Water Policy in Central Texas: The Challenges Associated with Effective Management in the Lone Star State

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I have not violated the honor code in any way on this work.

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Introduction: Water, Society, and Texas

Water is more than a naturally occurring phenomenon; it is a commons resource that has become endowed with cultural meanings. As a society, little value is placed on water; the general attitude is defined by the assumption that the resource is infinite. Society has become removed from water; the relationship is depersonalized and water is viewed as a commodity, instead of as a finite natural resource. Power has shaped the management of fluid resources, making it more than a commons. Over time it has evolved into a social construction; the cultural meanings ascribed to water are generally shared and provides a base for human interactions, especially since resource-related decision-making often encompasses many different people. In the United States, various institutional frameworks exist to manage water supplies, power plays a role in understanding how these entities support social and economic development. An understanding of the institutional framework and an awareness of how issues related to water policy is part of the puzzle of resource development and management. The challenges of water policy and management are best understood on a state-by-state basis.

While oil and energy are Texas's banner industries, there is no resource with a greater significance for the state's future than water. Texans use around 16.5 million acre-feet of water annually.[1][2] Water use is split sixty/forty between groundwater and surface water.[3] Texas faces challenges regarding resource scarcity. The state struggles trying to reconcile political goals and scientific concerns with a complex management structure that is comprised of a blend of state agencies and localized districts. This has resulted in a policy battle between regulatory agencies,

[1] "Questions about Groundwater Conservation Districts in Texas," Texas A&M University System, 2002, http://twri.tamu.edu/reports/2002/2002-036/2002-036_questions-dist.pdf (accessed 12 February 2012) 1.
[2] One ace-foot is enough water to cover one acre of land to a depth of one foot and is the equivalent of 325,851 gallons of water.
[3] "Questions about Groundwater Conservation Districts in Texas," 1.

the courts, and individual landowners. Historically, the winners in this battle have been those who hold the most power.

Texas History and Water: Geographical Landscape

The availability of water has influenced community development in Texas. From the beginning, settlements have flourished due to both available and accessible water. Knowledge of Texas history provides a framework for understanding the nuances of modern resource management. Texas is the second most populous and the largest of the forty-eight contiguous United States. Geographically, the state resembles areas of both the American South and the American Southwest. The land is rich with resources and has supported indigenous populations dating back as far as ten thousand years. The area was suitable for settlement due to an abundance of water resources, including fifteen major river systems. These river systems and their tributaries have a stream length of approximately eighty thousand miles and flow into the Gulf of Mexico via seven different patterns, traversing much of the state.[4] This wealth of surface water is complimented by a plethora of groundwater, including nine major aquifers and twenty-one minor aquifers.[5]

Many areas of Texas rely heavily, often exclusively, on groundwater supply to meet municipal and agricultural needs. The city of San Antonio is dependent entirely on water drawn from the Edwards Aquifer. This dependency stresses available resources because the rate of pumping is not always in step with groundwater availability. The lack of visibility makes it challenging for lawmakers and individuals to fully grasp the depth and size of groundwater

[4] Richard A. Earl and Lawrence E. Estaville, *Texas Water Atlas* (College Station: Texas A&M University Press, 2008) 18.
[5] Earl and Estaville, *Texas Water Atlas*, 26.

resources. Related legislation is plagued by a refusal of those in power to acknowledge the scientific connection between groundwater and surface water resources.

It is estimated that Texas is almost entirely privately held, estimates claim that private property accounts for between ninety-four and ninety-seven percent of land.[6] Development has led to the diminishment of wildlife habitats and open spaces. As the population grows, Texas has become increasingly urbanized; this has led to the state losing large tracts of rural and agricultural land, which has shifted the modes and uses of available water. While Texas lacks property taxes, it has estate taxes. These taxes often leave heirs to traditional landowners with significant tax burden in relation to land values, a situation that contributes to land fragmentation. As communities continue to grow, they have outpaced their available water supplies. This has made it more important to design efficient and cooperative water regulation that allows the state to successfully meet the needs of each community.

Texas History and Water: Settling Texas

The name Texas originates from the Caddo Indian word "Tejas," meaning "friends" or "allies."[7] Often called the Lone Star State, the state is notoriously proud of their time as a Republic and comments regarding secession often more serious than joking. Power over the land has changed hands many times. The term "six flags over Texas" originates from the different nations that that have governed the area: the Kingdom of France, the Kingdom of Spain, the Mexican Federal Republic, the Republic of Texas, the Confederate of America, and

[6] Andrew Sansom, *Water in Texas: An Introduction* (Austin: University of Texas Press, 2008) 3.
[7] Edward R. Moore, "Caddo Cultures in Texas," Texas Indians, 1998, http://www.texasindians.com/caddo.htm (accessed 3 February 2012).

the United States of America.[8] Spain was the first European country to claim the land, but France held a short-lived colony around the same time. Texas was under Mexican power until 1836 when the state won their independence, becoming the Republic of Texas.[9] Texas county government development has its roots in the *municipios* of Mexico. The development of the *municipo*, which includes the town and surrounding settlements, shaped water resources allocation and control.[10] The Republic of Texas recognized *municipos* as counties, validating the laws developed during Spanish-Mexican rule.

In 1845, Texas joined the United States as the twenty-eighth state. In 1866, the Texas Constitution was the first state constitution to specify the county as a legal subdivision. The related powers of counties included infrastructure projects, medical services, and administering the court system.[11] The promotion of the county system fostered the development of local institutions and infrastructure that influenced the development and control of water resources. After the Civil War, Texas entered a long period of economic stagnation where only the cattle industry thrived, creating the image of the Texas cowboy.[12] This model was a hold over from the days of Mexican power and the *vaquero* ideal.[13] The presence of the *vaqueros* is symbolic of the strong independent ideologies that remain prevalent and drive governmental policy in Texas.

Oil jolted Texas out of economic stagnation, raising the state's status in a developing America. The Texas legislature passed regulatory statutes for oil alongside statutes related to

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[8] Charles A. Jr. Spain, "Flags of Texas," *Handbook of Texas Online*, http://www.tshaonline.org/handbook/online/articles/msf01 (accessed 25 January 2012).
[9] Ibid.
[10] "Time to Act: The Future of the Texas Hill Country," Hill Country Roundtable, http://www.texascenter.org/publications/act.pdf (accessed 12 February 2012) 3.
[11] "Time to Act: The Future of the Texas Hill Country," 3.
[12] Ralph A. Wooster, "Civil War," *Handbook of Texas Online*, http://www.tshaonline.org/handbook/online/articles/qdc02 (accessed 25 January 2012).
[13] "The Last Cowboy: Cowboys in America," Independent Lens, Public Broadcasting Company, http://www.pbs.org/independentlens/lastcowboy/cowboys.html (accessed 25 January 2012).

groundwater protection and well abandonment beginning in 1899.[14] During the first two decades after the discovery of oil, the petroleum industry strengthened Texas folklore on the national level, popularizing images like the crass, nouveau riche oilman and the roughneck, both stereotypes that gained notoriety in films and novels like Edna Ferber's *Giant*.[15] As investment flourished, oil became the focal point of new technology and industry, allowing Texas to lead the nation in export revenue at the turn of the twentieth century. The first oil discovery, while not significant, was made while drilling for water. Other profitable oil wells were found in the same manner. The pursuit of oil and water is connected through drilling practices, but oil is considered more desirable, so it has been a priority during development.

Texas History and Water: San Antonio and Acequias

> "It has been said that every Texas has two cities: his own and San Antonio. The history of Texas for a century and a half was largely the history of San Antonio."
> – Boyce House[16]

As the seventh largest city in the United States, the story of San Antonio provides context for understanding the present challenges related to water development. As power changed hands, the legal and governmental systems blended and adapted. In 1718, the Spanish chose to settle San Antonio for its strategic position between the Rio Grande and their settlements in East Texas. The area was also desirable because of the abundant and accessible fresh water resources, including the San Antonio River.

For centuries prior to colonization, the earliest people in Central Texas were the nomadic Coahuiltecan groups. Unlike Native Americans settled in other parts of Texas, these groups did

[14] Roger M. Olien, "Oil and Gas Industry," *Handbook of Texas Online*, http://www.tshaonline.org/handbook/online/articles/doogz (accessed 25 January 2012).
[15] Ibid.
[16] Boyce House, *City of Flaming Adventure: San Antonio* (San Antonio: Naylor Publications, 1968) 1.

not practice fixed-site agriculture, but they mainly lived in what is now considered Central Texas. Prior to Spanish arrival, their lifestyle was successful. After the establishment of Spanish missions, the Spaniards success was linked to the cooperation of the Indians and vice versa.[17] This required both sides to adapt to new customs and technologies. Since the semiarid climate and weather in this area is comparable to parts of Spain, the Spanish settlers were able to import their technology to capture water in the area.[18]

Spain did not have a large enough population to successfully settle San Antonio without the cooperation of the Catholic Church. Their colonization strategy in San Antonio was based on developing three institutions: the missions, the *presido*, and the municipality.[19] The missions worked to convert the Native Americans that populated Central Texas to the Spanish lifestyle. They exercised their power to organize the communities into navigable centers. These missions partook in large-scale farming practices that were supported by extensive irrigation. Agriculture sustained both the missions and the *presido*.[20] The *presido* provided defense for the missions against hostile Native Americans tribes, like the Apaches and later the Comanches. The institutional presence empowered the missionaries and allowed them to earn the respect of the Indians under their jurisdiction. The municipality took advantage of the military force of the *presido* to create a lawful government that secured the long-term community organization.[21]

In conjunction with these first acts of social cooperation came organized water management and distribution. In January 1719, the first *acequia* was built using Indian mission labor. *Acequias* fit the topography of the San Antonio River Valley; the shallow depth of the

[17] Charles R. Porter Jr., *Spanish Water, Anglo Water* (College Station: Texas A&M University Press, 2009) 25.
[18] Porter, *Spanish Water, Anglo Water,* 6.
[19] Porter, *Spanish Water, Anglo Water,* 21.
[20] Ibid.
[21] Porter, *Spanish Water, Anglo Water*, 22.

banks made irrigation feasible and small dams lifted the water into the irrigation ditches.[22] The function of *acequias* was water distribution, but their presence enabled the Spanish to strengthen community ties and solidified their political presence. The *acequias* fostered the development of a localized system of equitable resource distribution. With this power came a new legal system, based on decrees that reflect issues that are still relevant. One decree, issued by Viceroy Casafuerte to a Franciscan Friar, outlines a five-point fairness doctrine addressing regulation:

1. The water was to be divided and distributed and shared.
2. The water was sufficient for all.
3. The water's use was to be in common.
4. Use of the water should be rotated via assignment of days to the interested parties.
5. There would be cooperation and conservation of the water.[23]

While each point is still relevant to present water use and allocation, the idea of cooperation and conservation is significant for present water use challenges. This decree is an example of the type of documents that shaped water use and have had a lasting influence on policy. The decree uses specific language; phrases like "interested party" raise questions of cooperation and power without defining how this is to be administered. Cooperation and the related challenges are a dominant force in regulating water. Viceroy Casafuerte did not grant ownership over water, he initiated usufruct rights. These are rights that occur as a result of landownership and proximity. A riparian right is an example of this system, because it is a water right derived not from true ownership of the water but from proximity to the resource through land ownership.[24] Originally, land transfers were started with royal grants; at this point, lands that were riparian, meaning next to flowing water, did not give the grantee the right to take water unless the right was explicit. Viceroy Casafuerte's decree initiated a stronger system of riparian rights.

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[22] Porter, *Spanish Water, Anglo Water*, 14.
[23] Porter, *Spanish Water, Anglo Water*, 54.
[24] "Water Appropriation Systems," *Western States Water Laws*, National Science and Technology Center, http://blm.gov/nstc/WaterLaws/appsystems.html (accessed 20 January 2012).

As their municipal government developed, San Antonio formed a strong identity as a Spanish city. The Mexican War of 1846 was a critical point in halting the city's development. The annexation of Texas set off a chain of events that resulted in an armed conflict lasting from 1846 to 1848, because Mexico did not acknowledge the success of the Texas Revolution.[25] Any population growth or new economic opportunity was then disturbed by the violence of the Civil War. During the Civil War, San Antonio was a key agricultural center for the Confederate troops, but the *acequia* system could not keep pace with the demand. In 1852, due to economic hardship, the city sold at public auction lots appurtenant to the headwater spring of the San Antonio River.[26] The Spanish had granted these lots to the city; these grants included the right to use water. After the original sale, the land was resold several times over, creating endless controversy regarding ownership of both the land and the water. In 1856, the Texas Legislature officially incorporated San Antonio, marking the end of the remnants of Spanish government. The city charter outlined the rights and duties as related to the *acequia* system; it confirmed former water rights, which protected the remaining surface water rights.[27]

In 1878, the city council approved the construction of a water works system, moving towards water as a consumer commodity. This marked a shift from the *acequia* system towards modern machinery, a process that sparked the development of water technologies around Texas. These technologies included the drilling of artesian wells as a means to access of the water lying below the surface of the city. By 1900, the San Antonio River no longer provided the city's

[25] "Prelude to War," *U.S. Mexican War*, Public Broadcasting Company, http://www.pbs.org/kera/usmexicanwar/index_flash.html (accessed 25 January 2012).
[26] Porter, *Spanish Water, Anglo Water*, 92.
[27] Porter, *Spanish Water, Anglo Water*, 94.

drinking water; it was completely supplied by artesian wells and the *acequia* system was phased out. This transition marked the start of San Antonio's dependence on groundwater resources.[28]

Texas History and Water: The Evolution of Texas Water Law

Substantial modifications in Texas water statutes occur more frequently than other aspects of property law. As previously discussed, Texas was under the control of Mexican law starting in 1821 and achieved independence in 1836.[29] When the Republic of Texas joined the United States in 1845, it retained its public debt and obligations, meaning that the United States did not initially have federal public lands.[30] This gave the state legislature the freedom to develop property laws that were unique to Texas. With this came a failure to recognize the hydrological connection between water resources. The result is that Texas uses different standards to govern surface water and groundwater. Surface water is regarded as the property of the State, while groundwater is considered the property of the landowner. This designation has held strong since it was affirmed by a 1904 Texas Supreme Court decision. The state has been slow to adopt regulatory laws related to groundwater despite its importance to development. Perhaps the most dangerous force is Texas's reliance on the rule of capture, a statute that hinges on the fictional belief that surface and groundwater are independent from influence.

Modern water law is like a rebellious child born from Old English Common Law and Hispanic tradition. The Fourth Congress of the Republic of Texas elected to preserve Spanish and Mexican mining law, but this did not extend to water law. In 1840, the Republic adopted

[28] Porter, *Spanish Water, Anglo Water,* 121.
[29] Glenn Jarvis, "Historical Development of Texas Surface Water Law: Background of the Appropriation and Permitting System and Management of Surface Water Resources," in *Essentials of Texas Water Resources*, ed. Mary K. Sahs (Austin: State Bar of Texas, Environmental and Natural Resources Law Section, 2009) 65.
[30] Jarvis, "Historical Development of Texas Surface Water Law," 68.

Old English Common Law, but the validity of past contracts and grants were determined in relation to the civil law of the time.[31] The Republic did not pass significant water-specific legislation, instead used the existing riparian rights. Around fifteen percent of land in Texas is still subject to rights related to grants originally issued under Spanish and Republic of Mexico grants, so these lands are subject to historical water rights.[32]

One of the first pieces of water legislation was the Irrigation Act of 1852. This Act was a response to a growing agricultural economy. This law gave county governments the authority to regulate the construction and maintenance of irrigation works, replacing the previous regulatory power held by the community *alcade* system during Spanish and Mexican rule. The legislation stated that the statute was consistent with the "principles of the Mexican laws."[33] The passage of this statute reflects the beginning of a blended legal system and a disconnection between the goals of the courts and the state legislature. The courts relied on a common law water rights riparian system, while the legislature passed statues regulating the use of water.

In 1852, Texas governed water using the riparian doctrine. Riparian water rights are largely unregulated, unquantified, and are tied to land ownership. After the adoption of common law in Texas, there was the implication that ownership determined the right to use water from a stream or a lake. In 1856, the Texas Supreme Court held in *Haas v. Choussard* that the "right to the use of water adjacent to one's lots, as it flowed in its natural channel was a right inherent and inseparably connected with the land itself."[34] This recognition was important for irrigation development in semiarid areas, but was later contested by *Flemind v. Davis*. This case was initiated when a downstream riparian user sued an upstream user for unreasonable use. The

[31] Ibid.
[32] Porter, *Spanish Water, Anglo Water*, 127.
[33] Ibid.
[34] Ibid.

court ruled, using common-law riparian rules, that the upstream user only had the right to use the water in a manner equal to the others holding the right.[35]

The legislature was faster pass laws easing the process of resource allocation for private corporations. Many of the successful laws authorized water diversions for irrigation or recommended the construction of dams or water development projects. An example is the Private Corporation Act of 1871, which organized canal companies for the purposes of irrigation, issued public land, and authorized the free use of surface water.[36] These statutes reflect the power of the legislature to authorize surface water rights in Texas streams, as recognized by the related court decisions. These statutes were a base for conflict between private rights and corporate rights, as highlighted by *Mud Creek Irrigation, Agricultural and Manufacturing Co v. Vivian* (1889). In this case, landowners sued a private irrigation company after the company attempted to enforce their charter and statutory rights. The court held that statutes applied only to streams on public lands, claiming that related legislation lacked the authority to take away or impair the vested rights of riparian owners without providing the constitutional right to just compensation.[37]

Legislation and court rulings opened the door to a range of disagreements; in response to political and economic pressures, the legislature addressed these problems through the adoption of the prior appropriation doctrine and the Irrigation Act of 1889. The purpose of this act was to "encourage irrigation, and to provide for the acquisition of the right to the use of water, and for the construction and maintenance of canals, ditches, flumes, reservoirs, and wells for irrigation,

[35] Jarvis, "Historical Development of Texas Surface Water Law," 70.
[36] Ibid.
[37] Jarvis, "Historical Development of Texas Surface Water Law," 71.

and for mining, milling, and stock-raising in the arid districts of Texas."[38] The act was not a comprehensive solution to the problems associated with the previous diverging law.

The Irrigation Act of 1895 modified some of the problems created by previous legislation. This Act protected the riparian right to ordinary underflow of stream water, but it did not define the terms. The Act limited some of the power of irrigation companies to combat the effects of previous statutes. These laws introduced the "first in time, first in right" style of prior appropriation doctrine.[39] Their passage attempted to provide a secure and recognized legal right to surface water. These more comprehensive surface water rights were attached to land grants made between 1840 and the Appropriation Acts of 1889-95, an era when vast tracts of land were transferred from the government to private ownership.

Since 1895, land acquired from the state carried water rights based on prior appropriation and the position of preexisting riparian rights was uniformly acknowledged. Between 1895 and 1913, landowners could appropriate water from a stream merely by filing a sworn statement and map with the county clerk that described the diversion. This system was loosely administered and based on an honor system. The lack of structure led to overlapping water rights, descriptions of unrealistically large irrigated acreages, and claims that required more water than the stream could supply. These rights are considered "certified filings" in the records kept after 1913.[40]

As mentioned, the most powerful force in groundwater allocation is the rule of capture. This allows anyone who owns land above a subterranean water reservoir to pump available water without limits for any purpose. The lack of oversight for groundwater stands in stark contrast to the surface water's rigid regulation; this contrast is even more dramatic because the legislation

[38] Ibid.
[39] Jarvis, "Historical Development of Texas Surface Water Law," 74.
[40] Otis W. Templer, "Water Law," *Handbook of Texas Online,* Texas State Historical Association, http://www.tshaonline.org/handbook/online/articles/gyw01 (accessed 16 January 2012).

fails to recognize the connectivity between the two resources. Further complicating this issue, Texas's nine major and twenty-one minor aquifers have different geological formations, making it difficult to administer uniform regulations.

Texas History and Water: The Secret and Occult Legal Legacy of W.A. East

In 1904, W.A. East brought suit against Houston & Texas Central Railroad Company for the alleged destruction of his well. The resulting ruling defined the development of twentieth century groundwater policy. In the original appeal, East claimed the well on his land had supplied his family with adequate water until the Houston & Texas Central Railroad Company dug a deeper well on the adjacent property that had the capacity to pump significantly larger quantities of water. When East filed suit, he claimed that the presence of the Houston & Texas Central Railroad Company's well has caused his well to dry up. The Supreme Court ruled in favor of the Houston & Texas Central Railroad Company, arguing:

> "the person who owns the surface may dig therein and apply all that is there found to his own purposes, at this free will and pleasure; and that if, in the exercise of such right, he intercepts or drains off the water collected from the underground springs in his neighbor's well, this inconvenience to his neighbor falls within the description of damnum absque injuria, which cannot become the ground of action."[41]

This section of the ruling affirmed the rule of capture and the right of a landowner to all accessible water below their land. The ruling is influential both because it affirms the rule of capture, as well as the related discussion regarding the challenges of classifying groundwater:

> "because the existence, origin, movement and course of such waters [groundwater] and the causes which govern and direct their movements, are so secret, occult, and concealed that an attempt to administer any set of legal rules in respect to them would be involved

[41] Jody Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," University of North Texas: August 2005, http://www.cep.unt.edu/theses/purvis.pdf (accessed 20 January 2012) 6.

in hopeless uncertainty, and would, therefore, be practically impossible.[42]

This case set precedent and established the rule of capture as an undeniable right that defined groundwater allocation. *East* gave the courts them a ruling to reference so they could opt out of ruling on groundwater related issues.

When *East* was decided, experts did not understand the relationship between aquifers and surface water resources. The power of the *East* opinion has been a powerful impediment in adopting new laws better regulating groundwater use. After a century of scientific discovery, groundwater can no longer be deemed a "secret and occult" resource, yet the *East* legal precedence is still strong. The legacy includes: interpreting and enforcing individual water rights when the claimants file for both appropriative and riparian rights, determining which party holds the right when a number of claimants file suit regarding a section of surface water, and the lack of technical definitions and relevant hydrologic evidence. Both the courts and the legislature has set a powerful precedent due to their tendency to disregard the hydrologic cycle and to divide water into several legal classifications while ignoring resource interconnectivity.

In 1955, the Supreme Court upheld the precedent set by *East* and supported the policy of judicial nonintervention in groundwater cases. In related court cases, Texas courts have consistently elected not to use their power to modify related water legislation. In *City of Corpus Christi v. City of Pleasanton*, the court ruled that percolating waters are the property of the owner, who has the right to use these waters as they choose.[43] This mandate was echoed during both *Denis v. Kickapoo Land Company* (1989) and *Sipriano v. Great Spring Waters of America* (1999). The frequency of cases contesting tenets developed in *East* reflects the growing animosity of individual landowners against powerful corporations. To avoid discussing the rule

[42] Sansom, *Water in Texas*, 6.
[43] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 13.

of capture, the Supreme Court often elects to instead focus on the Conservation Amendment of 1917, which gave the power of resource regulation to the state legislature. In *Sipriano*, the Supreme Court discussed the idea of waiting to see if related legislation would be effective before evaluating the rule of capture and evaluating common law would be an appropriate measure to preserve natural resources and protect property owners.[44]

Texas History and Water: Legislation in the Twentieth Century

1913 is an important year in Texas water policy because of the passage of the Irrigation Act. This Act established the Texas Board of Water Engineers, which was tasked with creating the procedures for determining surface water rights.[45] This critical legislation designated all non-appropriated waters as state property and abolished riparian rights held by lands acquired from the state after 1895. The Act repealed earlier laws and adopted a uniform system of statutory water laws.[46] At this time, the Board held the authority to grant permits for the statutory appropriation of state-held water. While the Act was comprehensive, it did not provide clear processes for regulating and monitoring appropriated rights.

In response to drought conditions, the Irrigation Act of 1917 modified the problems associated with the 1913 Act. The intent of the legislation was to increase state control over the development of water resources. To insure this, a Conservation Amendment was passed to designate legislative authority.[47] This Amendment provided the base for both water conservation and reclamation districts. The language provided more solid support for voluntary public conservation and legislative power:

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[44] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 14.
[45] Earl and Estaville, *Texas Water Atlas*, 113.
[46] Jarvis, "Historical Development of Texas Surface Water Law," 77.
[47] Jarvis, "Historical Development of Texas Surface Water Law," 78.

> "The conservation and development of all the natural resources of this State… and the preservation and conservation of all such natural resources of the State are each and hereby declared public rights and duties; and the Legislature shall pass all such laws as may be appropriate thereto." (Section 59, Article 16)[48]

This language designates water resources regulation as a public law and duty and empowers the legislature to pass appropriate water law. It legitimized lawful rights acquired prior to its enactment while granting authority to the legislature to pass laws designed to promote public rights. This raised the question of how to define these rights and how use issues relate to the intent of conservation. The related law does not answer these questions, but the Conservation Amendment places the power of regulation directly in the hands of the state legislature. Since the citizens placed the power of groundwater regulation in the hands of the legislature, it gives the courts little cause for overturning the rule of capture, meaning that a century of groundwater law has been defined by decisions made at the turn of the century.

The 1967 Water Rights Adjudication Act merged the riparian and prior appropriation water rights. The act countered the confusion created by the dual system of water rights and attempted to address the challenging relationship between state ownership of surface water and protection of private property rights. Part of this process was empowering an agent of the state to organize the system. The Act required all riparian and unrecorded water users to file claims with the Texas Water Commission, now known as the Texas Commission on Environmental Quality. The filed claims were based on actual use during 1963 through 1967. The Commission evaluated these claims, as well as claims filed prior to the Act. Approval of these claims required court decisions, known as "Certificates of Adjudication." The deadline to file these

[48] Texas Constitution, Art. XVI, §59.

rights closed in 1969. The Adjudication Act defined and quantified surface water rights using adjudication provisions patterned after an existing system used in Wyoming.[49]

These laws and court rulings are the base for the modern-day dual-doctrine approach to surface water. Over time, riparian law has faded in favor of using prior-appropriation doctrine, although remnants, such as a provision that allows a 200-acre-foot exemption for domestic and livestock use for riverside landowners, still exist.[50] Surface water in Texas is either naturally occurring or is created through the construction of reservoirs; presently most of the resources are permitted for use. Historically, Texas has provided very little protection for environmental flows, which are "the amounts of water necessary to sustain aquatic life in the rivers and bays and the estuaries into which they empty."[51] The legislature did not officially recognize the protection of aquatic environments as a beneficial use of water until 1985, when fairly modest provisions were included in water rights permits as a means to protect environmental flows.[52]

As a part of the state's continuing statutory revision program, the Texas Water Code is considered a living document.[53] At present, Texas Water Code totals over a thousand pages. Despite the length, the initiative has made water statutes more accessible and understandable by employing a more orderly format and eliminating ineffective provisions. One common theme is the promotion of voluntary action. The idea of voluntary stewardship places power in the hands of the individual. Texas Water Code explicitly states:

> "The legislature finds that voluntary land stewardship enhances the efficiency and effectives of [the] state's watersheds … It is therefore the policy of this state to encourage voluntary land stewardship as a significant water management tool."[54]

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[49] Jarvis, "Historical Development of Texas Surface Water Law," 84.
[50] Sansom, *Water in Texas*, 175.
[51] Sansom, *Water in Texas*, 5.
[52] Ibid.
[53] Texas Water Code § 1.001.
[54] Texas Water Code § 1.004.

This supports the hypothesis that ideology can successfully influence institutional design. Research regarding Texas water management has suggested that water conservation behaviors are mainly influenced by social expectations. Proponents of voluntary action claim that the process is more effective than centralized management; in parts of Texas, local voluntary conservation agencies have emerged in reaction to distrust of state-mandated regulation.[55] This need to remain independent demonstrates the conflict between coercion and voluntary action as well as the challenges related to central as opposed to local efforts.

Water Management Structures: An Introduction

Water resource management is best understood as the convergence of agencies, laws, and politics to create policy; due to a complex system that blends bottom-up resource management with state regulations, regulating these factors is difficult. Water resources in Texas are a commons susceptible to depletion if the various governmental mechanisms for resource management do not coordinate conservation and regulation efforts with respect to long-term conditions. Water management is plagued by a fragmentation of power, making it difficult to work towards unified objectives. Ideally, it is more efficient to consider each agency as part of a whole – with each area only holding jurisdiction over the area they are supposed to manage; however, in reality, these jurisdictions often overlap. The state of Texas expects its population to double from twenty million to forty million by 2050; based on that sort of projected growth, it is crucial to critically evaluate Texas water regulation.[56]

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[55] Mark Somma, "Institutions, Ideology, and the Tragedy of the Commons in West Texas Groundwater Policy," *Publius: The Journal of Federalism*, 27:1, Winter 1997, http://publius.oxfordjournals.org/content/27/1/1.full.pdf (accessed 7 February 2012) 3.

[56] Larry McKinney, "Water For the Future," *Texas Parks and Wildlife Magazine*, July 2002, http://www.tpwmagazine.com/archive/2002/jul/ed_1/ (accessed 3 February 2012).

Numerous local, state, and federal government agencies share responsibilities related to resource management. Often their powers and abilities have been strengthened in response to environmental crises. Federal agencies do not play a large role in regulating groundwater resource management, especially in Central Texas. They are most pertinent in relation to insuring compliance with federal law and regulating federal lands. The key state agencies that influence water use are the Texas Commission on Environmental Quality, the Texas Water Development Board, the Texas Parks and Wildlife Department. Local controls include River Authorities, Groundwater Management Areas, Priority Groundwater Management Areas, and Groundwater Conservation Districts; these have influence on the use and regulation of water. Texas approaches modern water planning using a bottom-up approach, utilizing local and regional efforts to generate plans for the state.

Water Management Structures: State Agencies

The Texas Commission on Environmental Quality oversees the granting of water rights, the issuance of wastewater permits, as well as matters related to water quality and the drinking water system.[57] The TCEQ has existed in many forms and has had many different names, but it has always been a powerful force in policy. Once known as the Texas Natural Resource Conservation Commission, the present incarnation is the result of the 1991 merger between the Texas Air Control Board and the Texas Water Commission.[58] In 2000, the legislature officially named the agency the Texas Commission on Environmental Quality.[59] The agency's main duties revolve around the preservation of water quality as mandated by both federal law and the

[57] Sansom, *Water in Texas*, 152.
[58] Earl and Estaville, *Texas Water Atlas*, 120.
[59] Earl and Estaville, *Texas Water Atlas*, 122.

Environmental Protection Agency.[60] The governor appoints the three commissioners that manage the TCEQ for six-year terms; their confirmation is subject to the consent of the Texas Senate. They are term limited, with staggered terms expiring every two years. The current three commissioners have backgrounds in environmental science or environmental politics; but more significantly, all three men have political ties to Governor Rick Perry or the Texas Republican Party. The TCEQ is in charge of issuing water rights; when they do this, they assign a priority date that specifies the volume water associated with the right. These rights do not guarantee that water will be available; the rights are considered property interests. This water rights systems works with the more localized process initiated by the Regional Water Planning Groups.[61]

One program administrated by the TCEQ is the State Watermaster Program, a response to the reliance on the honor system in river rights compliance present in many river basins. This program attempts to combat the negative results of this practice and is currently present in three areas of the state: the Concho River Watermaster Program, the Rio Grande Watermaster Program, and the South Texas Watermaster Program. The program is designed to ensure compliance with water rights by monitoring stream flows, reservoir levels, and water use. The program coordinates diversions from river basins in specific areas and regulates reservoirs to prevent waste levels that exceed the existing water right permits.[62] The Watermaster must be informed of the intent to divert water and the amount of water to be diverted; assuming the water-right holder is in compliance, the appropriation is authorized and recorded. The TCEQ supports the program with a fee, currently starting at $50 per account, collected from all permit

[60] Sansom, *Water in Texas*, 152.
[61] "Water for Texas 2012 State Water Plan," Texas Water Development Board, January 2012, http://www.twdb.state.tx.us/publications/state_water_plan/2012/00.pdf (accessed 3 February 2012).
[62] Ibid.

holders based on water use and allocation.[63] The Watermaster program is one response to the pitfalls of regulating water with an honor system, but the limited geographic reach indicates that public resistance to regulation has prevented this program from having statewide influence.

The Texas Water Development Board is the principal state agency for water planning and provides financial assistance for water development projects.[64] The TWDB publishes the primary state water plan every five years and provides loans to all levels of government for water improvement projects.[65] Similar to the TCEQ, the six commissioners in charge of the TWDB were appointed by Governor Perry and have political ties to his administration. Most have experience at varying levels of state water agencies, but they all have connections to Texas business and industry. These appointments suggest a potential conflict between conservation-minded policy and economic interest. The TWDB's final water plan should be assessed using scientific modeling and analysis of water availability. While the TWDB employs many hydrologists and geologists to conduct these analyses, the scientists do not hold the decision-making power.

The Texas Parks and Wildlife Department is responsible for protection of fish and wildlife resource and the administration of parklands and wildlife areas. The nine-member board is made up of individuals appointed by the Governor. In accordance with state and federal law, the TPWD may comment on water rights, discharge, and wetland alteration.[66] The TPWD plays a large role when the habitat of an endangered or protected species is in danger. This duty is especially pertinent to aquifers, like the Edwards, that support large ecosystems.

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[63] "Watermasters – Texas Commission on Environmental Quality," Texas Commission on Environmental Quality, http://www.tceq.texas.gov/field/wmaster/wmaster.html (accessed 24 January 2012).
[64] Texas Water Development Board, http://www.twdb.state.tx.us/ (accessed 25 January 2012).
[65] Sansom, *Water in Texas*, 154.
[66] Ibid.

Water Management Structures: Local Agencies

The majority of water management is local; examples include city-owned water supplies and wastewater plants. Other structures have influence that spans over multiple counties, including River Authorities. These are quasi-governmental agencies responsible for the management and development of water resources in their respective basins.[67] Their governing bodies are composed of individuals appointed by the Governor f Texas. The only exception is the San Antonio River Authority; the city of San Antonio elects members every two years.[68] River authorities do not have the right to tax, but they generate revenue from water and power sales, wastewater plant projects, and through marketing water from managed reservoirs. Many River Authorities are involved in water quality issues, conservation programs, promotion of water recreation, park management, and educational programs.[69] River Authorities provide an excellent model for the process of water transfers, but they frustrate both governmental and environmental interests due to a perceived lack of accountability resulting from their semiautonomous structure.

Groundwater Management Areas were designed to cover all major and minor aquifers in the state as designated by the TWDB after the passage of Senate Bill 2 in 2001. In accordance with Chapter 35 of Texas Water Code, GMAs were created "in order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions."[70] An integral part

[67] Ibid.
[68] Ibid.
[69] Sansom, *Water in Texas*, 156.
[70] Texas Water Code § 35.001.

of the GMA requirements is the expectation that Groundwater Conservation Districts and GMAs will participate in joint planning. In 2005, the Texas legislature stipulated:

> "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."[71]

This created expectations of a joint planning processes, but it did not provide a to facilitate the collaboration between the GMAs and GCDs.

Related to GMAs, the TCEQ has the authority to determine what constitutes a Priority Groundwater Management Areas. These are areas identified as either experiencing or expected to experience critical groundwater problems during the next twenty-five years. These problems include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies.[72] The ultimate purpose of this designation is to ensure controlled management in areas facing supply challenges. Part of the PGMA evaluation considers the need for new groundwater conservation districts and considers the best options for this process. PGMAs are authorized to adopt policies, plans, and rules to address groundwater-related issues.[73]

Groundwater Conservation Districts are the most critical institution involved in managing water resources. In 1948, the Texas legislature addressed potential groundwater allocation challenges with the creation of GCDs. The legislature designated GCDs as a unit of government that is ratified locally to manage and protect groundwater.[74] GCDs are formed by three methods:

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[71] "Groundwater Management Area Facts: One Page History of GMAs," Texas Water Development Board, http://www.twdb.state.tx.us/gwrd/gma/pdf/TCEQ%20GMA%20summary.pdf (accessed 12 February 2012).
[72] "Priority Groundwater Management Areas," Texas Commission on Environmental Quality, http://www.tceq.texas.gov/permitting/water_supply/groundwater/pgma.html (accessed 12 May 2012).
[73] Ibid.
[74] "Groundwater Conservation Districts," Texas Water, Texas A&M University, http://texaswater.tamu.edu/groundwater/groundwater-conservation-districts (accessed 24 January 2012).

the state legislature, petition of property owners, or the TCEQ. With the exception of districts created by the TCEQ, the district's voting population exercises the right to confirm or reject the formation of a new district through election.[75] This right gives citizens a sense of agency regarding local regulatory structures potentially impacting water use.

In 1997, the legislature recognized GCDs in the Texas Water Code as the "preferred method of determining, controlling, and managing groundwater resources."[76] GCDs are funded through property taxes, well production fees, and administrative fees for well permits and export permits; according to statute most districts are permitted to levy a tax if approved by the voters.[77] Chapter 36 of Texas Water Codes states that the ownership of groundwater is a recognized right that cannot be deprived, but that right may be limited or altered by the rules of the GCD. In Chapter 36, GCDs are discussed in relation to the importance and responsibility involved in developing and enforcing management plans.[78] Chapter 36 presents some problems; by making groundwater regulation the discretion of the GCD, the section casually affirms the rule of capture. Chapter 36 does not force the GCDs to limit pumping, so a GCD could elect to forgo regulation. The code is clear that it does not have the power to deprive owners of their rights and that rights will be assigned based on the regulations in each individual district.[79]

GCDs are generally designed with respect to county lines, not aquifer boundaries. This is problematic because the regulatory control is not designed to compliment the resource. For example, a GCD with authority over a large aquifer does not necessarily have control over the entire resource; they are expected to formulate their plans based on the lines of the GCD. GCDs

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[75] Brock and Sanger, "Spotlight on Groundwater Conservation Districts in Texas," 6.
[76] "Chapter 36: Groundwater Conservation Districts."
[77] Brock and Sanger, "Spotlight on Groundwater Conservation Districts in Texas," 8.
[78] "Chapter 36: Groundwater Conservation Districts," Texas Water Code, http://www.statutes.legis.state.tx.us/docs/wa/htm/wa.36.htm (accessed 24 January 2012).
[79] Christopher Brown, "A New Chapter for Texas: The Rule of Capture, Groundwater Conservation Districts, and *Sipriano v. Great Spring Waters of America*," in *Groundwater in Brief*, March 1999, 8.

are generally designed to work within the powers and limitations of municipal governments, although some groundwater districts have jurisdiction that spans over several counties.

Recent Legislation Governing Water

Over the past fifteen years, four laws have successfully passed through the Texas legislature: Senate Bills 1, 2, and 3 and House Bill 1763. Each piece of legislation attempts to enhance and protect water use. These laws clarify some of the murky issues surrounding groundwater management, but they raise many related questions and concerns. Previously, the Texas Water Development Board was responsible for executing the State Water Plan and employed a top-down management system.[80] Between 1961 and 1997, the state prepared six State Water Plans that focused on building large-scale structures, like reservoirs, to store water to before shifting their focus towards effectively managing existing water resources.[81] The original State Water Plans were adopted when only a third of Texans lived in urban areas and seventy-nine percent of the communities obtained their water strictly from groundwater wells.[82]

State Senate Bill 1 changed this procedure for state water planning and initiated Regional Water Planning Groups. Then-Governor George W. Bush signed SB1 into law in June 1997.[83] This comprehensive water legislation was enacted during the 75th meeting of the Texas Legislature. It was a response to the increased awareness of the vulnerability of Texas to drought and recognized the limits of existing water supplies in relation to the increasing demand relative to growing populations. SB1 puts bottom-up water management processes into practice;

[80] Nohl P. Bryant, Cynthia Smiley, and Louis Rosenberg, "State Water Planning," in *Essentials of Texas Water Resources*, ed. Mary K. Sahs (Austin: State Bar of Texas, Environmental and Natural Resources Law Section, 2009) 442.
[81] Ibid.
[82] "Water for Texas 2012 State Water Plan," Texas Water Development Board.
[83] "Regional Water Planning," Texas Water Development Board, http://www.twdb.state.tx.us/wrpi/rwp/rwp.asp (accessed 31 January 2012).

the legislation modified the language of Texas Water Code, particularly in Chapter 36. These changes made it easier to attempt to meet projected water needs for the state. SB1 initiated the creation of sixteen Regional Water Planning Groups. This placed the power in an increasingly localized area, while still allowing the TWDB to maintain a sense of control. Each region is tasked with designing a region specific plan for the next fifty years. These sixteen plans were incorporated in the TWDB's 2012 State Water Plan. Each RWPG has a board consisting of at least eleven members, selected to represent a variety of interests including public, counties, municipalities, industries, agricultural, environmental, small businesses, electric generating utilities, river authorities, water districts, and water utilities.[84] In an attempt to remain transparent and to serve public interests, RWPGs hold open meetings as a means to allow citizens to voice concerns and obtain information. Originally, the TWDB mandated that each RWPG's comprehensive water plan be completed by 5 January 2002. The expectation was to update these plans every five years. Starting in 2002, the TWDB provided financial assistance to projects that met identified needs in a manner consistent with the approved regional water plans. The plans initiated by the RWPGs are powerful. For example, the Texas Commission on Environmental Quality may not issue municipal water right permits unless the permit is consistent with the RWPG's approved plan.[85]

Senate Bill 1 is the backbone of the bottom-up management and planning process. It includes local interests and stakeholders through RWPGs and replaces the original central planning system. SB1 is an important piece of legislation; it is part of the continuing evolution of water management. When the RWPGs were established, many of the river basins and

[84] The State Water Plan," Texas Water Matters, http://www.texaswatermatters.org/water_planning.htm (accessed 31 January 2012).
[85] Regional Water Planning," Texas Water Development Board, http://www.twdb.state.tx.us/wrpi/rwp/rwp.asp (accessed 31 January 2012).

watersheds were divided, hindering system-wide planning. The RWPGs created a new sense of unity. Yet, that unity does not result in harmony; RWPGs are susceptible to problems, including the presence of conflicting interests. Environmental issues are a priority to some RWPGs, while others ignore this during their planning period. These conflicts can render the individual goals of the RWPG ineffective, or at worst, when combined, destructive.

Superficially speaking, Texas seems to have an abundance of natural water, but many of these resources are reservoirs supported by groundwater. There is a failure to understand that fifty-seven percent of "surface" water is drawn from reservoirs filled with groundwater, not reservoirs filled with rainwater and diverted surface water.[86] Another problem stems from the timeline; the environmental impact of water supply projects was largely ignored until SB1 passed in 1997.[87] SB1 is a classic example of too little too late, mainly because the majority of water rights were apportioned before the passing of this legislation. The pitfalls of SB1 indicate that groundwater should be recognized as a larger part of the equation.

Senate Bill 2 was designed to remedy some of the flaws found in Senate Bill 1. Enacted in 2001, SB2 facilitated the creation of Groundwater Management Areas. Groundwater Management Areas were an attempted check on the powerful rule of capture; the legislation was designed to encompass all of the major and minor aquifers in the state. SB2 deals with evaluating and publicizing the findings of groundwater availability models and other data. SB2 stipulated that Groundwater Management Districts and the Groundwater Conservation Districts cooperate and share management plans, but the bill does not specify how to facilitate this coordination. The associated language merely notes that one district may compel another district to share management plans.

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[86] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 11.

[87] Larry McKinney, "Water For the Future."

Senate Bill 2 was initially promoted as a financial follow-up to SB1. It was supposed to provide the tools to effectively implement the current requirements for Regional Water Planning Groups. While the final version did not provide the promised financial package, it did include measures related to water resource management and protection. These included the creation of the Joint Committee on Water Resources, a committee that presently meets during the State Legislative interim. While it fell short of its financial promises, SB2 established the funding framework for supporting future water projects and authorized the formation of a state-level Water Advisory Council.[88] SB2 ratified eleven existing Groundwater Conservation Districts and created three new ones; it attempted to clarify the management role of GCDs over groundwater resources. SB2 used language that made it clear that groundwater ownership may be limited or altered by the rules of the district.[89]

Passed by the Texas Legislature in 2005, House Bill 1763 provided recommendations for regional collaboration regarding aquifers that were struggling to coordinate plans between GMAs sharing one groundwater source.[90] This bill instituted several changes to planning and management of groundwater districts. It requires groundwater management plans to base their desired future groundwater conditions using a joint planning process involving other districts. It mandates that districts issue permits up to the point that the total volume of groundwater permitted equals managed available groundwater. The language defined managed available

[88] "Texas Water Policy Update," Texas Center for Policy Studies, August 2001, http://www.texascenter.org/publications/txwaterpolicyaug.pdf (accessed 3 February 2012).
[89] Ibid.
[90] Mary E. Kelly and Laura Brock Marbury, "Down to the Last Drop," Environmental Defense Fund, March 2009, http://www.texaswatermatters.org/pdfs/lastdrop.pdf (accessed 31 January 2012).

groundwater as the amount available for beneficial use permits in accordance with desired future groundwater conditions.[91]

These laws ease the process of synthesizing the final publication of the TWDB's State Water Plan and attempt to modernize the planning process using integrated management. The 2012 State Water Plan recognizes that water, more than any other natural resource, challenges the state; meaning that scarcity and competitions for water, environmental concerns, and the associated costs of new water supplies have made sound water planning and management increasingly important. The 2012 State Water Plan presents the same challenges and problems found in prior plans. As in the 2002 State Water Plan, a primary recommendation is to construct more dams, divert more rivers, and construct new reservoirs. Instead of facing the potential crisis, the plan hinges on false idea that water can be made.[92]

The Hydrologic Cycle and Climate

In reference to the worldwide water budget, David Keith Todd wrote, "The total volume of water in nature is fixed and invariable."[93] Meaning, that while the quantity of water is unchanging, the form and location of water is constantly shifting. Due to Texas's size and geographic location, the climate ranges from arid to humid in a west-to-east direction. To accommodate the geographic terrain and produce accurate data, the US National Weather Service has divided Texas into ten climatic divisions.[94] The amount of available water is measured in two manners: evaporation and transpiration, collectively termed

[91] "Groundwater Management Issues in Texas," House Research Organization Focus Report, Texas House of Representatives, 6 June 2006, http://www.hro.house.state.tx.us/focus/groundwater79-14.pdf (accessed 3 February 2012).
[92] "Water for Texas 2012 State Water Plan," Texas Water Development Board.
[93] Earl and Estaville, *Texas Water Atlas*, 18.
[94] Earl and Estaville, *Texas Water Atlas*, 1.

"evapotranspiration." The actual and predicted measures are influenced by the hydrologic cycle. A basic understanding of the hydrologic cycle highlights some of the associated challenges of defining water resources. There is no beginning or end in the cycle since water circulates as a solid, a liquid, a gas, or a vapor. Water absorbed into the ground uses the earth as a conduit to travel back to the surface and rejoin the cycle. Typically, water percolates downward into the earth towards the groundwater table, where it is able to flow in a more lateral direction through the porous spaces in the geologic formation.[95]

The hydrologic cycle considers the phases of water; in contrast, policy divides use and allocation based on form. While hydrologists recognize the unity of the hydrologic cycle, bureaucrats do not use this knowledge to guide policy. The failure of policy to acknowledge the full cycle is based on the tendency to simplify and compartmentalize problems related to resource management.[96] Most water resource conflict stems from mobility issues, because interference of natural movement can result in depriving access to the resource.

The legal connection of water in the varying phases of the hydrologic cycle is considered conjunctive resource management. Conjunctive management is when water in two or more phases is managed as an integrated resource.[97] Conjunctive management is a desirable objective, because it is thought that larger amounts of water can be made available through this process. The Edward's Aquifer is a good case study in the application of conjunctive management. The water from the Aquifer is confined by artesian pressure; its natural discharge feeds some of the largest springs in Texas, which in turn provides considerable base flow to the San Antonio and

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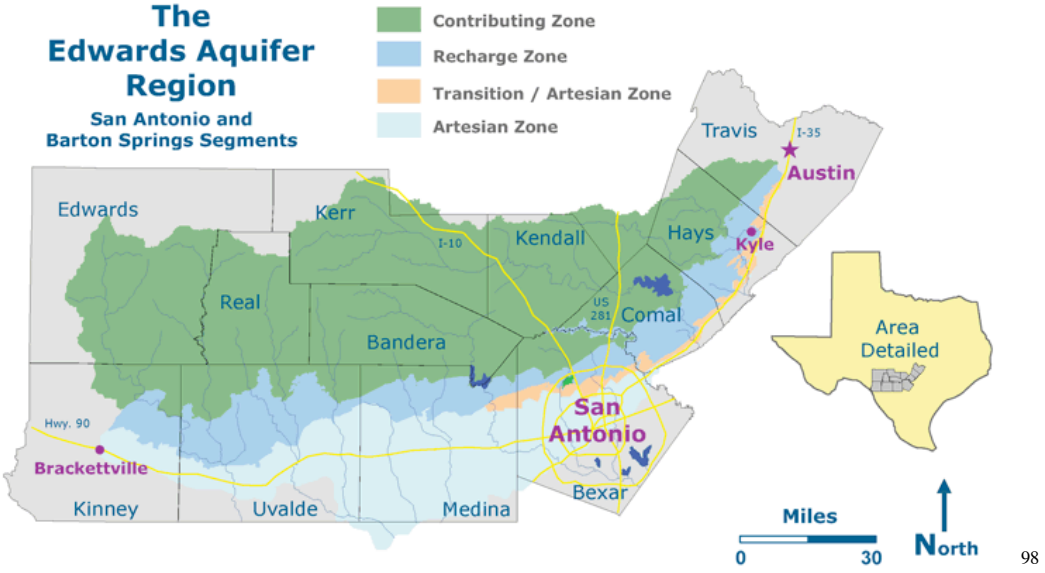
[95] Gabriel Eckstein and Amy Hardberger, "Scientific, Legal, and Ethical Foundations for Texas Water Law," in *Essentials of Texas Water Resources*, ed. Mary K. Sahs (Austin: State Bar of Texas, Environmental and Natural Resources Law Section) 10.

[96] Otis W. Templer, "Hydrology and Texas Water Law: …A Logician's Nightmare," 1992, Great Plains Research: A Journal of Natural and Social Science, http://digitalcommons.unl.edu/greatplainsresearch/50 (accessed 25 January 2012) 38.

[97] Templer, *Hydrology and Texas Water Law*, 39.

Guadalupe Rivers. The Edwards Aquifer is connected to many phases of the hydrologic cycle because river water levels are often dependent on precipitation levels, while the aquifer storage levels are dependent on flows within the formation.



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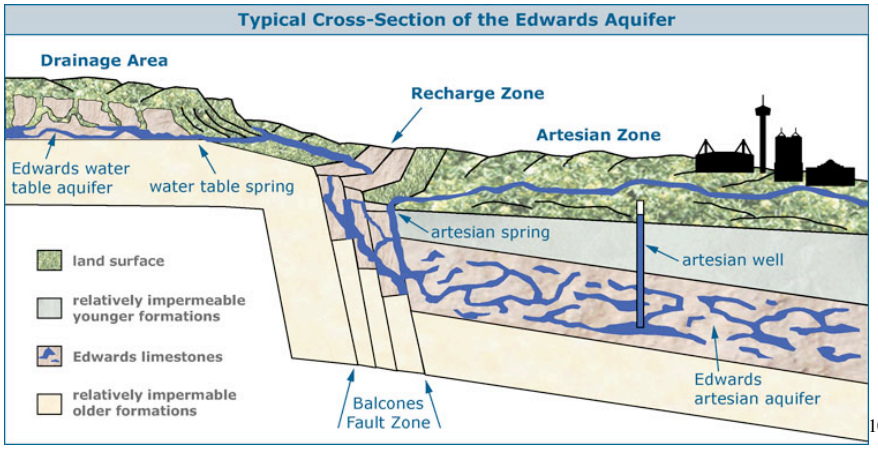
The Edwards Aquifer

Texas aquifers have remarkably diverse geologic structures and varying storage and recharge capacities. Central Texas is home to the Edwards Aquifer, one of the most prolific artesian aquifers in the world.[99] This aquifer is one of the greatest natural resources in Texas and provides water for almost two million people in south-central Texas.[100] The Edwards Aquifer underlies twelve counties in Central Texas. Due to its prolific nature, communities drawing water from the resource have been able to expand without developing alternative water resources. However, as the population grows, so does the demand for water, leading to ecological and economical concerns. Drought conditions have resulted in a dip in the Aquifer

[98] "Introduction to the Edwards Aquifer," The Edwards Aquifer Website, http://www.edwardsaquifer.net/intro.html (accessed 25 January 2012).
[99] Eckstein and Hardberger, "Scientific, Legal, and Ethical Foundations for Texas Water Law," 20.
[100] Earl and Estaville, *Texas Water Atlas*, 27.

water levels. This has raised tough questions regarding ownership, control, and use of this valuable groundwater resource.



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The Edwards Aquifer is comprised of underground layers of porous limestone. It is known as either an artesian or confined aquifer, meaning that the aquifer is contained between two impermeable layers – the base (floor) and the ceiling.[102] To reach water, wells must be drilled into the impermeable levels, which will cause water to rise until the hydraulic pressure equals atmosphere pressure.[103] Aquifers like the Edwards are generally recharged through lateral flow of water from recharge zones located at distant higher elevations, where the aquifer outcrops at the surface.[104] The stream pattern of the groundwater is controlled primarily by barrier faults that impact the continuity and permeability of the Edwards Aquifer, a displacement that contributes to highly complex flow patterns. This cycle is temperamental and varies in response to unpredictable climate cycles, meaning that a drought could cause a severe water shortage.

The Edwards Aquifer is comprised of four zones: contributing, recharge, artesian, and transition. Located in the Texas Hill Country, the Edwards Plateau sits in the contributing zone. This is an area of around 5,400 square miles with elevations ranging between 1,000 and 2,300

[101] "Introduction to the Edwards Aquifer."
[102] Eckstein and Hardberger, "Scientific, Legal, and Ethical Foundations for Texas Water Law," 20.
[103] Ibid.
[104] Ibid.

feet above sea level.[105] The contributing zone is the drainage area, meaning that runoff water flows through the porous limestone into the recharge zone. This is the location of the Balcones Escarpment; this fault zone formation is the demarcation line for certain ecological systems and species distribution. Its presence contributes to the development of unique habitats that support various aquatic species with habitats in Central Texas.[106] The contributing zone is not truly part of the Aquifer, but activities occurring in this area can cause source pollution that damages the surface water quality recharging the Aquifer.

The recharge zone is where fractured limestone outcrops at the land surface, permitting water to flow into the aquifer. Around seventy-five percent of the recharge occurs in this area when streams and rivers cross the permeable formation and become underground water.[107] This is a regulatory concern because if pollution occurred at the surface it could contaminate surface water flows responsible for recharging the Aquifer, or enter through sinkholes, caves, faults and fractures, pass through the unsaturated zone, and directly enter the Aquifer. Depending on the geologic formation, small volumes of groundwater can be withdrawn from wells in this zone.[108]

The artesian zone is confined between two relatively impermeable formations: the Glen Rose and the Del Rio. The weight of water entering from the recharge zone puts pressure on the water deeper in the formation. This can cause hydraulic pressure that creates discharge and fosters the formation of artesian wells.[109] Due to high pumping levels in the area, as well as drought, many of the naturally occurring springs in this area are often dry.[110] The Comal Springs and San Marcos Springs, two principle springs of interest for Aquifer management, are on the

[105] "Introduction to the Edwards Aquifer."
[106] Ibid.
[107] Ibid.
[108] Frownfelter, "Edwards Aquifer Authority," 330.
[109] Eckstein and Hardberger, "Scientific, Legal, and Ethical Foundations for Texas Water Law," 20.
[110] "Introduction to the Edwards Aquifer."

eastern side of the Artesian Zone. Consequently, major portions of regulation and management functions are implemented in this area. This area has relatively low permeability, lowering the risk of water quality problems and contamination.

The final zone of the Edwards Aquifer is the transition zone, located in geologic formations cropping out in proximity to the south and southeast of the Recharge Zone. These faulted and fractured units provide limited protection to the Aquifer. Due to the downward groundwater gradient, there is contamination risk related to surface activities entering the Aquifer through these faulted and fractured units.[111] A contributing zone lies within this area and is the source of watershed or runoff.

Water from the Edwards Aquifer is used for municipal, agricultural, and recreational purposes; fifty-four percent goes towards municipal supply.[112] San Antonio is historically one hundred percent dependent on groundwater from the Edwards Aquifer for industrial and municipal use, making it one of the largest cities in the world to be entirely reliant on a single water source.[113] The Edwards Aquifer is part of the larger Edwards-Trinity Aquifer System, which covers over 77,000 square miles from Southern Oklahoma to Western Texas, with the majority of the water going towards agricultural use.[114] The Edwards Aquifer is unique because of the rapid recharge rate, a factor determined by aquifer's ability to absorb surface water and precipitation through permeable layers. Around seventy-five to eighty percent of the recharge

[111] Frownfelter, "Edwards Aquifer Authority," 332.
[112] John B. Ashworth and Janie Hopkins, "Report 345: Aquifers of Texas," Texas Water Development Board, November 1995, http://www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWReports/R345%20Aquifers%20of%20Texas/R345Complete.pdf (accessed 25 January 2012).
[113] Ashworth and Hopkins, "Report 345: Aquifers of Texas."
[114] Earl and Estaville, *Texas Water Atlas*, 29.

occurs due to the crossing of streams and rivers, indicating that surface water becomes groundwater during recharge. The remaining recharge percentage originates from rainfall.[115]

The rapid recharge and high transmissivity of the Edwards Aquifer makes it vulnerable to overexploitation that can lead to surface subsidence as the sediments are redistributed into areas previously occupied by water.[116] The transmissivity is enough that, so long as there is adequate hydraulic pressure, significant amounts of water will flow. While the Aquifer can be artificially recharged, this is a temporary solution that is not financially viable and would only sustain the area through a few years of drought. Springflow is only dependent on the upper five to ten percent of the aquifer. This means that if the springs evaporate, water would still be present, but not necessarily accessible. According to scientists, the Aquifer contains enough water to supply the region for a few more centuries without the presence of increased precipitation, but only a small percentage of this water is economically viable to access.[117] If Texas was unconcerned with springflow maintenance, recreation, tourism, or downstream interests, groundwater supply challenges could be temporarily alleviated. To do this the state would have to be willing and able to draw the Aquifer to a historic low and irreparably damage surface water resources. This sort of proposal also presents economic challenges since the depth of the groundwater would make it prohibitively expensive to pump water.[118]

In the face of crisis, the only viable solution for maintaining long-term groundwater water supply is to strictly regulated withdrawals, so any short-term fix is especially dangerous for water levels. The Edwards Aquifer is a highly permeable, carbonate aquifer, but the actual productivity levels are unknown. The solution channels in the Edwards Limestone vary in size,

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[115] "Introduction to the Edwards Aquifer."
[116] Earl and Estaville, *Texas Water Atlas*, 18-19.
[117] "Hydrogeology of the Edwards Aquifer," The Edwards Aquifer Website, http://www.edwardsaquifer.net/geology.html (accessed 25 January 2012).
[118] Ibid.

making it difficult to quantify the amount of available water. The standard methodologies used in other aquifer formations are not applicable to karst aquifer systems.[119]

If there is rain, the Edwards Aquifer will recharge; however, drought is a constant problem, so the Aquifer faces basic use issues. These issues include: the creation of a cone of depression, well interference, and aquifer overdrafting or mining. The cone of depression results from drawdown, which is an area of decreased water pressure that occur when withdrawn water is not adequately recharged, causing lowered groundwater levels. In the Edwards Aquifer, this condition forces landowners to dig deeper wells to gain water access.[120] Well interference, occurring when the pumping from one well lowers the water level in nearby wells, presents similar challenges. Aquifer overdrafting and mining can result in higher water costs, land subsidence, water quality degradation, and potentially water depletion. Overdrafting can harm environmental flows.[121] Continued overdrafting can result in the practice of mining, which involves pumping water that will not be replaced. Dangerously low aquifer levels caused by mining can contribute to salinization, an occurrence that would destroy freshwater resources.[122] The practice of mining occurs when individual self-interest overweighs the desire to practice conservation. Mining is a temporary solution to a larger problem and a practice that presents a threat to the Edwards Aquifer.

The Edwards Aquifer has been a managed groundwater resource for over fifty years. In 1959, the Edwards Underground Water District was charged with responsibilities related to recharge, water and pollution prevention, comprehensive water planning, and drought

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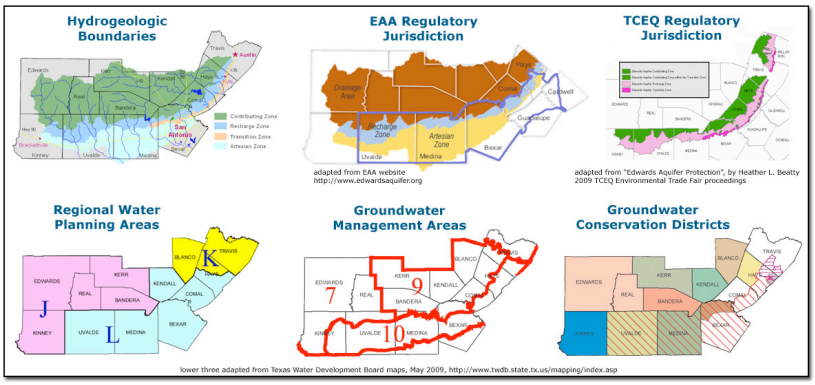
[119] Groundwater Management Plan: 2010-2015," Edwards Aquifer Authority, January 2011, http://www.edwardsaquifer.org/files/Final_GMP.pdf (accessed 7 February 2012) 11.
[120] "Questions about Groundwater Conservation Districts in Texas," Texas A&M University System, 2002, http://twri.tamu.edu/reports/2002/2002-036/2002-036_questions-dist.pdf (accessed 12 February 2012) 7.
[121] Ibid.
[122] "Frequently Asked Questions," The Edwards Aquifer Website, http://www.edwardsaquifer.net/faqs.html (accessed 12 February 2012).

management.[123] Under the EUWD, the rule of capture remained strong, causing concern to downstream users because of the potential damage to environmental flows and access to water. In an attempt to strengthen regulation, downstream users argue that the Edwards Aquifer should not be considered percolating water and should instead be designated as an underground river. This would make the Aquifer property of the state and subject to prior-appropriation doctrine. This claim is present in a number of pending court cases, including one due to be heard in the Texas Supreme Court this spring, but it has not halted authorities from maintaining and regulating the Aquifer conditions.[124]



[125]

The Edwards Aquifer formation underlies twelve different counties and falls under the South Texas Watermaster Program. Unsurprisingly, these twelve counties belong to many different GCDs, GMAs, and River Authorities. GCDs in the Edwards Zone include:

Bandera County River Authority and Groundwater District (Bandera County)
Barton Springs/Edwards Aquifer Conservation District (Travis County and Hays County)
Cow Creek GCD (Kendall County)
Hays/Trinity GCD (Western portion of Hays County)
Headwaters GCD (Kerr County)
Kinney County GCD (Kinney County)
Medina Country GCD (Medina County)
Real-Edwards C and R District (Real County and Edwards County)
Trinity Glen Rose GCD (Northern Bexar County)

[123] Frownfelter, "Edwards Aquifer Authority," 335.
[124] Ibid.
[125] "Introduction to the Edwards Aquifer."

Uvalde County UWCD (Uvalde County)
The Edwards Aquifer Authority (Uvalde County, Medina County, Bexar County and portions of Guadalupe County, Atascosa County, Caldwell County, Comal County, and Hays County).[126]

The Edwards Aquifer falls under five different River Authorities:

Guadalupe-Blanco River Authority
Upper Guadalupe River Authority
The San Antonio River Authority
Nueces River Authority
Lower Colorado River Authority[127]

Additionally, the twelve counties span across three Regional Water Planning Groups: Regions J, K, and L.[128] Even without analyzing each plan, it is fair to assume that there will be disagreements regarding necessary processes and methods for water conservation and allocation.

The overlap between the River Authorities and the Edwards Aquifer indicates a potential jurisdictional conflict when trying to regulate surface water flows and maintain aquifer levels. In this area, many of the dams and reservoirs were built with a focus on recreation and aesthetics, meaning there are man made barriers to preserving proper flow patterns. The Guadalupe River Basin has been named one of the country's most endangered rivers as a result of a lack of commitment to maintain flows and a significant amount of water diversion.[129] The Guadalupe River Basin alone relies on the Edwards Aquifer for over twenty percent of its annual flow and supports around eighty thousand jobs.[130] The depletion of this resource through mismanagement would have severe economic repercussions on the small Hill Country communities that are supported by economic activity and tourism related to the Guadalupe River. Each district has adopted its own practices for publicizing their plans; some have made information easily

[126] "Groundwater Conservation Districts (map)," Texas Water Development Board, http://www.twdb.state.tx.us/mapping/maps/pdf/gcd_only_8x11.pdf (accessed 31 January 2012).
[127] "Texas River Authority Index," Texas Parks and Wildlife Department, http://www.tpwd.state.tx.us/landwater/water/habitats/rivers/authorities.phtml (accessed 31 January 2012).
[128] "General Maps of Regional Water Planning Groups," Texas Water Development Board, http://www.twdb.state.tx.us/wrpi/rwp/map.asp (accessed 31 January 2012).
[129] "A Troubled Basin," The Aransas Project, http://thearansasproject.org/situation/basin-management/ (accessed 12 February 2012).
[130] Brown, "A New Chapter for Texas," 12.

accessible, while others are stuck in a technological rut. Instead of trying to analyze all of the related plans of multiple regulatory bodies, it is easiest to focus on the Edwards Aquifer Authority as a model for understanding the practices related to managing this vital groundwater resource.

The Edwards Aquifer Authority

While the Edwards Aquifer falls under many different jurisdictions, the Edwards Aquifer Authority is the most powerful regulatory structure. The story of the EAA is centered on power and crisis. In 1991, a catfish farm opened in the Edwards Aquifer region. Due to the rule of capture, this farm had a legal right to pump water that would equal one-fourth the amount of water then-used by San Antonio. In response, the state legislature used their power to pass the Edwards Aquifer Authority Act. This created the Edwards Aquifer Authority, a successful management structure that should be a model for managing aquifer regionalization efforts.

Initiated in 1993, The Edwards Aquifer Authority Act is a piece of landmark legislation that went into effect in 1996. Through the creation of the EAA, the legislature recognized the resource as "the primary source of water for the residents of the region, and [as] vital to the general economy and welfare of the state."[131] The Act created the Authority as a special conservation and reclamation district designed to manage and regulate the San Antonio segment of the Edwards Aquifer, specifically the portion in the Balcones Fault Zone. The EAA is responsible for an area that spans 8,800 square miles in south-central Texas.[132] The Act grants the EAA the power of eminent domain, authorizes the issuance of bonds, provides civil and

[131] Frownfelter, "Edwards Aquifer Authority," 328.
[132] "Mission: Manage, Enhance, and Protect," Edwards Aquifer Authority, http://edwardsaquifer.org/display_authority_m.php?pg=mission (accessed 7 February 2012).

administrative penalties, and validated the creation of the Uvalde County Underground Water Conservation District.[133]

As specified by the enabling legislation, the EAA began operations as both a conservation and reclamation district. The Authority is governed by a seventeen-member board of directors: fifteen of these individuals are elected from single-member districts, one is appointed by the South Central Texas Water Advisory Committee, and the other is named, on an alternating basis, by the county commissioner's court of either Medina County or Uvalde County.[134] The meetings, like all GCD meetings, are governed under the Texas Open Meetings Act. The board uses a committee system to make recommendations related to six areas: management and planning, agenda development, finance and administration, permits and compliance, research and technology, and legislative issues.[135] The EAA prides themselves on their creative, science-based aquifer management program, effective rule making and enforcement, and an efficient administrative structure.[136]

The Edwards Aquifer Authority Vision statement acknowledges the varying interests in the Edwards Aquifer, claiming that "the agency fosters region wide understanding and cooperation among stakeholders, decision-makers, and citizens for the benefit and sustainability of biological and other natural resources, as well as the people who depend on the [Edwards Aquifer]."[137] Specific powers vested by the state government make the EAA different from other groundwater districts. The EAA has responsibilities that extend beyond the basic requirements of other GCDs. These include precise instructions to conduct fact-finding proceedings to

[133] Ibid.
[134] Frownfelter, "Edwards Aquifer Authority," 337.
[135] Frownfelter, "Edwards Aquifer Authority," 338.
[136] "Mission: Manage, Enhance, and Protect," Edwards Aquifer Authority.
[137] "Groundwater Management Plan: 2010-2015," Edwards Aquifer Authority, January 2011, http://www.edwardsaquifer.org/files/Final_GMP.pdf (accessed 7 February 2012) 5.

determine qualifications for related groundwater rights, prevent contamination, and take measures related to protection of environmental habitats related to the preservation of threatened aquatic and wildlife species, in addition to the basic rights in Chapter 36 of Water Code.[138]

The EAA Act requires the Authority to implement a Critical Period Management Plan consistent with management objectives; a critical period is when a condition causes declining aquifer levels, resulting in reduced spring flows at the Comal Springs and San Marcos Springs. The CPMP becomes a final plan based on recommendations from the EAA committee. The final plan identifies each recommended action and is filed as a report to the governor and the legislature. The present plan, the 2010-2015 Water Plan, considers the interests of the three sub-regions in their recommendations. These sub-regions are the Western Sub-Region (Medina and Uvalde), San Antonio Sub-Region (Bexar), and the Eastern Sub-Region (portions of Comal, Hays, Guadalupe, and Caldwell). The different sub-regions allow the EAA to classify water allocation. In this case, water is primarily linked to municipal supply because of San Antonio, but tourism is an important factor for both this region and the Eastern Sub-Region. The Western Sub-Region is the only area dependent on agricultural activity, meaning that irrigation issues are especially relevant to this area. The EAA process acknowledges and respects the varying interests that hold jurisdiction in overlapping territory. The presence of the EAA does not simply invalidate the roles of other water planning entities, but the EAA always has the upper hand.

Due to the complex hydrogeology and geomorphology of the Aquifer, the EAA's ability to tailor regulation and management of the various zones to each area's unique characteristics is invaluable. In addition to sub-regions, the Act divided the Aquifer into two pools: the San Antonio Pool and Uvalde Pool. The Authority holds the right to designate new pools to further

[138] "Groundwater Management Plan: 2010-2015," 6.

to refine water management processes. The San Antonio Pool is the largest and defines all portions except those under Uvalde County. In this area, spring flows are related to Aquifer water levels. To manage this section, the Authority uses three key reference points in its management of withdrawals from the pool:

1. Aquifer levels measured at index well J-17
2. Spring discharge at Comal Springs
3. Spring discharge at San Marcos Springs.[139]

The Uvalde Pool is smaller and includes recharge from the Nueces and Frio Rivers; it contributes approximately fifty percent of the water within the Aquifer.[140] Withdrawals in this area are managed based on conditions determined by measurements drawn from index well J-27.[141]

The EAA has widespread influence over designated groundwater resources and has a jurisdiction extending five miles beyond its boundaries to regulate water quality. Wells present significant challenges to water levels; the EAA is one of the only GCDs with specified controls over Aquifer withdrawals and the capability to manage the point of groundwater withdrawals. This control is maintained through a sophisticated permit process that could be used as a model for improving the management of similar resources. Most importantly, the EAA retains power over the use of groundwater after it has been withdrawn from the Aquifer; this is used for various purposes, including regulation to prevent waste and defining efficient use.[142]

Despite their expansive powers, the EAA does not have jurisdiction over naturally occurring discharges of groundwater from the Aquifer through springs. The hydrological connection of spring flow to the Aquifer is the surface expression of groundwater; unless this flow is altered by the installation of man-made facilities, the discharge through the spring is

[139] Frownfelter, "Edwards Aquifer Authority," 329.
[140] Ibid.
[141] Ibid.
[142] "Edwards Aquifer Authority Act." § 1.23.

considered a withdrawal. Due to these stipulations, a spring and its discharge do not qualify as a withdrawal point subject to EAA management.[143] While the EAA is considered a shining example of conjunctive management, stipulations like this one indicate some of the challenges associated with navigating interconnected resources through conjunctive management. The EAA Groundwater Plan acknowledges these challenges; a section of the plan discusses the role of the other groundwater resources utilized by the eight counties that fall within the planning area. This includes water drawn from the Carrizo-Wilcox Aquifer, Trinity Aquifer, and Edwards-Trinity (Plateau) Aquifer. The plan states: "The Authority does not regulate these other aquifers. It is difficult to determine the amount of groundwater use from other non-Edwards Aquifer sources within the planning-area's boundaries because relevant statistics are based on reported county pumpage."[144]

The EAA does not suffer from the inter-jurisdictional conflicts prevalent in other areas of groundwater quantity management because the EAA Act and the legislature clearly designated regulatory authority. While the Texas Parks & Wildlife Department holds an interest in the management of threatened and endangered species associated with the area, they do not have jurisdiction over water withdrawal. The Texas Water Development Board has groundwater planning functions, but it does not have direct regulatory authority over the Aquifer. The Texas Commission on Environmental Quality administrates laws, but this power does not extend to managing withdrawals. There is a low chance of conflict at the county level. Traditionally, counties do not attempt to assert control over the Aquifer and municipal corporations only have the ability to prevent withdrawals as a condition of water service.[145] There is an issue of overlapping GCD jurisdiction and the presence of the Trinity Aquifer under sections of the

[143] Frownfelter, "Edwards Aquifer Authority," 340.
[144] "Groundwater Management Plan: 2010-2015," 28.
[145] Frownfelter, "Edwards Aquifer Authority," 342.

Edwards formation. The most common related conflict occurs when a person wants to drill through the Edwards Aquifer to access an underlying formation, like the Trinity Aquifer. To solve this problem, the person seeking a well permit is required to apply for construction permits from both the EAA and the other GCD.

There are seven GCDs in the same area as the Edwards Aquifer Authority:

Uvalde Country UWCD	Medina County GCD
Evergreen UWCD	Guadalupe County GCD
Plum Creek Conservation District	Trinity Glen Rose GCD
Barton Springs/Edwards Aquifer Conservation District.[146]	

To prevent direct conflict with these, the EAA Act maintains that the GCDs may enact provisions that manage and regulate the Aquifer, but only if the Aquifer delegates authority to the GCD. Additionally, the GCD management may not conflict with, or be duplicative of, the EAA Act, the Authority's rules, or orders of the board. This stipulation established the EAA as the most powerful source of regulation; there no way for another GCD to control the Aquifer without first seeking a permission from the Authority. In this way, the EAA staves off any potential problem related to an inability to fulfill stipulations in Senate Bill 2. SB2 specifically states that GCDs must cooperate and share management plans and statistics, but it lacks specifics and rules regarding this provision.[147] Interestingly, SB2 makes no note of the EAA's power even though the legislation was drafted well after the EAA established dominant regulatory control.

While the EAA avoids groundwater quantity management conflict, it is not immune to conflict related to groundwater quality. Each level of government – federal, state, and local – has its own array of regulatory programs intended to prevent Aquifer contamination. The law of preemption generally provides that a local regulation may be appropriate by an express statement

[146] "Groundwater Conservation Districts (map)," Texas Water Development Board, http://www.twdb.state.tx.us/mapping/maps/pdf/gcd_only_8x11.pdf (accessed 31 January 2012).
[147] Brock and Sanger, "Spotlight on Groundwater Conservation Districts in Texas," 7.

of intent, or by implication in the event of a conflict between local and state or federal law.[148] Generally speaking, state and federal law tends to avoid preempting local regulation of water quality issues. Certain laws, like Chapter 26 of Texas Water Code, are crafted as to not usurp the power of Authority to protect the water quality of the Aquifer. Chapter 26 gives the TCEQ sole authority of the TCEQ to designate water quality standards consistent with the Clean Water Act.[149] Another codified example is found in 30 Texas Administrative Code Chapter 213. This section lays out the requirements designed to protect aquifers from pollution caused by regulatory activities that can generate nonpoint source pollution and affect the quality of the surface water that could impact Aquifer recharge in the contributing and recharge zones.[150] However, Chapter 213 provides for exceptions and makes it clear that entities like the EAA have the ability to adopt water quality rules in the interest of protecting the aquifers. These regulations indicate that the TCEQ and the Authority share concurrent jurisdiction over aquifer water quality. Local governments share some authority over their respective jurisdiction to regulate certain activities. City governments hold police powers; in relation to water, a city can enact reasonable regulations to promote the health, safety, and welfare of its citizens. Additionally, local regulations may cover similar subject matter; in fact, they should be in harmony with the regulations set forth by the EAA.[151]

The EAA was initiated in response to several different threats, including the risk of damaged water quality, the hazards of a catfish farm drawing down available groundwater resources, and the danger of federal regulation. The EAA addresses some of the problems associated with the rule of capture, but pending court cases regarding the Edwards Aquifer and

[148] Frownfelter, "Edwards Aquifer Authority," 343.
[149] Texas Water Code § 26.023.
[150] Frownfelter, "Edwards Aquifer Authority," 342.
[151] Frownfelter, "Edwards Aquifer Authority," 344.

the Authority have the potential to invalidate these measures. Before the EAA, the federal district court for the Western District of Texas attempted to federalize the Aquifer by arguing for the need to protect threatened and endangered species dependent on Comal Springs and San Marcos Springs as a response to Texas's lack of action. The state was able to respond to this threat, as well as the use issues presented by the catfish farm, using the authority of the Conservation Amendment of the Texas Constitution. One response was the creation of a statutory-based permit system that does not resemble the common-law rule of capture was a huge step in groundwater management. This changed groundwater rights application for the Aquifer from a system based on ownership of land to one based on beneficial use during a described historical period that is usufructuary in nature.[152] This comprehensive management system was like no other previously enacted. The presence of such creative water management indicates a positive future for Texas groundwater, but due to the unique nature of aquifers in the state, it is not obvious whether this regulatory structure would be successful if applied to other aquifers.

Theory and Water Policy: Tragedy of the Commons

Water policy is best understood through history, but Garrett Hardin's "Tragedy of the Commons" explains some of the related ideological challenges. Hardin's theory is applicable because water is a finite resource that is necessary to support life and development. Due to the concern regarding groundwater levels, any issue regarding a fluid commons is relatable to Hardin. At the root of this idea is the concept of unrestrained self-interest in using a commons. The underlying reasoning is driven by the reality that commons are susceptible to exhaustion, so using the maximum amount of the resource will yield the greatest benefits before depletion. The

[152] Frownfelter, "Edwards Aquifer Authority," 385.

benefit/cost ratio is astronomical: the benefits are accrued by a single user, but the cost of those benefits is spread among all those sharing the commons. Managing the quality and depletion rates of a fluid commons is a true environmental policy challenge; the resource itself is fungible and presents mobility challenges.

The problems facing the commons range from concerns regarding access and amounts to associated challenges of preserving wildlife habitats. It is easy to find individuals who will agree that conservation practices are necessary for the preservation of the fluid commons, but actions do not reflect this statement. More importantly, the policy battle is not focused on this concern. Groundwater is an example of a typical commons: no one truly owns the resource, but it seems available to anyone with a modicum of access. However, access can lead to resource depletion, land subsidence issues, and salt-water intrusion. Surface water presents similar challenges because it is a heavily appropriated commons. The issue is straightforward: surface water quality can be degraded through consumption. Individual actions can damage surface water quality; the resulting conditions can have a serious impact on all those dependent on the resource. Surface water demonstrates how Hardin's theory is applicable beyond the more prominent concerns of resource quantity and groundwater issues.

Texas water is a classic example of tragedy of the commons. In response to threats on groundwater commons, governments have responded with policies that force local actors to organize regional agencies, arguing that these tactics are more effective.[153] In Texas, tragedy of the commons related to available groundwater supplies is a clear consequence of the rule of capture. Landowners have the power to use nonrenewable groundwater without significant regulation. A conservation effort by a single landowner only provides more water for those who

[153] Mark Somma, "Local Autonomy and Groundwater District Formation in High-Plains West Texas," *Publius: The Journal of Federalism*, Vol. 24, No. 2, Spring 1994, Oxford University Press, http://www.jstor.org/stable/3330721 (accessed 8 February 2012) 54.

do not practice conservation. In the case of Central Texas, one farmer could exploit these conservation efforts and yield a significant economic advantage. This is especially pertinent in the Western Sub-Region of the EAA because the counties of Medina and Uvalde are dependent on agricultural activity and require significant amounts of water to support irrigation. The presence of GCDs in Texas Water Code demonstrates that governments often react to a commons threat by enacting policies that encourage or force local actors to organize regional agencies. This argument is support by the claim that a regional organization will better meet the technical and financial requirements of commons regulation.[154] The issue with this solution is that the formation of GCDs is a voluntary action and each GCD is a self-governing institution.

Another commons challenge facing the Edwards Aquifer is the lack of monitoring and metering wells in unincorporated areas of the state. Currently, well permits are considered by weighing the public benefit against individual interest. Related the issue of permitted wells, is the problem of unregulated wells. These allow individual landowner in unincorporated areas to operate without supervision or restrictions. Based on Hardin's theory, these individuals are unlikely to hold their personal interest in higher regard than conservation interests recommended by state agencies. The TWDB estimates that there are over 1,000,000 water wells in Texas, but that only 130,000 have been inventoried.[155] Improving these records would take political will and significant financial resources; at present, those who hold regulatory power do not have the interest or the ability to address these issues. Hundreds of thousand of Texans live in unincorporated areas and rely on groundwater from individual wells. Between 12,000 and

[154] Ibid.
[155] "Well Information/Groundwater Data," Texas Water Development Board, http://www.twdb.state.tx.us/gwrd/waterwell/well_info.asp (accessed 12 February 2012).

28,000 new supply wells are drilled into Texas aquifers every year.[156] Kerr County is one example of a place where there are large areas of land that have not been formally incorporated, meaning there are likely numerous unregulated wells drawing from both the Edwards and the Trinity Aquifer systems. A problem faced by GCDs presiding over unincorporated areas is a lack of municipal resources for providing water meters to measure flows, making it difficult to regulate the commons.

Ideological challenges are present at both the individual and governmental level. The use of science when determining water allocation does not alleviate these problems because resource managers often hold preconceived notions of how to determine correct policy. Individuals who require water access to sustain their livelihood, as in agriculture, are unlikely to voluntarily adopt an alternative institutional arrangement for the sake of experimentation or a yearning to practice progressive politics. People are conditioned to believe water should be allocated for certain uses and that it is a commodity; this makes it difficult to achieve conservation related compromises.

Ideology has direct impact on the successes and failures of institutions controlling commons resources. Successful water conservation would have the power to require farmers and ranchers to change their behavior. Mark Somma argues that peer-inspired social expectations are a powerful impetus for change.[157] Local conservation agencies and voluntary conservation agencies are a reaction to the distrust of state or federally mandated regulations. They are an attempt to regulate peer inspired expectation. Local regulations are not the ideal solution to commons issues because they are adopted using a variety of perspectives. Local regulations are most successful when they are integrated with the expectations of the area; unfortunately, expectations are only likely to change in the presence of crisis, and even then self-interest can be

[156] Mary Sanger, "Water Metering in Texas," Texas Water Matters, http://www.texaswatermatters.org/pdfs/articles/water_metering_in_texas.pdf (accessed 12 February 2012).
[157] Somma, "Institutions, Ideology, and the Tragedy of the Commons in West Texas Groundwater Policy," 3.

a powerful force. Texas is an example of alternative environmental policy administration because of the nature of local government authority over water. Somma's study of West Texas describes an area that does not give significant control to the groundwater agencies and has a system distinct from both the command-and-control bureaucracy and the market economy.[158]

Water Policy: Present Institutional Challenges

At this point, it is clear that Texas does not have enough water to support projected population growth. As of September 2011, ninety-nine percent of the state was experienced severe, extreme, or exceptional drought conditions; the majority of counties had outdoor burn bans; and over nine hundred water supply systems were imposing voluntary or mandatory restrictions. Additionally, the TCEQ suspended the use of certain water rights in several river basins. The current drought ranks as one of the worst in the history of Texas.[159] The 2012 State Water Plan projected that existing water supplies would decrease about ten percent, from seventeen million acre-feet in 2010 to fifteen million acre-feet in 2060. If drought continues, the state could suffer economic damages similar to the crisis of the 1950s. One economic model, using drought statistics, estimates that Texas businesses could lose almost $12 billion in income, a figure which would increase to around $116 billion by 2060.[160] Faced with these staggering statistics, it is obvious that working towards more secure water management is a necessary step towards the maintenance and conservation of the remaining available resources.

Agencies like the Edwards Aquifer Authority are one part of an effective solution. The present number of management levels reflects Texas's tendency to rely on a decentralized mode of operations. This is explained by the thought that voluntary formation of groundwater districts

[158] Ibid.
[159] "Water for Texas 2012 State Water Plan," Texas Water Development Board.
[160] Ibid.

is a feasible solution that fits within present ideological demands. Using this theory, Groundwater Conservation Districts and Regional Water Planning Groups present a viable solution because they are ratified and run by community members. The composition of GCDs allows for integration into the community without the fear that they will be viewed as a regulatory threat or an abuse of power. This ideological element is an important part of institutional design because success is partially measured by how target populations adopt desired behaviors. GCDs and RWPGs represent a form of polycentric governance, which can be explained through markets or centralized government; this includes an understanding of interactions between local districts, the state, and the market.[161]

The power of the rule of capture presents the greatest threat to groundwater resources. Since 1904, the precedent from *East* has remained strong. No state politician would dare to oppose the rule, lest they be seen as an opponent of private property rights. However, as the rule has impacted more landowners, legislative measures have passed to weaken the rule. This includes the 1949 law that provided basis for the establishment of local conservation districts and legislative groundwater districts.[162] This modification later supported the development of structures like Groundwater Conservation Districts. While these districts hold power, their authority is diluted by the influx of other agencies. While groundwater is clearly a commons issue, there has been little to prevent some of the more damaging allocation issues; this concern includes the lack of regulation protecting landowners from the harm caused by other pumps. The presence of coercion could redefine how this resource is understood. While the courts have allowed for some clarifications regarding the intricacies rule of capture, their rulings lack significant reach. The no-injury exception includes prohibition on malicious pumping with the

[161] Somma, "Institutions, Ideology, and the Tragedy of the Commons in West Texas Groundwater Policy," 5.
[162] Joe Nick Patoski, "Playing by the Rule," *Texas Observer*, 24 June 2010, http://www.texasobserver.org/cover-story/playing-by-the-rule (accessed 12 February 2012).

intention of harming a neighbor, drilling a slant wells across adjoining property, and pumping water for wasteful purposes.[163] With the exception of slant drills, it is difficult to prove water right interference. Districts generally provide stipulations as to where wells can be drilled relative to property lines, but this does not prevent contamination. Landowners must prove that water was pumped with malicious intent – a difficult task unless the well caused contamination to an adjoining water source or damaged surface land subsidence. A landowner with groundwater access has potential to generate a significant profit from the resource without the fear of legal retribution.

The no-injury exception as it relates to the rule of capture is problematic and contradictory. As mentioned, the no-injury rule provides protections to landowners from being harmed by neighboring landowners pumping too much water. This exception recognizes the potential impairment of a landowner and attempts to prevent harm. Yet, the process for proving harm is extremely difficult. This rule modifies the rule of capture, but its intent to prevent harm conflicts with the statute. The adverse effect upon neighboring landowners was the same justification used to overturn the rule of capture as it related to oil and gas.[164]

Resource managers sometimes take actions that can potentially cause significant damage to groundwater supply. Groundwater Management Areas are responsible for projecting desired future conditions of the resource. To determine this, some GMA managers have exploited the process using "reverse engineering." This is where the projected future demand, generally developed by the associated Regional Water Planning Group, is extrapolated based on the level of pumping required to sustain the demand. This level is used to derive the potential impact to

[163] "Laws and Regulations Applicable to the Edwards Aquifer," The Edwards Aquifer Website, http://www.edwardsaquifer.net/rule.html (accessed 12 February 2012).
[164] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 46.

the aquifer and this potential impact is adopted as the desired future condition.[165] Essentially, these GMA managers use their power to create unrealistic projections using manipulated data that could lead to long-term depletion of essential water supplies. They do this in the interest of meeting their district's immediate need, as opposed to considering the future demand. The discussion of these conditions should be removed from the pressure of meeting district demands; GMA legislation does not stipulate that desired future conditions be relative to projected demand. GMAs should be separated from political pressure and desired future demands should be determined using a predetermined process. This would help Regional Water Planning Groups determine how to best meet projected water needs, while still considering the proportion of available resources relative to conservation and efficiency measures.

Conservation?

Pressure to adopt sustainable groundwater practices could curb part of the problem, but under the current system, this pressure has to come from the districts. Currently, Headwaters GCD, located in the Edwards Aquifer territory, is making efforts to keep up with increasing demands on the Aquifer, through storage and recovery projects, research on aquifer recharge, and recharge enhancement procedures such as brush control and water catchment basins.[166] Yet, Headwaters is not recommending obvious solutions, like establishing a cap on groundwater pumping – probably because this alternative does not fit the needs of those in power. San Antonio has taken steps to reduce water use, including rebates for more water-efficient utilities, promoting sustainable building techniques, and restricting water-use during drought conditions. The driving force behind the city's Conservation Ordinance is that small change will yield big

[165] Kelly, Mary E. and Laura Brock Marbury, "Down to the Last Drop," Environmental Defense Fund, March 2009, http://www.texaswatermatters.org/pdfs/lastdrop.pdf (accessed 12 February 2012).
[166] Brock and Sanger, "Spotlight on Groundwater Conservation Districts in Texas," 12.

results. And these efforts have proved successful: as of 2002, San Antonio had made per person (per capita) reductions of water use of thirty percent over the previous seventeen years. The city went from using 213 gallons per person per day (gpcd) to 149 gpcd.[167] Based on the reduction in water use, it seem like adopting similar conservation ordinances is a viable solution to maintain groundwater levels, but this only delays the inevitable. The success of these conservation efforts merely maintains water levels; they do not meet pace with projected growth. Bexar County and San Antonio are projected to expand, meaning that the demand for water pumped for municipal purposes will continue to rise.

While not promoted by political science, education is often mentioned as a potential solution to the commons problem that plagues water resources. Presently, GCDs are not required to include public education in their plans, so there is varying emphasis on educational activity. The Texas Agricultural Extensive Service is responsible for statewide public education activities relating to groundwater districts. In 1999, TAES appropriated $600,000 for educational programs in Priority Groundwater Management Areas.[168] The program has grown to include GCDs, but the monetary appropriations have not expanded. Education, even state-mandated, will only temporarily alleviate the situation. Increased funding of TAES would allow GCDs to bring in experts that are unaffiliated with the local politics to provide workshops and lectures for landowners. The lack of community affiliation could prove both a blessing and a burden. Since these experts are not necessarily affiliated with local politics, they can present unbiased data. Conversely, as outsiders, they are unlikely to gain the community's trust. This recommendation returns to the issue of self-interest and commons resources. Communities are

[167] Norman D. Johns, "Saving Water, Rivers, and Money: An Analysis of the Potential for Municipal Water Conservation in Texas," National Wildlife Federation, September 2002, http://www.texaswatermatters.org/pdfs/conservation_report.pdf (12 February 2012).
[168] Brock and Sanger, "Spotlight on Groundwater Conservation Districts in Texas," 11.

likely to claim to understand the related conservation issues, but continue to practice habits motivated by self-interest. Education is a band-aid solution that would only temporarily increase awareness.

The Texas Water Code recognizes some aspects of resource interconnectivity. GCDs are required to consider if the "proposed use of water unreasonably affects existing groundwater and surface water resources" when evaluating groundwater permit applications.[169] The TCEQ needs to analyze the effects of granting surface water permits on groundwater and recharge zones. The TWDB and the TCEQ should develop standard protocols that guide the incorporation of surface and groundwater resource data into water availability model (WAM) and groundwater availability model (GAM) analysis. These agencies need to prioritize funding to generate data that better reflects the role and importance of interconnectivity.[170] This data could be key in initiating policy based on conjunctive management.

Management goals determined using Groundwater Availability Models allow groundwater districts to regulate the permitted withdrawal levels from the aquifer. The process is not perfect, mainly due to the confusion regarding the definition of availability; this issue is often a point of contention between groundwater districts and Regional Water Planning Groups. GCDs should create management plans that define "availability" in a manner consistent with the figure determined by the Regional Water Planning Group. If the numbers are not consistent then the disputes should be referred to the TWDB.[171] Acceptance of the recommendation hinges on the issue of local control; many GCDs believe that RWPGs are not local enough and that consulting them undermines this principle.

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[169] "Chapter 36: Groundwater Conservation Districts."
[170] Kelly and Marbury, "Down to the Last Drop," 7.
[171] Mary E. Kelly and Laura Marbury, "Spotlight on Groundwater Conservation Districts in Texas," Environmental Defense Fund, 2005, http://www.texaswatermatters.org/pdfs/articles/conservation_districts.pdf (accessed 12 February 2012) 4.

A New Perspective: Environmental Justice and the Rule of Capture

The environmental justice movement is associated with conservation. Related policies should address distributive justice since the movement is "about the fair distribution of good and bad environments to humans."[172] The scope of environmental justice should include the distribution of natural resources; applying this concept, the rule of capture does not provide equitable distribution. The biggest issue when relating water to environmental justice is determining whether the resource is a human right or a human need. According to the World Bank and the United Nations, water is a human need. This interpretation is critical; a human need can be supplied in many different ways, a human right cannot be sold.[173] The ramification of this distinction is that water is a commodity, a view that seems to resonate with the Texan conception of water. Following this argument, an associated problem with the rule of capture is that it creates a condition where access to water resources is dictated by wealth. According to Maude Barlow and Tony Clark:

> "the antidote to the commodification of water is its decommodification. Water must be declared and understood for all time to be common property. In a world where everything is being privatized, citizens must establish clear parameters around these areas that are sacred to life or necessary for social and economic justice. Equal access to water is absolutely central to both life and justice."[174]

This argument hinges on the view of water. At present, water is no longer valued as a means for survival. This has led to an anthropocentric view of water; traditionally, an anthropocentric view of the environment has led to its degradation.[175]

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[172] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 26.
[173] Maude Barlow and Tony Clarke, *Blue Gold: The Fight to Stop the Corporate Theft of the World's Water* (New York: The New York Press, 2002) xiv.
[174] Barlow and Clarke, *Blue Gold*, 208.
[175] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 34.

Considering the rule of capture through the lens of the National Environmental Policy Act is one option for evaluating the law, as it relates to the purpose a federally recognized environmental justice initiative. The NEPA's purpose is:

> "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation; and to establish a Council on Environmental Quality."[176]

While the NEPA has no authority over past or present actions against the environment, it does have jurisdiction over future or planned activities that could potentially cause environmental degradation. The relevant question is whether an existing statute, like the rule of capture, can be challenged using the goals of the NEPA. There is significant water use data that links Texas groundwater depletion directly to the rule of capture. Since the NEPA is concerned with future impact, the logical argument is that continued action will have negative environmental impacts.[177] Through interpretation it seems that the rule of capture is something that the NEPA could challenge because the rule dictates future usage. Looking at the aims of the NEPA, the language of the rule of capture violates the purposes of the Act, so the environmental justice argument against the rule is a valid argument.

Water Transfers and Economic Solutions

Disregarding the issue of environmental justice and the concept of water as a human right, another associated problem is the inherent difficulty in applying market approaches to a fugitive resource – related market and regulatory bureaucracies generally come at either great

[176] "The National Environmental Policy Act of 1969," Council on Environmental Quality, http://ceq.hss.doe.gov/nepa/regs/nepa/nepaeqia.htm (accessed 8 April 2012).
[177] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 38.

expense or ineffective organization. The involvement of numerous agencies throughout the process is an unavoidable challenge; estimates claim that Texas has around 1,350 federal, state, and local water agencies.[178] In anticipation of future problems, one proposed solution promotes shifting from public to private regulation to combat fragmented levels of resource management. The private sector can play several roles in water development and management, such as development, transportation, and distribution.

The 2002 State Water Plan lists six major categories of water use: irrigation, municipal, manufacturing, steam-electric power generation, livestock, and mining. Three of these categories – agricultural irrigation, municipal, and manufacturing activities – account for ninety-five percent of all water used in Texas.[179] The 2002 Plan predicted increased water demands in all categories, a projection repeated in the 2012 State Water Plan. Providing adequate access to clean water is crucial to development. Since most surface water is fully appropriated and is barely sufficient to meet water demands during recurring drought periods, Texas needs to seek other means of developing water supplies. Transfers provide a solution that allows municipalities to purchase water from other users as opposed to building more reservoirs, giving the individual owners power to use their water as they please. This sort of water marketing can play an important economic, political, and social role in redistributing water as demand changes. A water transfer is a marketing transaction that involves either the sale of a water right or the sale of water by means of a leaser or water supply contract.

The Edwards Aquifer Authority, as well as other GCDs, already recommends water transfers as a viable option for better regulating water while still providing for the growing population of Central Texas. Texas has a history of transferring and marketing both surface

[178] Ronald A. Kaiser, "Solving the Texas Water Puzzle: Market-Based Allocation of Water," Texas Public Policy Foundation, http://www.texaspolicy.com/pdf/2005-03-water.pdf (accessed 13 February 2012) 30.
[179] Kaiser, *Solving the Texas Water Puzzle: Market-Based Allocation of Water*, 9.

water and groundwater to foster development in areas lacking access to the resource. Water marketing and transfers are a cost-effective way to supply water; transfers promote efficient water use. Marketing is best suited for satisfying new demand because it protects private property rights while encouraging voluntary transfers. As a transfer between a buyer and a seller, water marketing can take various forms including a sale or a lease.[180] Under the rule of capture, the landowner holds the rights to sell, lease, or assign their water right to another. If a right is transferred, any water captured using that right may be sold and transported off the land, or transported outside of the regulatory boundaries.[181] The only legislative restriction on such transfers is the presence of GCD regulations and the potential impact on the underflow of a river.

Transfers occur under current Water Code, but minor changes to the legal framework would ease the process. These changes include amending Water Code to indicate that voluntary transfers of surface and groundwater through marketing are the state's preferred method for reallocating water. The EAA is ahead of both Water Code and other GCDs in recommending ease in water transfers. Their recommendation provides a model for balancing private and public interests. Water transfers are a better solution for the issue of municipal population growth in cities like San Antonio, which is entirely dependent on the Edwards Aquifer. Of course, transfers are still a short-term solution because water is a finite resource – simply moving it from area to area will not solve the related commons problem.

If GCDs adopted and facilitated water transfers, they would be following the example of other Texas agencies. Texas River Authorities already practice this sort of water marketing. While they have other tasks, they are major water brokers; an example is the Sabine River Authority, which holds the surface water rights permits to Lake Tawakoni and sells a portion of

[180] Kaiser, *Solving the Texas Water Puzzle: Market-Based Allocation of Water*, 13.
[181] Kaiser, *Solving the Texas Water Puzzle: Market-Based Allocation of Water*, 23.

this water to the city of Dallas.[182] Based on data taken from current transfer proposals, as much as 2.4 million acre-feet of surface and groundwater will be voluntarily relocated in the coming decade.[183] One of the most important things the legislature can do is remove barriers and foster the development of public-private partnerships in which the private sector makes investments in a project, and allows the state to provide some financial assistance.[184] Groundwater transfers provide GCDs with an opportunity to levy a tax on such transactions. Water transfers improve allocation in two ways: they move water from lower to values in terms of use and they allow individuals to better calculate risk relative to water availability.

The allocation of surface water and groundwater through voluntary transfers and water marketing is not a complete solution. As seen with the formation of conservation districts, voluntary action can be a powerful force in implementing changes in water law. Reforms would encourage transfers by addressing the regulatory challenges created by water law. If enacted they would ease the process of water transfers, protect private property rights, improve the relationship between groundwater management to markets, and encourage private investment.

Water Marketing and Groundwater Regulation: The Radical Approach

Relative to other propositions, transfers are a mild recommendation for improving water markets. A radical approach to water development, management, and allocation is aquifer privatization. Benjamin Vaughan and Peter Emerson, economists with the Environmental Defense Fund, acknowledge the commons problem created by the current aquifer allocation scheme. In response, they suggest privatizing aquifers by adjudicating and quantifying groundwater rights based on average use over a period of time, such as twenty years. Under this

[182] Kaiser, *Solving the Texas Water Puzzle: Market-Based Allocation of Water*, 15.
[183] Ibid.
[184] Kaiser, *Solving the Texas Water Puzzle: Market-Based Allocation of Water*, 4.

proposal, rights would be defined by the Edwards Aquifer's annual safe yield, as opposed to a set amount of water. The annual yield is measurable through the relationship between the aquifer's stock and flows at its springs. Using different indicators, the U.S. Geological Survey can predict the minimum safe yield.[185] Adopting this approach to calculating yield could be a beneficial measure, but due to the fragmented nature of management, successful adoption of an unfamiliar process seems unlikely. In their proposal, Vaughan and Emerson recommend a new system for adjudicating prior-appropriation rights to groundwater. They suggest organizing rights by their priority date.[186,187] Under privatization, Vaughan and Emerson argue that transfers would become more pervasive than water sales. They believe this proposal would meet municipal demands by accommodating large-scale transfers without compromising local agricultural demands. While privatization is a radical solution, there are certainly elements of the plan, especially the recommendations regarding safe yield calculation, which could be beneficial when reforming governmental groundwater regulation.

Resistance is a hurdle in the evolution of groundwater rights; individuals with access are unlikely to voluntarily reduce their water usage and bureaucratic agencies enjoy having distributive power. Privatization proposals demonstrate how the markets could improve allocation; if a single owner held the right to a groundwater basin, it would be in their interest to maximize the present value of the basin. Ideally, maximize does not mean they would simply pump as much water as possible to generate a quick profit, but assumes that the owner would want to take the current and future value of the water. To do this, they would have to take the interconnectivity between sources as a guide to determine how to best regulate the rate of

[185] Terry L. Anderson and Pamela Snyder, *Water Markets: Priming the Invisible Pump* (Washington D.C.: Cato Institute, 1997) 186.
[186] Ibid.
[187] This would be based on the date pumping began; each class of rights would have an annual right with senior rights taking priority over junior rights.

pumping and protect their long-term investment in the aquifer. Privatizing water basins has been successful; the Genevois Basin, underlying the border between France and Switzerland, is controlled by a private entity as designated by treaty.[188] However, while privatizing groundwater might remove some bureaucratic red tape and improve allocation efficiency, the potential gains are not worth the costs of establishing rights. As long as groundwater appears to be abundant, no landowner is likely to voluntarily give up rights. Realistically, the likelihood of an individual gaining control of significant portions of land is low due to the high property values present in Central Texas; real estate in the Texas Hill Country has never felt the brunt of economic downturn, prices continue to rise and land rarely changes hands.

Opponents of the privatization proposition argue that private markets work well when there is competition in the provision of goods and when private transactions affect only the buyer and seller, a situation where the resulting costs and benefits occur over a relatively short time period. According to this argument, water allocation and project investment do not meet these conditions. In such a market, labor, land, and money are organized by industry, but they are not commodities. Land, or in this case water, is part of nature, and cannot be produced by man for sale. To commoditize nature is false, but the market still attempts to absorb the resource.[189] Opponents argue that changes in water use affects users beyond the buyer and seller; the benefits and costs of water projects do not necessarily yield money revenues; these water projects have too long of a payback period to be attractive to private investors. Based on this argument, water allocation cannot be left entirely to the markets and the private sector is not the ideal solution; additionally, privatizing water services would still require organizing a new regulatory

[188] Anderson and Snyder, *Water Markets: Priming the Invisible Pump*, 173.
[189] Karl Polanyi, *The Great Transformation* (Boston: Beacon Press, 1944) 72.

framework that protects and recognizes long-term costs and benefits.[190] Equity would not be easily achieved through private transactions in free markets because water would likely be manipulated to flow towards those with money and power. A social regulatory framework would better motivate private actors attempting to market water to consider both social values and environmental conditions.

Both sides present valid arguments. If one of the biggest problems facing water resource management is fragmentation, then privatizing the water market would reduce conflict and allow a unified body to make decisions regarding water allocation. The viability of this plan is predicated on the assumption that decisions are being made to maximize the potential water supply and the availability of the privatized aquifer. This is based on the hope that the owner has an interest in the value of their long-term investment, not in short-term liquidity. The dilemma of free riders and resource allocation creates a high cost of business when managing a fluid commons. Neither the command-and-control bureaucracy nor the market system addresses the issues posed by water management and regulation.

Looking Beyond Texas: Groundwater Solutions

Examining other doctrines governing water is one way to try to find alternative models of successful water management. The easiest process is to study doctrines used by states with similar climates. There are four doctrines present in the related states. Reasonable use doctrine, used by Arizona, Florida, and Nebraska, states that the landowner is allowed to use as much groundwater as they choose as long as the use is reasonably related to the overlying land.[191] This

[190] Douglas S. Kenney, *In Search of Sustainable Water Management: International Lessons for the American West and Beyond* (Northhampton: Edward Elgar Publishing, Inc, 2005) 33.
[191] Ronald A. Kaiser, "State Experiences with Groundwater Management," Texas Water Resources Institute, http://texaswater.tamu.edu/Resources/state-gw-mgmt.ppt (accessed 10 April 2012).

means that water cannot be sold or transported. The only advantage this doctrine has over the rule of capture is that it forces landowners to consider the needs of surrounding property owners. Otherwise, it raises the question of how to define need and how to fairly administer the doctrine. This doctrine presents challenges for areas without groundwater resources since surface water is already largely appropriated.

The doctrine of prior appropriation is used by Colorado, Idaho, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Montana, Oregon, South Dakota, Utah, Washington, and Wyoming. This "first in kind, first in right" doctrine has been discussed in this study regarding surface water. In relation to groundwater, it supports the belief that it is more beneficial for one user to have what they need, than to deal with equity issues.[192] This doctrine would not alleviate the associated problems with overuse and is not in line with conservation policies. Additionally, it creates a condition where a landowner can lose their rights due to non-use. This is counterintuitive to the goal of ensuring enough water for the future of Texas.

California uses the correlative right and public trust doctrine to manage groundwater. The concept of correlative rights maintains that courts should hold the authority to allocate water. This approach gives the power explicitly to the courts, with the assumption that they will consider both public and private interests. The problem with this approach is that it could give a corporation or a wealthy landowner more influence because they have the means to hire the best attorneys.[193] The public trust doctrine holds that certain resources are above private ownership and reside in the trust of the government. Texas already applies a similar system to surface water rights. Adopting this approach would be an important step towards viewing groundwater as a renewable resource as opposed to a commodity. However, adopting this doctrine in Texas would

[192] Ibid.
[193] Purvis, "A New Approach to Texas Groundwater Management: An Environmental Justice Argument to Challenge the Rule of Capture," 55.

be difficult because of certain attitudes held by many Texans. This measure could be viewed as an attempt to steal resources thought to belong to individual landowners.

When relating water regulation in Texas to other areas of the United States, it is important to consider the political climate and how history has shaped the societal view of land ownership. Texans have a strong sense of property rights; any legislation that takes ownership out of a landowner's hands is not an intelligent political decision. Texans tend to resent government interference, instead preferring local government to hold the most significant sources of power. Overturning the rule of capture seems like an obvious way to alleviate some of the burden. Thanks to the Conservation Amendment of 1917, the rule of capture does not need to be explicitly overturned. This amendment created a correlative rights doctrine that leaves the decision regarding the rule of capture to the courts.[194] Since the courts have refused to rule on the issue, placing more power in the hands of Groundwater Conservation Districts, especially ones modeled after the EAA, is one possible solution. This alternative could bring about positive change without violating state ego. These increased powers could include establishing more GCDs statewide and giving GCDs responsibility over conflict management. If Texas created a coalition of GCDs, this group could put the future of groundwater in the hands of individuals. This form of groundwater regulation would avoid the complaints of environmental justice advocates because it would, theoretically, provide a level playing field. This process could take into consideration both the good of the aquifer and the needs of its inhabitants, which would allow more responsible withdrawal limits. If designed correctly, this initiative would be grounded in environmentally sound management.

[194] Wendy M. Block and Frederick S. Richardson, "A Case of the Blues: The Inequity of Groundwater Regulation in Texas," *Planning Forum* 7, 2001: 49, 29.

Conclusion: Power and Water

At its core, any discussion of water regulation in Texas is based on issues related to power and coercion. Water rights flow towards those who hold the power. The biggest question in Texas water is whether the current system will ensure water for the economic and environmental future of Texas. At this point, the answer seems to be no. It is easy to blame this reality on the existence and power of the rule of capture. The court has been clear in waiting to postpone their decision regarding the rule of capture, but their opinions and decisions fail to indicate when decision day will come. Over the past century, Texas has taken steps towards integrated water management. Theoretically, this shift allows for the consideration of water allocation and management in relation to both economic goals and sustainable development. Agencies, laws, and politics are three basic tenets that control resource management. The current system remains fragmented, hindering comprehensive decision-making. Policy is a result of power and coercion, which can slow the implementation of responsible management.

This study contains theoretical solutions, but with these recommendations comes many more unanswered questions. Only time will tell if the fragmented institutional design of Texas water management will be destroyed or saved by ideological concerns and if the localized approach will slow water depletion rate to sustainable levels. Historically, Texas has shown itself willing to adapt and change with the times. If each level of water management could learn to successfully manage interagency coordination and cooperation, then maybe the state would be able to implement long-term solutions that could alleviate the impending water crisis. At present, Texas is too busy focusing on what past policy should be accomplishing. Instead, Texas should look toward the future and focus on developing water management that will ensure a sustainable future.

Endnote: *Edwards Aquifer Authority v. Day*

The day is finally here; the Texas Supreme Court addressed the rule of capture. For the past two years, the *Edwards Aquifer Authority v. Day* case has been moving through the court system. The fundamental contention in the case is whether an overlying landowner owns the groundwater beneath their property "in place" or whether the ownership is vested once the groundwater has been captured through pumping. Texas water experts have waited for the resolution of this case; the outcome determines whether the system of groundwater management, which relies on regulatory actions by local groundwater districts, can continue.[195] The ruling in *Day* was handed down during February 2012. The case was initiated when a landowner requested a permit for seven hundred acre-feet and was granted a permit for fourteen acre-feet so they brought a claim alleging a taking by the EAA.[196] In this case, the court held that landowners have a vested right to water in place, but the court remanded the case to rule on the question of takings. This decision defines the courts interpretations of the rule of capture similar to the right of capture for oil and gas.[197] The implication of this ruling will be determined through further litigation as the courts parse out the details of what constitutes a taking, but the decision is considered a victory for landowners.[198] Essentially, the ruling implies that individual landowners, through their vested interests, already privately own the water in the Edwards Aquifer. This ruling is dangerous because while the courts determine definition of a taking, groundwater pumping maybe left unchecked during critical periods of drought. This ruling jeopardizes some of the recovery programs surrounding the Edwards Aquifer, including the

[195] Mary Kelly, "Courting Chaos?" Texas Water Solutions. 4 March 2010. Environmental Defense Fund, http://blogs.edf.org/texaswatersolutions/2010/03/04/courting-chaos/ (accessed 3 April 2012).
[196] Amy Hardberger, "Biggest Decision in Texas Groundwater Since 1904!" Texas Water Solutions, 27 February 2012, Environmental Defense Fund, http://blogs.edf.org/texaswatersolutions/2012/02/27/biggest-decision-in-tx-groundwater-since-1904/ (accessed 3 April 2012).
[197] Ibid.
[198] Ibid.

Edwards Aquifer Recovery Implementation Program, a consensus-based approach to maintaining flow in the springs while still adhering to pumping limits.[199] The court was clear in their ruling that groundwater beneath a landowner's property is afforded constitutional protection from extensive governmental regulation. This ruling is similar to the oil and gas ownership law. Opponents of the ruling worry that this interpretation of groundwater allocation will harm the spring flows and environmental habitats found in the Edwards Aquifer by creating a condition where groundwater is unregulated.[200]

The rule of capture is the most dangerous piece of the Texas water puzzle. Through defining and strengthening the rule of capture, the courts have demonstrated their power over water. Previously, they used this power by exercising their right silence. The ruling in *Day* has the potential to override the solutions and the various measures that provide balance to the rule of capture, once again allowing it to reign supreme. The groundwater management system in Texas is not perfect, but it attempts to provide a fair and balanced approach to resource conservation. Districts were subject to a number of legislative and due process constraints, arbitrary decisions can be addressed in the courts, and those running the districts could be voted out of their position. This ruling throws the legitimacy of these controls into chaos and has the potential to impact regional water planning, the maintenance of surface water rights, and the ability to protect environmental flows. Much of the investment and economic activity in Texas depends on secure water rights; the ruling in *Day* creates an uncertain environment that could have a negative impact on the Texas economy.

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[199] Ibid.

[200] Luana Buckner, "Why courts should reconsider aquifer ruling," 10 April 2012, San Antonio Express-News, http://www.mysanantonio.com/opinion/commentary/article/Why-courts-should-reconsider-aquifer-ruling-3472150.php (accessed 12 April 2012).

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