used and the alphabet soup of administrative hierarchies. For example, there is the distinction between a groundwater conservation district and groundwater management areas (GMAs), where the former is defined by elected representatives of a political entity and the latter is a geologically based concept determined by aquifer boundaries. Frequently, several political districts overlay the same aquifer, requiring joint planning among the political entities (Lesikar et al. 2002). So we have the HPUWCD as a political entity stretching over 2 geological entities, or GMAs; a small portion of the district covers 3 counties near Amarillo that are within GMA #1, while the main part of the district in the Southern Plains is within GMA #2.

Until 1985 water underground was classified in government parlance as lying in "underground water reservoirs," a misleading term conveying the old idea that the saturated sand was actually a large lake. The Legislature in 1995 and 1997 established the GMA concept, and in 2001 ceded full administrative control of these management areas to the Texas Water Development Board (Mace et al. 2008). A subsequent law in 2005 added clout to the water board by mandating that conservation districts work with each other by 2010 to determine "desired future conditions" for aquifers: it is these 3 words that have generated much of the debate and resistance from some producers.

Setting desired future conditions means each district overlying an aquifer must agree on how much of that aquifer's water should remain after a period of time in the future. As Mace et al. write in their 2008 history of Texas Water Law, "In essence, a desired future condition is a management goal that captures the philosophy and policies addressing how an aquifer will be managed. What do you want your aquifer to look like in the future [17]?" The High Plains district (HPUWCD) has thus established what is known as the 50/50 rule, meaning that the goal for its portion of the Ogallala in Texas is to have 50% of the saturated thickness remaining in 50 years, which would be 2060. But other districts overlaying the common geological entity (GMA #1) set different goals for the same time period, ranging from 40% to 80% (Brauer 2009).

The "desired future conditions" approach is seen by some observers as a fanciful but pointless attempt to introduce water conservation measures. In his 2006 book *Ogallala Blue*, author William Ashworth quotes a Nebraska-based geologist who is highly skeptical of a plan to preserve a percentage of the Ogallala Aquifer's saturated thickness. Such plans do not consider the composition of the aquifer at different levels, the quoted geologist argues, and it is composition that determines how much water can be accessed (Ashworth). But Ashworth then quotes a Texas geologist and water official who acknowledges limitations to the 50/50 rule, yet argues that such efforts—even when involving "voodoo and bluff"—are a necessary first step in making stakeholders aware of the need to conserve groundwater (p. 227-228).

Since groundwater conservation districts began setting desired future conditions, legislative and judicial actions in Texas have added more potentially confusing information that producers, municipalities, water districts and other stakeholders must sort through in their attempts to navigate water policy. First, at the behest of landowner lobby groups, the Legislature addressed a nagging question in state water law—whether a property's owner right to capture the water meant he or she owned that water before capture. If so restrictions on its use amounted to a legal "taking," and this could lead to suits for damages. In 2011 Texas Gov. Rick Perry signed into law a bill that stated, "The Legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property" (SB 332 Texas Legislature online 2011). Yet, further wording asserted that the new law did not "affect the ability of a district to regulate groundwater production" as established under previous law (SB 332).

The Texas Supreme Court weighed in similarly in a 2012 case brought by 2 property owners near San Antonio who had

[16] The HPUWCD #1 now comprises all or part of 16 counties.

[17] The law as written in the Texas Water Code - Section 36.108, Joint Planning In Management Area (2007 Section d) reads as follows:

> Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area. In establishing the desired future conditions of the aquifers under this section, the districts shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another.

challenged restrictions in how much water they could pump from Edwards Aquifer region. The court in *Edwards Aquifer Authority vs. Day* ruled in the property owners' favor and to the delight of producer groups. The ruling held supported the vested interest claim, meaning a landowner would have to be compensated for any taking of his or her groundwater rights. Critics have asserted that the ruling erodes the power of conservation efforts and has "sown confusion about the capacity of the state to regulate natural resources, while ignoring the science that ought to drive policy decisions" (Torres 2012 p. 144).

The abstract to a pair of 2013 commentaries on the implications of the Day case makes clear, however, that the Supreme Court ruling has by no means settled the debate:

> The decision is complicated and, in places, seemingly contradictory. By opening groundwater management to regulatory takings, a door to another complicated area of law has been opened. Although the Day case answers some questions, others remain unanswered. And there are strong opinions on what Day means and doesn't mean (Johnson and Ellis 2013 p. 35).

Charlie Flagg, the rancher in Elmer Kelton's novel of the 1950s, would probably not be surprised at the complexity of the science and the shifting court rulings and laws that attempt to come to terms with Texas water challenges today. Toward the end of the novel Charlie and another landowner are arguing with a federal auditor about changes in subsidy policies that cost Charlie's friend $30,000. "They can't make regulations retroactive," Charlie says. "That's against the United States Constitution" (Kelton 1973 p. 315). It is that U.S. Constitution that conservative landowners opposed to new water laws invariably cite in public hearings regarding water district policies such as the 50/50 rule for desired future use. Thus, we can turn our attention in the remainder of this article to such hearings, and to the narratives that a vocal group of landowners has voiced in the Charlie Flagg tradition.

HIGH PLAINS HEARINGS: "LOBBING AN INCENDIARY RULE BOOK"

If every story has a climax, as we often see in literature, the HPUWCD's efforts to establish a desired future condition for its part of the Ogalalla Aquifer reached that climatic period in the spring of 2011. The district had drafted proposed rules toward the 50/50 goal that would extend its control beyond regulations established in the 1950s to govern the spacing required between water wells. According to the district's monthly *Cross Section* newsletter for March 2011, the proposed amendments included designating "high water decline areas." These were areas of the region that had seen greater declines than other areas and, thus, would merit tighter restrictions. Other amendments required producers to meter their wells and report annually how much they had pumped and also established an "allowable production rate" for each well—a cap on how much each well could pump in a year (HPUWCD 2011).

District officials set dates for 5 public hearings throughout March 2011, including the March 24 hearing in Lubbock. The *Lubbock Avalanche-Journal's* account made the hearings seem more like a military campaign than a policy meeting. Hundreds of people turned out, including, it would seem, the ghost of Charlie Flagg. On the other side were unlikely opponents, 5 board members—all of whom were "conservative, deliberative West Texans with ties to agriculture," according to reporter Elliot Blackburn (2011b).

Blackburn's article asserted that "board members lobbed an incendiary 48-page rule book into their 16-county region about a month ago, immediately drawing the attention of growers, cattlemen and their suppliers who faced watching their livelihoods burn up under a dry Texas sun" (Blackburn 2011b). Much of the anger from producers was directed at the proposal to impose greater restrictions on those in high decline areas. Many argued that such restrictions would place these producers (who had bank loans initiated when there were no such restrictions) at a disadvantage in trying to make a living from their land.

The following week the district withdrew the most contentious amendments. "We have heard you loud and clear," then District Manager Jim Conkwright was quoted in the newspaper account (Blackburn 2011b). Revised proposed amendments dropped all mention of high decline areas and, instead of immediate implementation, established a 4-year phase in period for pumping restrictions to reach the desired annual goal of 1¼ feet per acre. Having diffused much of the anger, the board set 2 additional hearings on the revised amendments for June 27, 2011—one in Dimmitt and the other in Lubbock.

District officials recorded these hearings and provided the author of this article a CD copy of the recordings after a written request. After listening and transcribing opening and closing statements from district officials and comments from each attendee, the author then looked for patterns among the comments—an informal kind of "coding" process that is typical in humanities and social science qualitative research. The coding process involved noting the stories told by the speakers or those implied in the speakers' arguments.

RHETORIC AND THE NARRATIVE OF OVERCOMING THE MONSTER

Aristotle and other ancient rhetoricians developed taxonomies of how such arguments worked. Rhetorical "proofs" persuaded either because the speaker or author marshalled

convincing facts (arguments of *logos*), because he or she exhibited a trustworthy character (arguments of *ethos*), or because he or she excited the passions of the audience (arguments of *pathos*). Rhetorical studies consider figures of speech that affect meaning, such as metaphor; stylistic moves that make speech or writing memorable (such as repeating the opening consonant in series of words); and commonplace arguments that recur in different cases, such as the argument that providing for the future residents is a necessary goal in any water policy (e.g., "we need to save water for our grandchildren"). Oftentimes commonplace arguments such as the one about saving for grandchildren are mini-stories that are expanded in novels and songs into grand epics with a moral.

Narrative, as we have seen, is the telling of stories, cause and effect relationships in time. Hence, stories can be seen as a kind of rhetorical proof, perhaps revealing one's character or ethos to be commendable and therefore believable, or as commonplace argument, perhaps forecasting that consequence Y is likely to follow X because it did so in the story one is telling. Modern rhetorical scholar Jimmie Killingsworth argues that narrative is a kind of rhetorical appeal that convinces by showing the audience members how they can identify and associate with the events the speaker or writer tells of (Killingsworth 2005).

We have already seen how the various ways of knowing the aquifer, from the hydrological to the legal, all have an element of story telling and persuasion. As would be expected, such persuasive stories also are easy to spot in transcripts of HPUWCD June 27, 2011, hearings related to the Ogallala Aquifer.

At those hearings speakers were each limited to 3 minutes to present their stories and arguments; some used prepared notes and others appeared to speak from the cuff. Some spoke at both hearings. Before each hearing HPUWCD Manager Jim Conkwright opened with about 15 minutes of background, explaining the changes that district officials had developed since the initial 50/50 proposal was floated and shot down in March. The most obvious rhetorical move in Conkwright's opening words was to establish the ethos of the board and paid employees as being reasonable and responsive to suggestions. Conkwright said:

> I've already discussed the public meetings. We felt like these were of great benefit to the district and I've heard back from many of you who say you feel like the changes that were reflected in what you are here to testify on today show that the board and staff heard and incorporated those thoughts and ideas into those amended versions of the proposed rules (June 27, Dimmitt).

The manager's opening comments at both hearings also established a sense that district officials and producers were partners rather than adversaries in water policy. Conkwright frequently used the pronoun "we" when addressing the groups, as in "We've got 4 years to get there" when describing the annual pumping limitations. "This will be a learn and figure this thing out time period," he added later, strongly establishing a setting in which the officials and producers were all together on the same learning path regarding conservation.

This opening appeal designed to establish the ethos of district officials as partners rather than adversaries may have diffused some of the Charlie Flagg-like suspicion on the part of the producers, who nevertheless remained critical of the 50/50 policies even with the proposed changes. While much of that suspicion can be understood as inherent in an epic story of identifying and overcoming the monster, Conkwright's opening comments did seem to convince many producers that if indeed they were fighting a monster, it was not the HPUWCD. A speaker from Hockley County who attended both hearings established his ethos as that of a good man, a private property owner, a Christian, and "a constitutionalist" but also spoke as if the district officials were on his side in the battle to defend private property rights.

"Carroll, James, Bob, Bruce, Jim," the Hockley County producer said, addressing district officials familiarly. "I will stand with you . . . in public, in private, with all my heart and with all my conviction and with all my energy [so] this board can vote no and resist implementing these rules upon free Texans" (June 27, Dimmitt).

At the second hearing, the speaker clearly identified the monster he saw threatening Texas farmers as that of "socialists," "statists," "collectivists" in government who are attempting to "perform this horrid act in the name of conservation…." (June 27, Levelland). The speaker even further villainized the monster by referring to it as "National Socialist," which of course was part of the official name of Hitler's party during the Third Reich. Invoking another war image—this from the 19th century war of Texas independence from Mexico—the speaker said, "I wanted to let you know that we as Texans are at an Alamo moment" (June 27, Levelland).

A speaker from Lubbock who addressed both hearings invoked an archetype that is common in overcoming the monster narratives, that of the monster as a shapeshifter or a trickster who disguises himself to hide his nefarious intentions (e.g., the wolf in sheep's clothing). He first asserted that the private property owner was a better steward of water and other natural resources than was a "tyrannical" government. He then added, "It is totally unnecessary to implement a fascist form of government upon the people of Texas under the guise of preserving water for those 50 years from now" (June 27, Levelland). In addition to invoking the trickster enemy story line, this comment also contained the rhetorical commonplace argument of dissociating appearance from reality by asserting that what may appear to be conservation is really a government power play.

This speaker from Lubbock revealed either an instinct or training in Classical rhetorical argument techniques, including clever word plays and figures of speech. "Meters, limits, restrictions, grace periods, limits to report, adjustments, penalties, fines, well shut downs, spot checks—what country do we live in?" he asked at the Dimmitt hearing. This opening comment employed rhetorical asyndenton, the stacking of nouns without intervening conjunctions, which suggests a wearying and overwhelming effect from many actions—as if the monster systematically laid waste the freedoms of area farmers. The rhetorical question at the end also added emphasis, allowing the hearer to fill in an answer that this country could not be the United States.

A farmer from Hockley County argued at the Levelland hearing against proposed rule changes by combining the commonplace argument of consequence—that allowing X to occur will lead to Y—with the related narrative of stopping the monster (in this case regulation) before it became invincible. "There's nothing here to stop the water rules from coming in and becoming even more oppressive in the future," he said. "When you make laws, regulations, a lot of times it's like taking a prescription medicine," the speaker said. "There's unintended consequences." He then repeated the phrase "You're going to force people. . ." followed by examples, as in "You're going to force people out of some crops they have produced for years" (June 27, Levelland).

Often the monster is an enemy from outside the tribe, like the Philistine giant Goliath who threatened Israel in the Old Testament. A speaker from Lamb County at the Dimmitt hearing evoked the outside enemy image of "newcomers" to the community, people who use services such as the hospital but "don't pay their bills." He contrasted these newcomers with people like himself, those whose ancestry in the regions dates to the 19th century, those who gave land and money for roads, highways, railroads, schools, and churches (June 27, Dimmitt). Another version of the outside invader is oil companies who pump water into the ground for fracking subterranean rocks to free their oil. "If the water hogs want war, we'll give them war," the same speaker said (June 27, Dimmitt).

The relationship between oil companies and farmers in Texas is interesting and complex. It is not uncommon to see oil pump jacks mixed in among the cotton fields, farmers receiving extra income from the leases. Politically, oil workers and farmers may be aligned in their distrust of environmentalists in government, but they can be at odds over such resources as water. Such suspicion dates to the early 20th century when some farmers across the country resisted the incursion of automobiles and tractors into their horse drawn lifestyles. In Kelton's *The Time it Never Rained* Charlie Flagg responds "dubiously" to a suggestion that perhaps the drought-parched land would be better used for oil rigs than ranching. He says:

> Maybe, but you pay a price for it. An oilfield scars up the land. And them oil people, they don't care much about the land, most of them. They're only interested in what's under it. They'll use up your water or leave it polluted with salt if you don't watch them. There'll come a time in this country when a barrel of water is worth more than a barrel of oil (1973 p. 305).

Another speaker at the Levelland hearing offered a variation on theme of big business as the monster by pointing to Xcel Energy—a utility holding company based in Minnesota that provides power to 8 states, including much of the Texas Panhandle and Eastern New Mexico. The speaker alleged that Xcel was using water without care for steam generation and cooling at its Lamb County power plants. "They'll still be able to pump all they want," the speaker said. "I mean, I know everybody wants electricity. I want electricity, too. But this is everybody's water. It's not just their water" (June 27, Levelland). A representative of Xcel countered that the company uses just 4% of the county's groundwater and has various technological systems in place for reclaiming and reusing water.

A theme that has been present in American history since the Revolution is that of conflict between urban and rural interests. Often the big city is demonized as a monster looming over much lower populated, vulnerable rural areas. One speaker at the Levelland hearing echoed a common complaint that residents of Lubbock and even the city government itself is careless, allowing water to run down the streets and watering in the heat of the day. In West Texas this urban versus rural story line reached its climax in the spring before these hearings. That's when oil businessman and Panhandle landowner T. Boone Pickens backed off his proposal to sell water from under his land to San Antonio or Dallas, 2 cities several hundred miles to the Southeast. Instead, a deal was reached to keep the water for smaller rural Panhandle municipalities as Pickens agreed to sell his rights to the Canadian River Municipal Water Authority (Blackburn 2011a). Certainly this agreement helped diffuse much of the anger toward Pickens, and resolved much of the story line that had him as the monster.

Uneasiness among rural Texans toward the growing urban islands in their midst has led to subtle twists in the overcoming-the-monster story line, particularly in how that story accommodates the rugged individualist character. As we have seen, the 1904 Texas Supreme Court introduced what might have been the 20th century's mantra of muscular individualism, "the rule of capture," into Texas parlance; that phrase on its own, however, does not convey any value judgment for the 21st century on how large a capturing entity might be. Indeed, the law has been paraphrased half jokingly in Texas lore as "the law of the biggest pump."

Perhaps not surprisingly, then, the rule of capture itself has been characterized as a kind of monster—the mythological Greek Hydra, a water snake with many heads that has the power to regenerate those heads when severed. In a scholarly article, Eric Opiela—a Karnes City, Texas lawyer and candidate for the 2014 Texas Agriculture Commissioner Republican primary—called the rule of capture "outdated," in part, he argued, because it makes distinctions now disproven between surface water and groundwater, and because it was enacted before the growth of large cities and their big pumps. Evoking the shapeshifter and trickster image he concluded that "The rule of capture has grown from a simple tort preclusion doctrine into a two-headed Hydra that also purports to recognize a property right in groundwater" (Opiela 2002 p. 13). Undoubtedly this theme (cities as monsters) that is underlying the Texas Agriculture Commissioner race in late 2013, and which appeared briefly in the 2011 High Plains water district hearings, will continue well into the 21st century as a compelling story line.

CONCLUSION: GOOD GUY-BAD GUY STORIES WILL PERSIST IN WATER POLICY

Three weeks after the HPUWCD hearings in Dimmitt and Levelland, the board of directors voted to approve the amended 50/50 management plan for its portion of the Ogallala Aquifer. The vote at the July 19, 2011 board meeting was 4-0 in favor of the plan. The following year, in August 2012, a group calling itself "Protect Water Rights Coalition" mailed out a newsletter with the headline "Taking Property Is Not Conservation," accusing the water board of being dysfunctional and announcing that the protest group had sought legal counsel (Protect Water Rights 2012) [18]. The water district followed with a post card titled "Rumor VS Fact" that said nothing had changed from the July 19 vote—countering rumors that the district would not enforce the new policies (HPUWCD no date). But the following year, at an October 8, 2013 meeting, the HPUWCD directors agreed to hold a hearing before the next board meeting to consider an additional 1-year moratorium on penalties for landowners who did not install new wells (Musico 2013b) [19]. At that November 12, 2013 meeting, they voted unanimously for the 1-year extension through the end of 2014; the vote came after all but one of a dozen speakers rallied either for the extra time or for doing away with the 50/50 policy permanently. Speakers, including some from the water rights coalition, reprised themes of property rights and "water-grabbing" government officials in the state capital, Austin. "I think DFC (desired future conditions) is linguistic trickery," one landowner said. "Desired means mandatory"(HPUWCD November 2013 hearing, author's notes). The landowner who did not want the moratorium extended likened the Ogallala's condition now to an old cattle trail chuck wagon carrying a water pail, with cowboys dipping more than their fair share—thus, jeopardizing the entire journey. Clearly the 50/50 debate and the colorful story lines that people use to understand it will continue for the foreseeable future.

Of course, it must be emphasized that the comments quoted in this article came from just a few of the hundreds of people who attended the various HPUWCD hearings. Many producers seem at peace with the ruling. Yet, the persistence of these kinds of comments at such hearings reveals that Elmer Kelton's fierce individualist Charlie Flagg is still very much alive in West Texas. Charlie does not sound quite as angry in Kelton's novel of 1950s Texas as the outspoken Lubbock-area cotton farmers do—perhaps only because he boycotted such government meetings. But no doubt he would recognize the frustration felt by such rebels.

Paradoxically, while anti-government attitudes remain strong in rural Texas today, so does the willingness to take federal subsidies for crop insurance and other such assistance. Texas ranks number one in such subsidies—$27.3 billion worth between 1995–2012, according to U.S. Department of Agriculture figures gathered by the Washington D.C.-based Environmental Working Group. Texas received the largest total subsidy amount for the period of any state, with other farm belt states like Iowa and Illinois coming close behind (EWG 2013) [20].

The coexistence of anti-government attitudes with acceptance of subsidies at least among some producers exhibits a key finding in this research. All of us embody multiple perspectives that at times are fragmented and paradoxical, modulated by expediency, pragmatism, and the need for economic well-be-

[18] The water rights coalition has since established an Internet presence with a Web page whose mission as stated is "fighting non-compensated government takeover of private property"(Protect Water Rights Coalition 2013); the group also has a Facebook page with links to various media interviews.

[19] Composition of the HPUWCD board of directors by 2013 had changed substantially from the 2011 board that passed and amended the 50/50 rule. Two of the 5 directors had resigned and another 2 were defeated in the 2012 election. Turmoil over the new district water restrictions and metering requirement likely contributed to the turnover, according to *Lubbock Avalanche Journal* reports (Young 2013). Additionally, long -time District Manager Jim Conkwright retired in the summer of 2013; the board chose farmer and former South Plains Underground Water Conservation District Director Jason Coleman as the new manager.

[20] The issue of farm subsidies increasingly has become a topic of debate in regional and national politics. Some argue that they often are an unfair entitlement to already wealthy farmers and should be eliminated. Others counter that such subsides are necessary to ensure the stability of the U.S. food and fiber supply given unpredictable weather and economic variables. The debate brought challenges to Texas Gov. Rick Perry's credentials as a Charlie Flagg brand of fiscal conservative in his bid for the 2011 Republican Presidential nomination when news media reported that he had taken $9,624 from the Conservation Reserve Program between 1991 and 1998—admittedly a small, but symbolic amount (Ratcliffe 2011)

ing. Knowledge of water and the aquifer is derived from multiple domains (science, history, religion, law, etc.). But as we have seen in this article, all these types of knowledge of natural phenomena and their impacts on people contain stories with plots. Some of the most powerful of these stories are archetypal accounts of good and bad, cause and effect. An account of a natural phenomenon or event, such as drought, that blames identifiable groups (cities, oil drillers, government employees) may not work for consensus building, but accounts that downplay human responsibility may be ineffective. The plot does not convince us; sadly, we seem to need a human enemy, not some vague enemy like drought, or worse, an enemy that is the child of all of us, like climate-change gasses. There is always an urge to find the bad guy.

The need for good and bad characters may be strongest in cultures with a strong monotheistic religious background, where creating a shared identity among God's people also requires an outside group that is ungodly. Such in-group–out-group identity formation is especially necessary in areas of scarce resources (e.g. water), according to scholar of religion Regina M. Schwartz. In *The Curse of Cain: the Violent Legacy of Monotheism* she asserts that the notion of a Biblical covenant between God and his people "has left a troubling legacy of the belief in land entitlement, one that continues to ghost territorial disputes" (Schwartz 1997 p. 42). When West Texas farmers and ranchers argue that they have worked the land for more than 100 years only to face onerous restrictions now, they in effect are arguing that government policy is threatening their covenant with God.

The federal or state government is easily portrayed as the enemy or monster at large—even the Antichrist of Biblical prophecy. Robert Fuller in his book, *Naming the Antichrist: The History of an American Obsession* asserts that millions of Americans hold an apocalyptic worldview that ultimately means the triumph of believers over the out-group. "Because they tend to view their nation as uniquely blessed by God, they have been especially prone to demonize their enemies," Fuller writes (1995 p. 4-5).

Elmer Kelton's Charlie Flagg did not share such a strong identity with Biblical prophecy as Schwartz and Fuller are identifying. He was much more the pragmatist. Like many farmers he might pray for rain, but also would work hard to ensure that at least some of his stock survived if God did not oblige. His suspicion of government agriculture programs and pity for those who took such aid was perhaps less borne out an apocalyptic worldview and more out of the pragmatic belief that no one can better care for his or her resources than the person who owns them and depends upon them.

Still, Kelton as a West Texan embodied the strong Protestant ethic that dominates the region. Perhaps because of this strong ethic evident in his prose, not everyone has been smitten with Kelton's novel. The author of this article has encountered several people including some students whose response to the novel was more in line with that of University of Texas literary scholar Don Graham, who has dismissed Kelton's writing and themes as being overly steeped in Calvinistic self-denial, a style of "staid rectitude" (Graham 2011 p. 50). One colleague of the author of this *Texas Water Journal* commentary article put the book down after a few pages, offended by Charlie Flagg, who he said, reminded him too much of his own "authoritarian daddy."

Yet, in trying to forge some kind of consensus about water conservation and other environmental issues in Texas, it is vital to consider attitudes that are admired as part of the Texas rural heritage. Such attitudes may seem rife with paradoxes, streaked with stubborn individualism. Thus, we can look forward to many legal and political battles over ever-scarcer water resources and over policies such as the 50/50 rule that aim to preserve some of that water in the Ogallala Aquifer. And we can wonder with some apprehension whether such individualism is sustainable for Texans, indeed for the millions worldwide who suffer from lack of water and from other environmental deprivations. Still, we cannot ignore those attitudes or fail to respect them, or fail to take into account the very human tendency to translate complex and often contradictory knowledge from multiple domains into a less confusing story line.

Those involved in water science, law, and policy who are practiced and fluent in the specialized language and knowledge afforded by their fields may at times be frustrated when trying to introduce their expertise into the public—especially when that public's economic livelihood and traditions are challenged by the specialized expertise. Such threats to one's traditions inevitably will evoke anxiety, and anxiety is a breeding ground for narratives involving good and evil—the battle against monstrous outside forces. The resulting chain of responses to threats is universal in human society; no one of us is immune to this "fight or flight" instinct.

Therefore, the most penetrating lesson of this research would seem to be that anyone involved in water policy or any other policy, for that matter, must always be aware that specialized knowledge will often be heard in a quite a general way—a familiar story line that places the hearer in a situation that requires all of his or her wit and wherewithal to prevail. Often such stories borne out of anxiety will fade over time and the realization that regardless of what stories one follows, the science is unequivocal—in this case, that the Ogallala Aquifer is being depleted rapidly. Cooperation and conservation are necessary to preserve at least part of it for the next generations.

For now the HPUWCD's willingness to hold repeated hearings on the same water policy issues would seem to be the most prudent course of action. One would have to think that the tenacious Charlie Flagg ultimately would learn from

a patient government board like the HPUWCD, even as his story was likewise teaching and inspiring members of that board.

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