A Hydrosocial Paradox:
Returning Water to the Santa Fe and Wimmera Rivers

A Thesis Presented to
The Department of Southwest Studies
Colorado College
Bachelor of Arts

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May 2015

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Fish in the Sea, you know how I feel
River runnin' free, you know how I feel
Blossom on a tree, you know how I feel
It's a new dawn, It's a new day, It's a new life for me,
And I'm feelin' good

-Anthony Newley & Leslie Bricusse

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Introduction

Rivers are the arteries of life in arid and semiarid environments. Life in dry regions of the world has survived and at times thrived thanks to the fresh water of rivers. The Santa Fe River in the semi-arid New Mexican climate and the Wimmera River in the harsh landscape of southeastern Australia are ambassadors to life in desolate lands. Water scarcity has made human life in the Santa Fe and Wimmera regions closely entwined with their respective rivers' lives. In this study, I use a detailed historical examination of the Santa Fe River to uncover key elements that form human-river relationships, which I then apply in an analysis of the Wimmera River region. This comparative study constructs a bi-regional understanding of human-river relationships.

The Santa Fe River is a tributary of the Rio Grande that originates in the Sangre de Cristo Range. Its river channel runs through the city of Santa Fe; however, the river water seldom reaches the Rio Grande, only making the confluence in flood events. Nichols and McClure Reservoirs in the upper watershed impound the Santa Fe River surface water and constrict its flow to form part of the city of Santa Fe's water supply. Historically, the Santa Fe River supported Pueblo peoples, Spanish Colonists, Mexican Settlers and U.S. citizens. Changes in the Santa Fe River are reflected in its changing relationships with the people and cultures along it.

I employ two conceptual tools to analyze the life of the Santa Fe River: Richard White's (1995) organic machine, and Jamie Linton's and Jessica Budds' (2013) hydrosocial cycle. Combining these approaches constructs a dialectic framework that explains many of the key elements at work in human river relationships.

In his book *The Organic Machine: The Remaking of the Columbia River*, White (1995) proposes that contemporary rivers can be observed as 'organic machines' that are fragmented into many parts with differing functions. Although humans segmented and mechanized rivers through dams, reservoirs, diversions and other engineered structures, they still maintain their natural qualities (White 1995). White explains that a river system needs to be viewed as a whole to comprehend its life and position in the environment. White (1995) also believes that to comprehend human and environmental history around a river, the relationship between the two must be investigated. This relational approach fits with the growing interest in water amid human-environment studies.

Linton and Budds (2013) contend that there is an inadequate acknowledgement of water's broader social dimensions in water and society research. To fill that void, they advanced the "hydrosocial cycle" as a conceptual framework for understanding how "water and society make and remake each other over space and time" (Linton and Budds 2013, 1). The hydrosocial cycle places water's social and political nature within the context of the hydrologic cycle (Linton and Budds 2013). In other words, the life and function of water cannot be understood without considering water's societal role and society's hydrologic role.

The relational-holist approach garnered from these concepts opens the door to the Santa Fe River's complex history. The human-Santa Fe River relationship is marked over time by developing human populations controlling and modifying the river to fulfill their expanding water needs. The city of Santa Fe over-allocated the river water and its flows dwindled until they no longer existed. As Andy Otto, Executive Director of Santa Fe Watershed Association (SFWA), says, "no one seems to remember when the [Santa

Fe] River stopped flowing" (2014). People engaged in a relationship with the river where they consumed its water while its decline in health went largely unnoticed. Santa Fe's story of growing populations, over-allocation, and river desiccation is not unique in the western U.S., but rather an echoing theme (Reisner 1986).

In a study of the hydrological cycle in the western U.S., Tim P. Barnett and associates (2008) found that 60% of climate related trends of river flow, winter air temperature and snow pack between 1950 and 1999 were human-induced. Human impacts on the hydrology of the western U.S. have altered local climates and consequentially the state of rivers and local environments. A report by Daren M. Carlisle et al. (2010) highlights the magnitude of human's influences on U.S. rivers. Carlisle (2010) investigated stream flow at 2,888 monitoring sites across the U.S. and discovered that 86% of the assessed streams had flows altered by human, gives weight to using the hydrosocial machine approach.

However, in the past five years, Santa Fe made a less common choice in western river relations and decided to release water back into the Santa Fe River. In 2011, the city of Santa Fe initiated the Living River Ordinance, which releases up to a 1,000 acre-feet of stored water per year back into the Santa Fe River channel. These releases are designated as environmental flows, meaning they cannot be diverted, retained or consumed in any manner. The addition of environmental flows to Santa Fe's water management is unprecedented for the capital city and the state of New Mexico, but Santa Fe is not alone in this practice.

R.E. Tharme (2003) believes that the widespread recognition of the escalating anthropogenic impacts on hydrologic systems has led to an increasing number of implemented environmental flow regime projects. In 2003, there were at least 207 individual environmental flow methodologies or experiments in 44 countries (Tharme 2003). The life of the Santa Fe River is thus a microcosm of a growing trend toward river alterations and environmental flow management. As such, it provides an opportunity to analyze how a human-river relationship led to the restoration of environmental flows and ascertain how others can replicate such success.

I conducted a comparative case study on the Wimmera River in the state of Victoria in southeastern Australia to produce a greater understanding of human-river relationships. I visited the region to gather primary data from interviews of present and former federal, regional, and local government officials and to document the Wimmera River system first hand. This primary research combined with secondary sources on the life of the Wimmera River was analyzed through the same hydrosocial-organic machine lens that was applied to the Santa Fe River.

The Wimmera region's environment is arid and drought prone. The life of the Wimmera River has changed throughout a long history of relations with humans (Victorian Environmental Water Holder 2012). In 2007, amidst an extreme drought the life of the Wimmera River all but vanished, leaving a dry, cracked riverbed (Wimmera's Flowing Tale 2013). However, the Wimmera River was revived with the release of environmental flows in 2010. Comparing human relations with the Wimmera to those with the Santa Fe River reveals that grassroots politics, community involvement, and human ingenuity are key elements in reviving rivers. Comparative regional analysis also points to a new paradoxical paradigm in water management: water scarcity, ironically, has often triggered the plans to return water to the rivers, even in times of drought. This senior paper explores why that paradigm has developed and what it means for other small streams in semi-arid regions.

Chapter 1
Environmental History of a Flowing River

We have not killed the River, we have disappointed ourselves.
—Richard White, 1995

The Santa Fe River attracted human settlement in the region and has supported it for hundreds of years. The evolution of human livelihoods along its banks continually changed the life of the Santa Fe River.

Early human accounts speak of a pristine stream flowing from the mountains with numerous springs and wetlands speckling the landscape. Señor Don Pedro Alonso O'Crouley, a Spanish merchant, described the Santa Fe River as a "crystal clear river with small choice trout" (O'Crouley 1774) in his 1774 *Description of the Kingdom of New Spain*. The present Santa Fe River is a ghost of its former self. As Tara Plewa described, "now the dry channel sits several feet below street level and is often discounted and ignored by the thousands of tourists that cross its bridges each year" (2009, 3). The Santa Fe River's transformation from a flowing mountain stream to a dry urban ditch is a compelling story of human development in a water-scarce environment. This offers opportunity to reflect on the local and southwest regional history of human and river relations. To learn from the ever-changing life of the Santa Fe River, we must explore the environmental history of the Santa Fe region. Our story of the Santa Fe River begins with a running river.

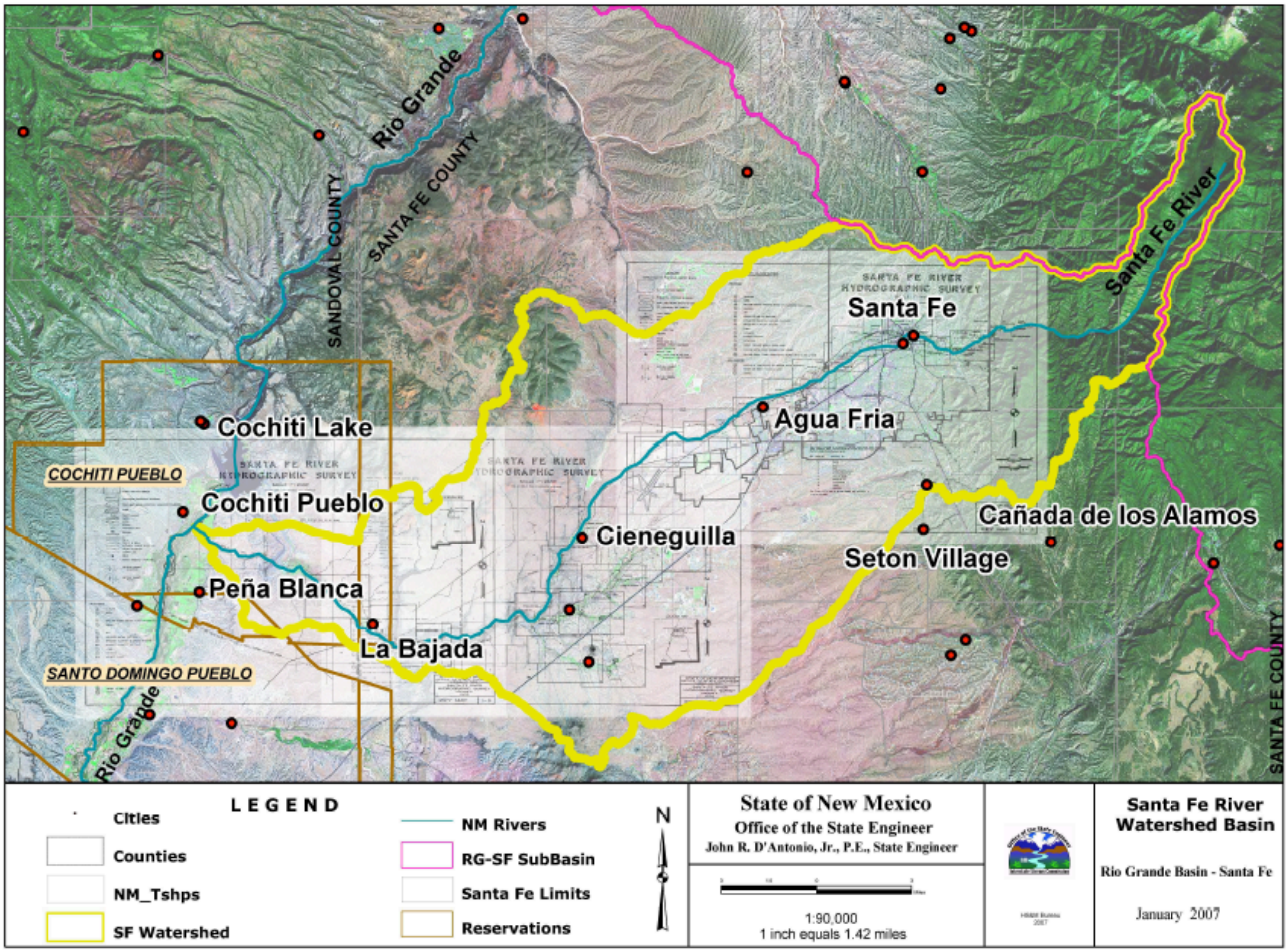


Figure 1.1: Map of Santa Fe Watershed.
Source: D'Antonio, Office of the State Engineer for the State of New Mexico (2007).

❖ Early Life ❖

The earliest known occupants of the Southwestern United States were Paleo-Indian hunter and gatherers (Phillips et al. 2011). The Paleo-Indian hunters and gatherers used rivers not only for the water, but also to hunt wildlife that the rivers attracted (Phillips et al. 2011). Around 1000 AD, across the Southwest, groups began developing agricultural practices (Phillips et al. 2011) and the population of these ancient groups grew. The indigenous American tribes began to resettle next to streams to utilize their surface waters (Dana et al. 2013). The dry lands of the Southwest are not leached of minerals and nutrients nor covered in vegetation, making it acceptable to agriculture (Dana et al. 2013). Water availability is the issue.

The majority of the 'humanized' southwestern landscapes before 1492 were altered for irrigation (Dana et al. 2013). The ancient peoples developed the art and science of collecting and retaining water through dams and weirs (Dana et al. 2013). Although it is not clear if the Pueblos used permanent canals, some argue that the diverted stream agriculture resembled modern-day irrigation by utilizing stream flow through canals, head gates, diversion dams, wells, and reservoirs (Phillips et al 2011). Groups also practiced runoff irrigation or floodwater farming, which depended more on rainstorms and snowmelt runoff (Phillips et al. 2011).

Studies by Phillips et al (2011), Rivera (1998), Doolittle (2002), Dana et al. (2013) and Rodríguez (2006) documented early life in the Southwest, but the exact condition of the rivers and the ancient peoples' views of water remain relatively obscure. As Fred Phillips and associates put it "knowing the full scope of these ancient peoples' beliefs about and attitudes toward water is impossible" (2011, 34). Regardless, it is evident that in the Southwestern United States, water scarcity has entwined the lives of humans and rivers.

Recorded human relationships with the Santa Fe River date back to the late 1580s (SF Hydro 1976). There is limited documentation about the early peoples of the area, but a few personal accounts and ruins give some insight into their activity prior to Spanish colonization. The Rodríguez-Chamuscado Expedition of 1581-1582 reported that there were four pueblos established in the basin of the Santa Fe River (SF Hydro 1976). This expedition also spoke of Santa Fe's agricultural habits: "whether the inhabitants of those pueblos diverted the surface waters of the Santa Fe Creek for irrigation purposes is speculative, though it is believed that runoff from springs and marshes in the area may have served as the source of irrigation waters" (SF Hydro 1976, xi). The existence of Pueblo life prior to Spanish colonization is also evident from accounts of a pueblo existing at La Ciénega, which is a relatively fertile area watered by springs on the lower reaches of the Santa Fe River (SF Hydro 1976). These records show the Santa Fe River was long home to Pueblo peoples prior to the Spaniards' arrival.

❖ Spanish Colonies ❖

In 1598, Don Juan de Oñate marched a little army and band of settlers north out of Mexico with the purpose of adding the province of Nuevo Mexico to the Spanish Empire (Phillips et al. 2011). At that time, the Spanish reported four active Indian pueblos where springs merged with the Santa Fe River (Borchert 2010). Theses pueblos were likely the same ones that Rodríguez-Chamuscado's earlier expedition mentioned.

In 1608, Don Pedro de Peralta succeeded Oñate as the governor of New Mexico. In the following year, Peralta moved the colony's capital from San Gabriel to "the site of an abandoned pueblo, situated on a little stream at the foot of the great mountain chain later called the Sangre de Cristo Mountains"(Julyan 1998, 324). In 1610, he officially established the new capital of the "Kingdom of New Mexico" naming it *La Villa Real de Santa Fe* (Julyan 1998, 325). He likely adopted the name from Santa Fe, the city outside of Granada, Spain where the monarchs Ferdinand and Isabella oversaw the final conquest of the Moors in 1492 (Julyan 1998).

The place name of Santa Fe tells a greater history than just this connection to Spanish royal encampment. Some scholars, including Tara Plewa (2009), believe that the proper name bestowed by Peralta is *La Villa Real de la Santa Fé de San Francisco de Asís.* San Francisco de Asís is the patron saint of nature and rain, thus Peralta may have been making a reference to the dry climate and water dependence (Plewa 2009). However, Robert Julyan (1998) contends that documentation for that name is lacking.

Julyan argues that most Pueblo Indian groups refer to the area with names that mean "bead water," because beads were made from shells there (Julyan 1998, 325). It is also believed that Native American peoples called it Po's Gae or "the watering place" (Santa Fe 1995, 6). The Tewa-speaking Pueblos along Rio Grande call Santa Fe names meaning "down at the water" (Julyan 1998, 325). These names lead many to think that the Santa Fe area had been long recognized as a place for water resources.

Em Hall (2014), University of New Mexico Professor and author of several books on water in Southwest, proposes that Santa Fe was recognized as a place that did not have enough water to sustain human life. He believes that that is why it was an abandoned pueblo site when Peralta moved the capital. The various interpretations of Santa Fe's place name prompt an intriguing argument of how Pueblo people, Spanish settlers and even Anglo inhabitants viewed the area. Water resources are at the heart of the debate. Regardless of how Santa Fe was named, water was scarce, and the Spaniards had to figure out how to effectively use these water supplies to build the capital of New Mexico.

The Spanish colonies existed in the arid landscape by establishing irrigation systems called *acequias*. The Spanish learned the *acequia* system from the Moors and brought them over to the New World (Rodríguez 2006). An *acequia* begins when river water is diverted into a large irrigation channel called the *acequia madre.* From there secondary ditches deliver the water to members of the community, *parciantes,* using gravitational force (Sunseri 1973, Rodríguez 2006). A *mayordomo* is the ditch boss of an *acequia. Acequias* require a lot of maintenance and communal labor, which the *mayordomo* organizes (Phillips et al. 2011). In this way, acequias developed communities with a particular way of life and set of values throughout New Mexico and the Southwest. This settlement and agricultural practice emphasizes equitable distribution and fair use of water, demonstrating that "a core value of acequia agriculture is the sharing of water to support life" (Rodríguez 2006; Groenfeldt et al 2013). The scarcity of water in the Southwest demands efficient use; *acequias* have been and remain a key aspect of how to make local water match local needs.

The Spanish colonists and the prior and contemporary Pueblo peoples had similar structures in their irrigation practices (Phillips et al. 2011). They also shared ideals about rivers.

> In terms of their relation to the[Rio Grande] river, the Spanish farmers who settled along the river—many of them soldiers turned settlers—and Rio Grande native peoples eventually found much in common, including *gentle use* of the river

(emphasis added, Phillips et al 2011, 38).

The term 'gentle use' is ambiguous, possibly signifying a relationship with the river where the Spanish are more aware of and sensitive to their influences upon it. On the other hand, gentle use may have been a product of the limit of their technology to consume water. Others, such as David Groenfeldt, contend that acequia practices are romanticized and weren't more closely connected with nature, "they didn't really damage nature that much because it was so small scale. The principal of keeping nature alive wasn't really there" (2014 Personal Interview). Groenfeldt's critique may be inappropriately placing a 20th century perception of nature on a prior time with a different meaning of nature.

Regardless of the gentleness of their relationship with the Santa Fe River, increases in settler population began to strain resources. Spanish colonization greatly expanded water diversion for human use, both through more than 30 additional acequia systems and by digging domestic wells to tap into the ground water resource (Groenfeldt et al 2013, Ware 2005).

❖ Mexican Rule ❖

Mexico gained control of New Mexico in 1821 and held it until they lost the Mexican-American War and signed the Guadalupe-Hidalgo treaty of 1848 (Ware 2005). However, this acquisition did not affect the prevailing water institutions (Rodríguez 2006). *Acequia* governance was respected and its usage spread in the region during Mexican rule (Rodríguez 2006). The Mexican government established a punishment system that reinforced the joint responsibility of all villagers to maintain the *acequia madre* (Clark 1987). This penalty system shows that acequias were at the key aspects in water governance and the structure of the community. Josiah Gregg, who joined the Santa Fe

Trade after the Mexican independence, expressed that villages grew in clusters around *acequias* and that "distribution and use of water was the major source of controversy in New Mexico"(Clark 1987, 16). Even in the 1800s, water scarcity made managing water a contentious act. Mexican water governance did not greatly alter the communities in New Mexico; *acequias* remained the centerpiece for the local government and water management.

For the Santa Fe River, Mexican governance from 1821 to 1848 was a relatively calm time. The city of Santa Fe was reported to have a population of 6,000 when the Mexicans took the reigns in 1821 (Spiegel and Baldwin 1963). The size of the settlement grew during the Mexican term, but the modes of river alterations and water management largely did not. The United States' acquisition of the territory of New Mexico in the treaty of Guadalupe-Hidalgo would be a momentous moment in the life of the Santa Fe River. The transition into a U.S. territory brought significant transformations for Nuevo Mexicanos, the Pueblos and the Santa Fe River.

❖ Growing Towards Dams ❖

In 1846, U.S. general Stephen Watts Kearny started the occupation of New Mexico. Kearny and his troops conducted the occupation with a minimum of interference with the existing institutions (Clark 1987). Kearny did not want to upset the resident Mexicans by changing everything that was in place. At that point, the New Mexican province had the oldest tradition of water control and use in all of the present United States (Clark 1987). Therefore, he enacted and presented to the local Mexicans what known as the Kearny Code. It states that the "'laws heretofore in force concerning water courses, stock marks, and brands, horses, enclosures, commons, and arbitrations shall continue in force"'(Clark 1987, 24). All irrigational practices such as *acequias* and other preexisting institutions for water use were officially recognized and undisturbed.

The unobtrusive principles of the Kearny Code did not greatly impact how people related with the Santa Fe River. Nevertheless, the Kearny Code left the expanding municipal use of Santa Fe River water mostly unchecked, which would have significant implications for the river's life. During their respective reigns over Santa Fe, Spanish Colonists and Mexican authorities both used as much of the Santa Fe River water as they wanted. This unfettered consumption of the Santa Fe River persisted in the U.S. territorial governance. It remained unquestioned through New Mexico's 1912 statehood until it was challenged in the mid-1950s. The consumptive habits of the years between Kearny's occupation and the mid-1950s greatly impacted the life of the Santa Fe River and acequia culture.

From the mid 1800's to the turn of the century, the American West exponentially grew in human occupancy and landscape modification. With these changes came increased water requirements, and Santa Fe followed regional trends, tasked with harnessing a water supply out of a water-scarce environment (Reisner 1986). Anglos traversed the nation to the West in pursuit of gold, beaver fur, land, and opportunity (Reisner 1986). Rivers provided the primary source of fresh water in these semi-arid environments, but a new form and mentality of regional development required larger and more intensive systems to harness sufficient water.

Chapter 2
Ephemeral Waters of a Forgotten River

Everything depends on the manipulation of water—on capturing it behind dams, storing, and rerouting it in concrete rivers over distances of hundreds of miles. Were it not for a century and a half of messianic effort toward that end, the West as we know it would not exist.
—Marc Reisner 1986, 3

At the turn of the century, dams, reservoirs, and expansive piped systems were etching the western landscape and transforming it into an inhabitable landscape. The shaping of the modern West gained a serious boost in 1902 when Theodore Roosevelt signed the Reclamation Act into law (Pisani 2002). It launched the U.S. government's boldest program of regional economic development and public works (Pisani 2002). The U.S. Bureau of Reclamation headed the campaign, aiming to create large-scale irrigation projects in the West (Pisani 2002, Reisner 1986). The results were more massive than anyone expected. The Bureau constructed some of the highest and largest dams in the world, on dauntingly powerful rivers like the Colorado, the Sacramento and the Columbia (Reisner 1986). Marc Reisner describes the effect the bureau and irrigation had on settlement: "…millions settled in regions where nature, left alone, would have countenanced thousands at best…"(1986, 2). In its own dry landscape, the Santa Fe River's history is a microcosm of the dilemmas, pitfalls, and accomplishments of modern western development.

❖ Wrangling Waters ❖

The Santa Fe River was dammed and its water commoditized to support the urban development of Santa Fe and to create a protective buffer from dry spells and floods (Plewa 2009, Groenfeldt 2010). These strategies not only reflect national trends (Reisner 1986), but also mark a significant cultural change in the relationship between people and the Santa Fe River.

In 1880, the commissioners of the County of Santa Fe gave the newly formed Santa Fe Water and Improvement Company "'exclusive right and privilege of erecting dams and reservoirs, and impounding water on the River of Santa Fe'" (Plewa 2009, 245). The Water Company immediately exercised these powers and built the first dam, Old Stone Dam, on the Santa Fe River (Groenfeldt 2010, Plewa 2009). Old Stone Dam retained a meager 25 acre-feet of water in the upper watershed (Plewa 2009). Although the dam retained only a small proportion of the river's average 6,173 acre-feet flow (Plewa 2009), it was still an essential turning point in the way Santa Feans view and relate to the river.

In one year, the Santa Fe River went from the flowing artery of a city to a stagnant pool of water delivered through pipes to paying customers. This commodification of Santa Fe River water required residents to recognize its new literal and metaphoric value. Obviously, one had to pay to use the water, but this change also broke the past practice that the river was a communal resource whose water was to be distributed among the community. Alongside this commodification, Old Stone dam was one of the first physical turning points in the life of the river. Santa Feans realized that to use the water, they didn't have to work with the natural flow. They could stop the flow and have it work for them. The relationship began to shift away from humans learning to *live with* the river to humans learning how to *control* the river.

The Santa Fe River was not only controlled to be Santa Fe's secure supply, civic leaders thought it needed to be protected. In 1892, President Benjamin Harrison created the Pecos River Reserve to preserve the land and protect the headwaters of the Santa Fe and Pecos rivers (Clark 1987). Another reason to establish the reserve was "'to secure a permanent and unpolluted water supply to the people of Santa Fe'" (Clark 1987, 72). The development of Santa Fe pressed government officials to decide how the landscape would be protected or modified. Ironically, the Santa Fe River was dammed, but its headwaters protected.

Yet Old Stone Dam proved to be insufficient to quench the city's thirst. To fix this problem, in 1893 the Water Company began construction of a second dam, Two Mile Dam, only hundreds of feet downstream of Old Stone (Plewa 2009). Two Mile Dam had a 387 acre-feet capacity (Plewa 2009). This progression of building bigger dams on a river parallels development in the West caused by expanding cities and water remaining scarce. Two Mile Dam also led to confrontations between traditional acequia systems and city officials.

The concrete Two Mile dam immediately disrupted the water flow to acequias (Plewa 2009). To determine how acequias would continue to receive their water, the state legislature transformed the historic acequia communities into corporate entities with legal standing. As Tara Plewa (2009) explains, "[acequias] could now sue and be sued, collect fees, and were required to publicize rules and regulations and elect ditch commissioners" (248), most importantly acequias could now fight for control of their water rights. This established the potential to halt the city's unregulated consumption of the Santa Fe River water, which went unrealized for another half century (Tyler 1990).

The Santa Fe River was being transformed into an organic machine. The nature of the river: its flow, health and water were altered to be a system that functioned within and for society. However, it refused to be tamed without a fight. In 1904, the Santa Fe River roared- producing a powerful flood that completely filled the Old Stone Dam with sediment (Plewa 2009). Two Mile Dam held fast and stopped the flood from completely devastating the city. Figure 2.1 and 2.2 show Two-Mile reservoir being cleaned out. The flood of 1904 frightened the city, convincing community members that more dams were necessary, both for flood protection and to provide more water to an ever-growing population.

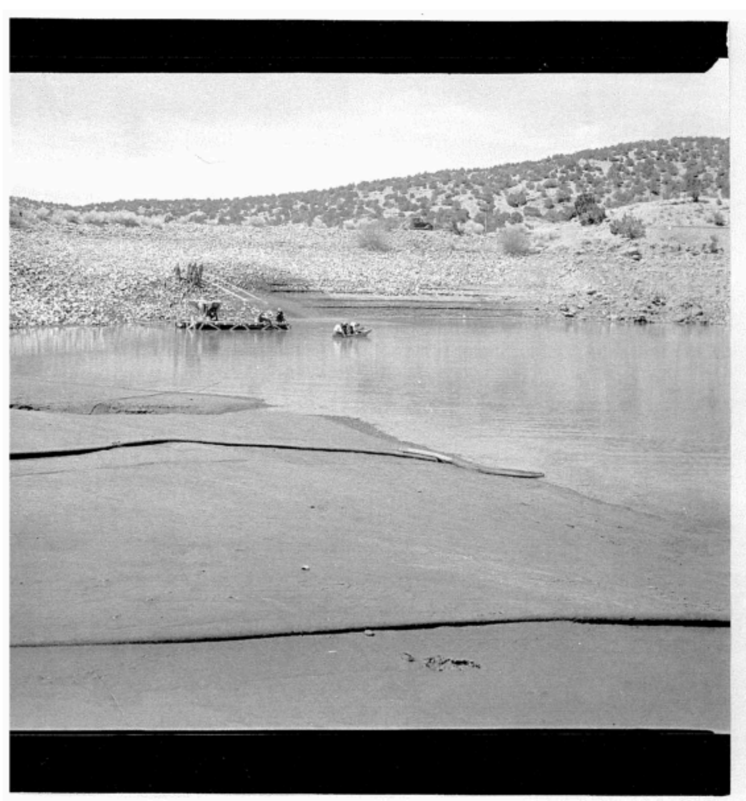


Figure 2.1 Cleaning out Two Mile Dam and Reservoir. Unknown Date (Post 1904 flood?).
Source: Fray Angélico Chávez History Library

Figure 2.2 Cleaning out Two Mile Dam and Reservoir. Unknown Date (Post 1904 flood?) Source: Fray Angélico Chávez History Library

❖ Stronger Walls for a Disappearing River ❖

By the end of the 1930s, Santa Fe's local population reached over 20,000, four times the 5,072 that resided there in 1910 (Plewa 2009). This growth placed more stress on the Santa Fe River and advanced the development of damming and retaining its waters. In 1928, the Water Company constructed McClure Dam (previously named Granite Point) 3.5 miles upstream of Two Mile (Plewa 2009). It had an original capacity of 650 acre-feet of water, but it was increased in 1935 to retain 3,059 acre-feet (Plewa 2009). At that point, the Water Company stored half of river's flow (Groenfeldt 2011, Plewa 2009). This storage rose to 60% during World War II. The city of Santa Fe built a new army hospital to support the war effort and in 1943, the Water Company augmented the water supply with an additional dam, Nichols Dam, in part to provide water for the hospital (Plewa 2009).

That the dams retained 60% of Santa Fe River water doesn't mean that the remaining 40% flowed down the river channel (Plewa 2009). Instead, Santa Fe River water was consumed year round, with the reservoirs being drawn down during the winter months and seasonal pools filling the rest of the calendar water supply (Plewa 2009). Its water only flowed downstream when flows were above average for consecutive years or when an occasional powerful storm produced an overflow (Plewa 2009). By the 1950s the Santa Fe River was nearly fully mechanized, its hydrologic regime a cog in the wheel of urbanization.

❖Out with the Old, Forget the New ❖

The developing city of Santa Fe not only faced the feat of wrangling enough water to support its growth, but also confronted legal changes for water use. Water law and management from the previous settlers were outdated for the current situation in the western U.S. New Anglo settlers arrived to the arid and semiarid climate of the West, a land that had never been home to so many. Migrants included a swarm of miners chasing golden dreams to the West. The young state of California became a hub for mining communities with water needs that drove changes in water management.

Before the 1848 treaty of Guadalupe-Hidalgo, the principles of the riparian doctrine primarily ruled western water law. This doctrine states that landowners that live next to a stream or river had right to use its water as long as they did not actually divert water from the course of the stream (Clark 1987). The mining process required water to wash away sand and debris from the minerals; however, the mineral deposits were not necessarily located in a stream or on its banks (Clark 1987). Therefore, the miners needed the ability to divert water from the streams. The riparian rights doctrine; however, could not fit these requirements. A new system that permitted diversions was sought after. Out of this dilemma arose the prior appropriation doctrine with the slogan 'first in time, first in right' (Clark 1987). It determined what diversions were permitted and how water rights were prioritized.

The prior appropriation doctrine allowed the water to be diverted as long as it was used beneficially and there was no prior right to it. It is a chronological system of water allocation, meaning he/she who first appropriated water from the river has priority to that water as long as he/she beneficially uses it. The user who holds the most senior water right can call for the full amount of his/her water right before others receive any regardless of how much water is in the river. The definition of 'beneficial use' has been controversial since it was first employed. Beneficial use was predicated of human use. The user has a right to that water as long as it is utilized for supporting human life or an economic function. That can take many forms including irrigation farming, raising livestock and domestic use (Gopalakrishnan 1973). Prior appropriation would evolve to be the most influential legal tool for governing water in the West.

The miners of California incidentally sparked another significant change in water management in the mining act of 1866. This act allowed free access to public lands for prospectors, subject to the local customs and rules of several mining districts (Clark 1987). Importantly, it "recognized the right to appropriate water as determined by local custom"(Clark 1987, 38) a freedom that opened the door to an array of managing principles. This also seems to resonate with New Mexico's tradition of respecting local *acequia* customs.

The state of Colorado was the next state to make a significant move in constructing a new structure for western water law. It was the first western state admitted into the union following the passage of the mining act of 1866 (Clark 1987). Their constitution declared that water was no one's property, untying the allocation of water rights from the federal government. This departure from the common-law became the basic premise of the Colorado doctrine, which determined that "all of the waters within a state were the property of the public held in trust by the state" (Clark 1987, 39). It asserted that the acquisition of water rights came solely from the state, completely independent of the federal government (Clark 1987). Two lines of reasoning supported the Colorado doctrine. First, a state assumed jurisdiction over all land within its borders when it entered the federal union. Second, under the mining act of 1866, water rights on public land were subject to local customs (Clark 1987). The U.S. government was obligated to recognize and respect the water doctrines on public land in any state (Clark 1987). The Colorado doctrine was widely adopted by other western states to design and implement their own water doctrines. All interior states west of the one-hundredth meridian, except Montana, placed state ownership of surface waters in their constitutions or legally declared it through legislation (Clark 1987).

State ownership allowed prior appropriation to be the prevailing doctrine in western states. New Mexico officially stated the doctrine of prior appropriation in 1905. However, there were a significant amount of special laws that recognized comparable policies of prescriptive water rights prior to 1905 (Clark 1987). These laws were in place to defend irrigators and *acequias* from newcomers (Clark 1987). Today, prior appropriation is the primary doctrine for water governance, but Spanish and Mexican customs were not wholly replaced. Many were assimilated or persisted and remain present today. As Ira G. Clark (1987, 42) states, "The water institutions of New Mexico represent a fusion of the old with the explicit definition of prior appropriation which came with the new".

Prior appropriation marked a significant deviation from the longstanding idea that a settlement could take as much water as it desired. As sociologist Chennat Gopalakrishnan explains, "it grew from the practice of the early settlers of taking water where they found it and using it where they needed it" (1973, 62). Water was too scarce and cities were becoming too big to continue unregulated consumption.

New Mexican water users had their river use regulated by prior appropriation, but the code did not offer the rivers any type of protection from overconsumption. The health of rivers was not considered in prior appropriation management. Even today, rivers are rarely given any rights to their own water; " [prior appropriation] permits diversion regardless of the diminution of the stream" (Gopalakrishnan 1973, 63). Prior appropriation led to a popular attitude that 'water in the river was wasteful'. This proved to be a costly way of thinking for many rivers. The Santa Fe River suffered from prior appropriation's disregard for river health, but may have been more greatly damaged by the city's lack to follow prior appropriation's policies in their own consumption.

The city of Santa Fe accepted the prior appropriation doctrine as the governing principle, but never enforced it on their water consumption. In other words, they continued using as much water as they wanted even though they did not have any senior water rights. This played a big role in the eventual disappearance of the Santa Fe River's flow and had tremendous impacts on the acequia communities. This unregulated, municipal consumption remained until the 1950s. When acequia members and citizens finally scrutinized their water rights, Santa Fe employed the Pueblo Rights Doctrine to try to defend their water usage.

The Pueblo Rights Doctrine protects municipalities that can trace their water right origins back to a Spanish or Mexican pueblo grant. Under the Pueblo Rights Doctrine, a municipality could claim an expanding right to the waters of non-navigable streams flowing through or nearby the pueblo if they can prove that their water right is from a previous Spanish or Mexican pueblo (Brockmann and Martinez, 2012). The idea is that it eliminates the need to continually obtain new water rights to serve the climbing needs of growing populations (Brockmann and Martinez, 2012). The employment of this doctrine has been complicated and highly contentious, especially since the doctrine may never actually existed.

New Mexico's viewpoint with the Pueblo Rights Doctrine has been elusive and inconsistent, as made apparent by the city of Las Vegas. In 1958, the New Mexico Supreme Court adopted the Pueblo Rights Doctrine in the decision of *Cartwright et al. v. Public Service Co* (Mulvany 2005). The Public Service Company, representing the town of Las Vegas and the city of Las Vegas, was challenged by a number of water users on the Gallina River who claimed the Public Service Company was trespassing by diverting their senior water right (Brockmann and Martinez 2002). The court found that the town and city of Las Vegas were successors to the Mexican pueblo of Nuestra Senora de Las Dolores de Las Vegas. This Mexican pueblo was established in 1835; therefore, as successors the city and town of Las Vegas "had a right to divert and use as much of the waters of the Gallina River as was necessary for their use with a priority date of 1835, which were prior and paramount to any rights of the plaintiffs in the case" (Brockmann and Martinez 2002, 112). Under the assertion of the Pueblo Right Doctrine, the city and town of Las Vegas were granted unrestricted consumption of the Gallina River water.

The story of Las Vegas did not end with the ruling of *Cartwrights et al. v. Public Service Co.*. Over 40 years later, in *State ex rel. Martinez v. City of Las Vegas* and the subsequent appeal cases, the Supreme Court determined that the Pueblo Right Doctrine is incompatible with New Mexico water law (Mulvany 2005). James C. Brockmann and Eluid L. Martinez (2002) explain, "in particular, the court found the perpetually expanding nature of the Pueblo Water Right Doctrine conflicts with the fundamental principles of beneficial use that lie at the heart of New Mexico water law" (120). The story of Las Vegas makes evident the complexity of adjudicating water rights based on historical grants and shows that one entity can't have an ever-expanding right in a prior appropriation system.

Santa Fe experienced similar challenges to the Pueblo Water Right Doctrine. The New Mexico Products Company claimed the city of Santa Fe was interfering with Product Company's senior right for irrigation (Brockmann and Martinez 2002). The district court initially declared in the *New Mexico Products Co. v. New Mexico Power Co.* case that the Pueblo Water Right Doctrine was valid in New Mexico and that the city of Santa Fe had an expanding right to the waters of the Santa Fe River to fulfill the needs of a growing population (Brockmann and Martinez 2002). However, the New Mexico Supreme Court disagreed with the district court's ruling.

The New Mexico Supreme Court backed up their opposition to the district court by citing a previous decision from the United States Supreme Court. In the unrelated case entitled *United States v. City of Santa Fe* the U.S. Supreme Court found that the city of Santa Fe never received an official grant from the Spanish king; therefore, it did not have a pueblo water right (Brockmann and Martinez 2002). Santa Fe's unregulated use of the Santa Fe River surface water was not based in a legal water right. After the New Mexico Supreme Court's decision to not grant Santa Fe a pueblo right, the capital city had to acquire water rights to meet its expanding demand.

By the 1950s, the Santa Fe River had supported the life of early Pueblos, Spanish Colonies, Mexican settlements and the rapid emergence of the New Mexican capital city. The river's initial relations with humans started with small communities that diverted its water in simple acequia systems and respected it as the lifeblood of the community. Decades later, it would quench the thirst of nearly 40,000 people, many of whom only saw it for the wealth of its water, if they saw a river at all. The stream that once ran from the Sangre de Cristo Mountains into a landscape of springs and floodplains now rarely trickles past the vertical walls of dams into its dry, incised channel. The Santa Fe River was never a river like the Colorado River, with a lush diversity of life along its banks, and never would have imagined supporting a population as large as the city of Santa Fe. It has stretched its capabilities and leads a life of an ignored ditch in an engineered river system.

Chapter 3
A Thirst Larger than a River

"From the time that men first crossed the [98th meridian] as explorers to the present, there has been in this region a constant and persistent search for water."

-Prescott Webb (Gopalakrishnan 1973, 62)

Living in the arid American West involves searching out and acquiring any drop of water that can support human settlement. The rivers are the obvious starting point, but their water is tougher to use than one might expect. Nevertheless, Anglo-American settlers used their wits and technology to transform rivers into societal tools, organic machines that facilitate further development. In 1936, these settlers completed their crowning achievement, Hoover Dam, which brought the control of the mighty Colorado River into human hands. The water impounded by the Hoover Dam is stored primarily in Lake Mead, the largest reservoir in the U.S. with the capacity to retain nearly thirty million acre-feet of water (Bureau of Reclamation 2015). This water feeds cities across the West, but is still an inadequate supply for cities like Las Vegas, Nevada, which must search for and tap additional sources. Outgrowing a river's capacities to support life and finding new water sources are recurring themes of western society and river systems. The Santa Fe River reflects these western trends driven by water scarcity and societal development.

The Santa Fe River sat impounded with a silent flow of piped water to the city, but this wasn't enough to fulfill the city's thirst. The capital city's water needs surpassed the amount of surface water the river could produce by the 1940s (Borchert 2010). Santa Fe had to search for more water. As David Groenfeldt (2014) describes the situation, "this is not about water management, it is about getting more water". The city was controlling the river, but still had to collect more water. They decided to look beneath their feet; the city's pipes were aimed at groundwater.

❖ Groundwater ❖

Wells and groundwater were by no means a new concept for Santa Feans, "the use of private hand dug wells as a source of domestic water supply for individual households most likely dates back to the settlement of area by the Spanish settlers during the early 1600s" (New Mexico State Engineer Office 1978, Vol. II, xix). However, groundwater had never played a prominent role in the municipal water supply. When surface water supplies were dangerously dwindling in 1946, a well was drilled in the city of Santa Fe to relieve the pressure (New Mexico State Engineer Office 1978, Vol. II). By 1978, five more city wells were drilled, providing a total maximum of 4,865 acre-feet of water per year for municipal use (New Mexico State Engineer Office 1978, Vol. II)

As the city continued to develop, the successor to the Santa Fe Water Company, Public Service Company of New Mexico (PNM) began construction of the Buckman well field located 15 miles northwest of the city near the old town of Buckman (Wilson et

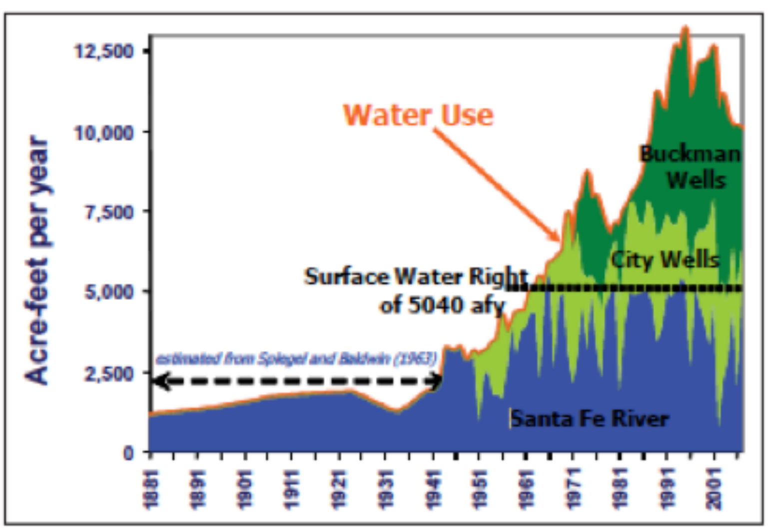


Figure 3.1 City of Santa Fe's Historical use of water (1881-2005). Source: Borchert 2010, 39.

al. 1979). PNM is the state's largest utility company and built the majority of the groundwater system of Santa Fe. From 1950 to 1979 over 40,000 acre-feet of groundwater was withdrawn through their wells (Wilson et al. 1979). The Buckman well field has become the city's primary source of groundwater. Figure 3.1 displays the city of Santa Fe's historical water use. This figure shows the large quantity of water that began to be pumped from the Buckman wells beginning in the early 1970s.

The City and Buckman well fields are the major sources of groundwater for Santa Fe, but private wells are still scattered across the groundwater basins. In a Hydrographic Survey of the Santa Fe River in 1978, the State Engineer of New Mexico office found 1,238 domestic and/or stock water wells (Vol. II, 1978). Currently, there are a couple thousand private wells, which remain relatively unmonitored and unregulated, a disconcerting fact when put in the context of how tight Santa Fe's water supplies are. Rick Carpenter (2014), the city of Santa Fe's Water Resources and Conservation Manager, explains the difficulty in monitoring private wells, "people don't want the government coming in on their real property investment and limiting it". Many would like to give the State Engineer jurisdiction to monitor the wells, but there is resistance from many homeowners who don't want to lose the fiscal value the wells bring to their property.

The dilemma surrounding private wells is based in a historical argument on how groundwater should be allocated. The homeowners' resistance is supported by the common law or English doctrine. The English doctrine emphasizes that the "water is the absolute property of the owner of the overlying land in perpetuity" (Gopalakrishnan 1973, 67). They believe that they have exclusive right to use any water that lies under their property in the manner they desire. This doctrine is still the ruling law for groundwater in Texas. However, the state of New Mexico recognizes the prior appropriation interpretation of groundwater rights. The prior appropriation interpretation views the water under your house as part of a larger underground water basin; therefore, who can use it is determined by who has the most senior right. In New Mexico, declarations of groundwater basins by the Office of the State Engineer in the 1950s established this prior appropriation style of groundwater allocation.

Excessive groundwater use is a dangerous game. The quantity of water in an aquifer, how it recharges, and how long it takes to recharge are difficult to compute and vary by location. Generally, it is easy to over pump and hard to recharge. Santa Fe consumption of groundwater has increased exponentially since the 1940s (see figure 3.1) and is having noticeable effects on the water tables and the river itself. According to Lee Wilson and David Jenkins (1979), Santa Fe's water tables historically lowered at a range of .5 to 2.8 ft. per year. They also point out that it is evident that the water table has lowered from "the fact that many springs and cienegas along the Santa Fe River have dried up over time" (Wilson et al. 1979). Although it is less obvious than surface water use, groundwater use alters the Santa Fe River. Balancing surface water and groundwater use is a delicate act for the city, one that greatly affects the lives of the Santa Feans and the river.

Conjunctive water management of surface and groundwater is complex. It is a search to sustainably use both surface water and ground water supplies. In Santa Fe's case, this is part of Rick Carpenter's job as the city of Santa Fe's Water Resources and Conservation manager. Carpenter believes that too much water has been sucked out of the aquifers, thus they should be given time to recover. He is trying to manage the city's water use in a way that allows the Buckman well field to recharge. Nevertheless, he doesn't plan to decrease the consumption of the city well field. Carpenter (2014) explains that they have "always pumped the maximum water right of the city wells, and that's probably never going to change because it's cheap water and in the middle of town so it is easy to distribute to our customers". The Buckman wellfield is the one that is dramatically losing water. To give the Buckman well field time off and meet the city's water demand, Carpenter and the city searched out an additional surface water source from outside of the Santa Fe River watershed.

❖ Buckman Direct Diversion ❖

The Buckman Direct Diversion Project (BDD) is an extensive piped system that transfers 8,730acre ft. of surface water from the San Juan River to the Santa Fe area (Civil engineering 2008). The city of Santa Fe receives 60% of San Juan surface water, Santa Fe County 19% and residential community of Las Campanas is allocated 21%. The city of Santa Fe has had rights to San Juan-Chama water since the early 1970s, but hasn't had an avenue to use this water right until the construction of the BDD (Civil Engineering 2008). The San Juan-Chama project and the BDD pipes this water over 350 miles to reach the capital city (see figure 3.2). The BDD project went online in 2010 and has provided relief to the city's dependence on the Santa Fe River surface water and the aquifers. It gives the city a greater diversity of water resources, which provides it with flexibility to conjunctively manage its water supplies and makes it more resilient to climatic events. Nevertheless, the BDD expands the Santa Fe's hydrologic machine and distances citizens even further from their water sources.

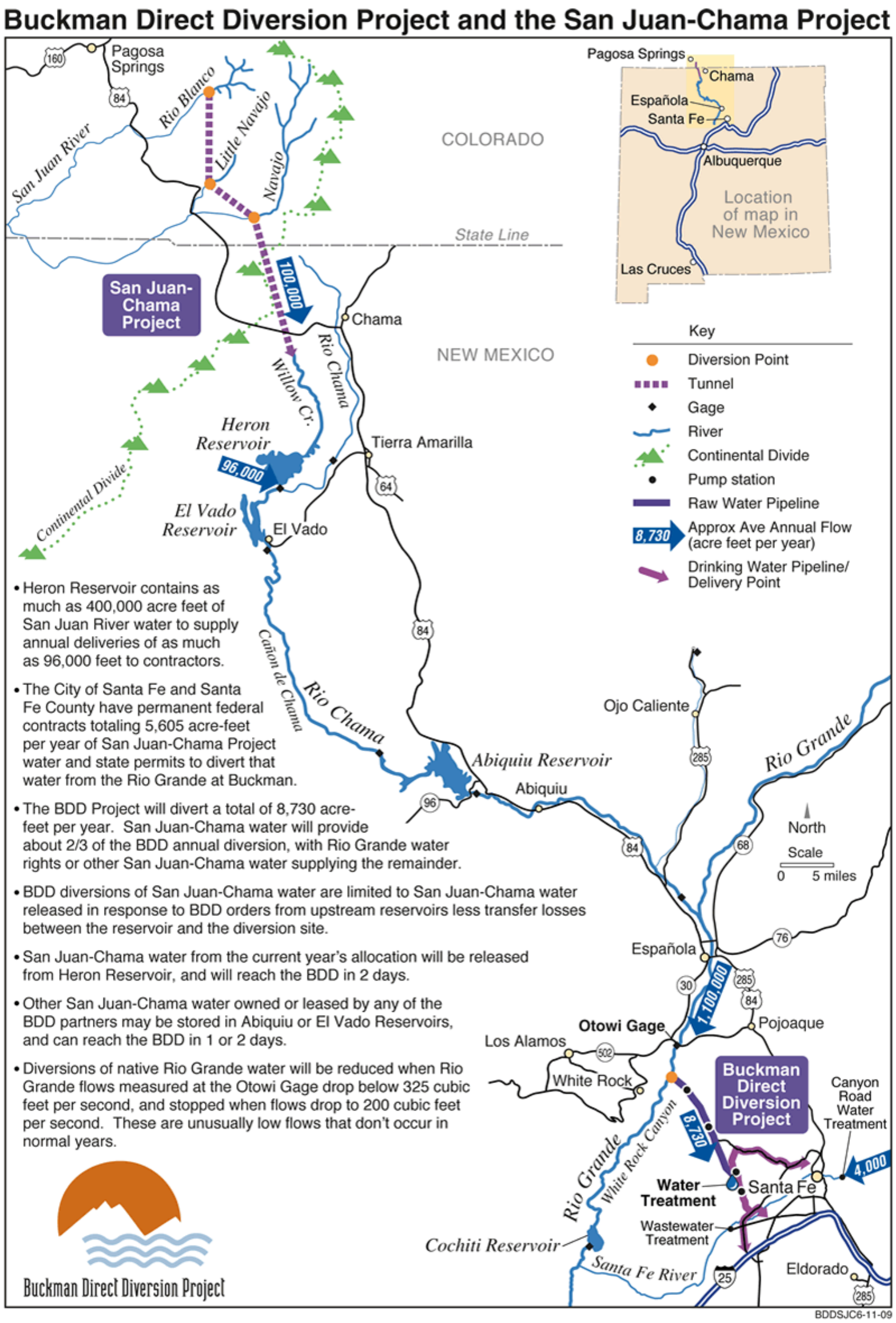


Figure 3.2 Schematic map of San Juan-Chama and Buckman Direct Diversion projects. Source: Buckman Direct Diversion 2008.

❖Conservation ❖

Santa Fe has become a national leader in water conservation. Santa Feans were using 167.5 gallons of water per capita per day in 1995 (see figure 3.3), which has been reduced to a present day consumption of 101 gallons and the goal is 85 (Rick Carpenter 2014). This saved water would have otherwise had to be produced to keep the city supplied. Rick Carpenter (2014) views water conservation as a "pseudo resource" and "the cheapest source of water". This gives the city a motive to conserve water aside from the environmental benefits it brings. The decline in water consumption is inversely related to the population growth of Santa Fe (see figure 3.3), a trend that some argue is a road to more development. Regardless, the city of Santa Fe and its citizens have displayed a true commitment to water conservation.

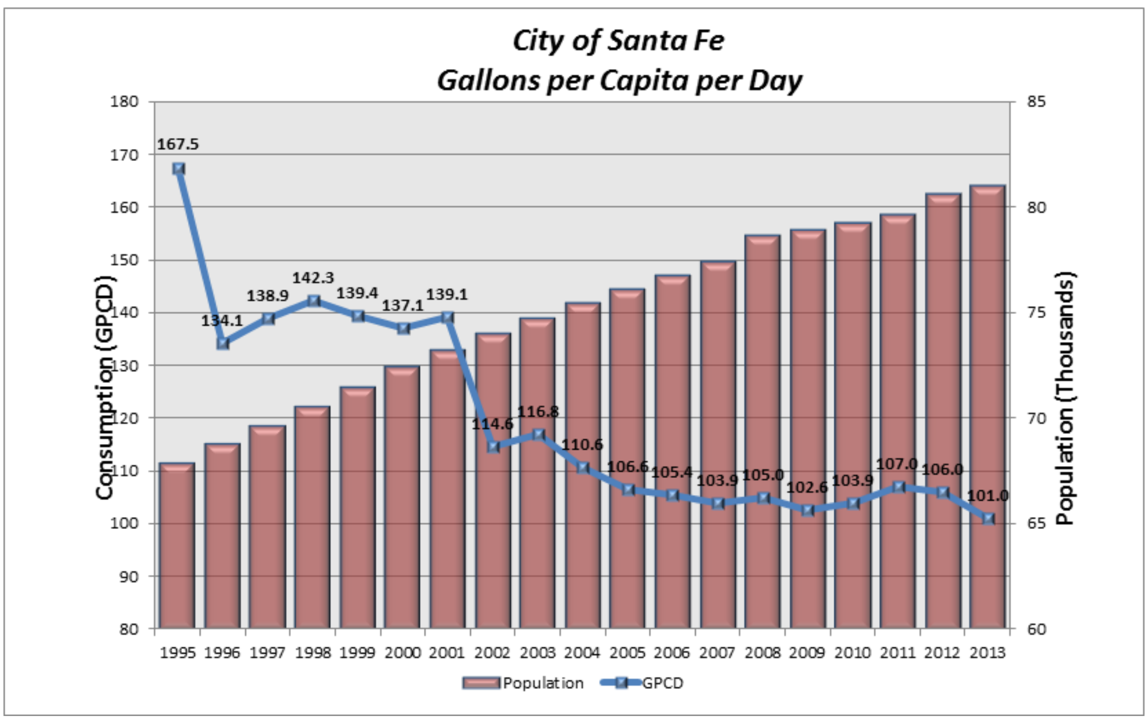


Figure 3.3 City of Santa Fe's water consumption and population growth from 1995-2013
Source: City of Santa Fe webpage

The key to conservation is showing the public its importance and engaging them in it. Carpenter (2014) says the most effective conservation program is, "a very proactive, progressive, aggressive public education campaign to change the culture; the way that people think about water and how to use, save, and value it". In Santa Fe, it appears that the public is receiving the message. They have proved that they are not only willing, but want to conserve water. The city of Santa Fe also urges its citizens to conserve through rebates, retrofits and incentives (City of Santa Fe 2012). Even with these successful conservation programs, Santa Fe is still is looking to utilize other sources like wastewater and storm-water.

❖Where else? ❖

As water becomes even scarcer in the West, cities are scrambling to find different avenues to acquire water. Other cities are using treatment plants to clean wastewater. Most wastewater is treated to be reclaimed wastewater or 'gray water' that is not potable, but has many uses. The city of Santa Fe has a wastewater treatment plant (WWTP)

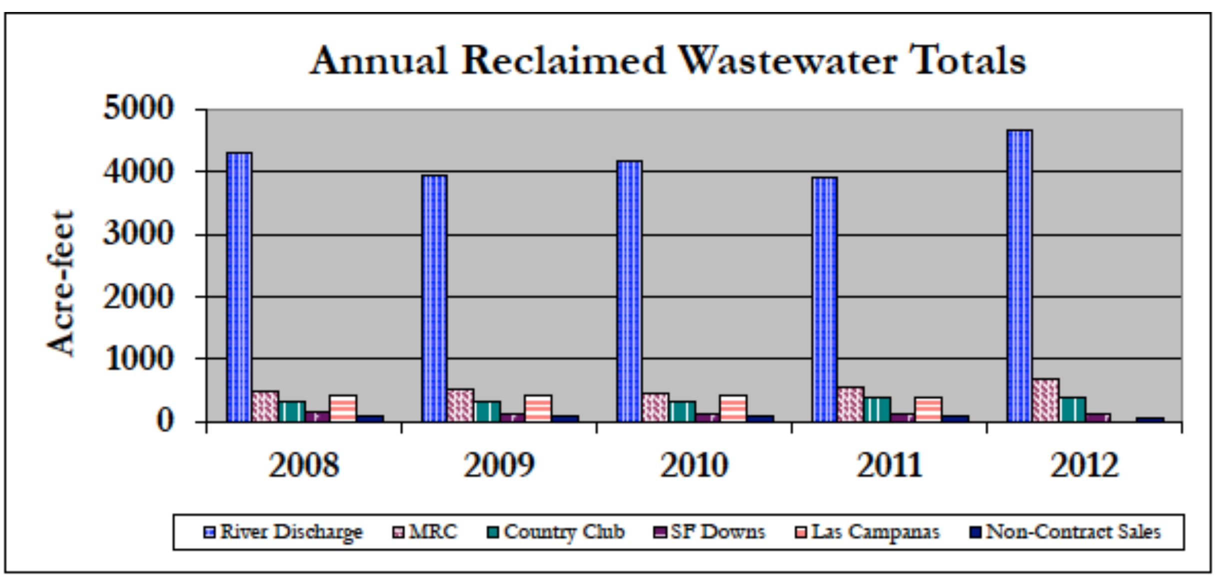


Figure 3.4 Total annual reclaimed wastewater uses (2008-2012) Source: City of Santa Fe 2012, 29

along the Santa Fe River downstream of the city. Figure 3.5 shows the outer wall of the WWTP. Reclaimed water from this plant is used for dust control, irrigation and watering of parks and public spaces, and enabling flow in the Santa Fe River downstream of the WWTP (City of Santa Fe 2012). In 2012, 21% of the wastewater was reused and the remainder was sent down the river to support river and riparian ecosystem, and local agriculture (City of Santa Fe 2012). The large sum of wastewater (nearly 5000 acre-feet in 2012!) that is sent down the Santa Fe River creates the only perennial stretch of the river below the reservoirs.

Figure 3.5 Santa Fe's Wastewater Treatment Plant Photo by author (2014)

Cities are also working to more effectively collect storm water. The Southwest receives a large portion of its water from large storms that quickly drop large amounts of water. This primarily happens during the monsoon season that lasts from July to early September and is characterized by isolated thunderstorms that arrive in the afternoon. These downpours are not only difficult for people to use, but many times produce destructive floods. Cities are searching for ways to harness these storms into a safe water resource; however, currently for many it is one of the last resources that turn to.

The city of Santa Fe has deprioritized storm water use for the time being. Nevertheless, many people are urging water managers to look seriously at storm water now. Andy Otto (2014), the Executive Director of Santa Fe Watershed Association, believes that it is time for storm water to be "taken off the shelf and examined for its potential as a real resource".

Since humans' first arrival in the Santa Fe area, they have manipulated the landscape for its water. Simple diversions advanced to dams that retained the entire Santa Fe River's flow and eventually groundwater and distant waters were obtained to fill their growing thirst. Santa Fe is a microcosm of urbanization in the West that is in a constant dance with water scarcity. As Reisner describes the West, "one does not really conquer a place like this. One inhabits it like an occupying army and makes, at best, an uneasy truce with it" (1986, 4). A truce involves negotiation. In the case of the rivers and the environment, river advocates are their proponents and restoration efforts their victories. In the late 20th and early 21st centuries, a remarkable story of awareness and restoration has unfolded in Santa Fe and along its riverbanks.

Chapter 4
Towards a Living River

"Can you personify the Santa Fe River for me?"

"Clear blue eyes…a resilient quality… emaciated but the eyes reflect an inner core that is alive."

—Claudia Borchert 2014

The relationship between humans and the Santa Fe River is a long, complex history. The condition of the Santa Fe River and its role in the environment has changed greatly through the development of different cultures and settlements around it. What is now recognized as the Santa Fe River hardly resembles the river seen in 1610 or 1848 or even in the early 1900s. Since the 1980s, restoration efforts have attempted to improve the health of the river ecosystem. These projects demonstrate a shift in the human-Santa Fe River relationship where people are now speaking for and acting in favor of the river.

This chapter presents a timeline of moments in these human-Santa Fe River relationships that affected the life of the Santa Fe River (figure 4.1) before discussing restoration efforts. Later, the restoration projects are categorized into surveys and reports, ecologic rehabilitation and outreach. Each section includes discussion of a few specific efforts, but it is not an all-encompassing list of restoration efforts. There are many more worth discussing, but this provides an overview of the type of work done on the Santa Fe River.

Flowing through Time

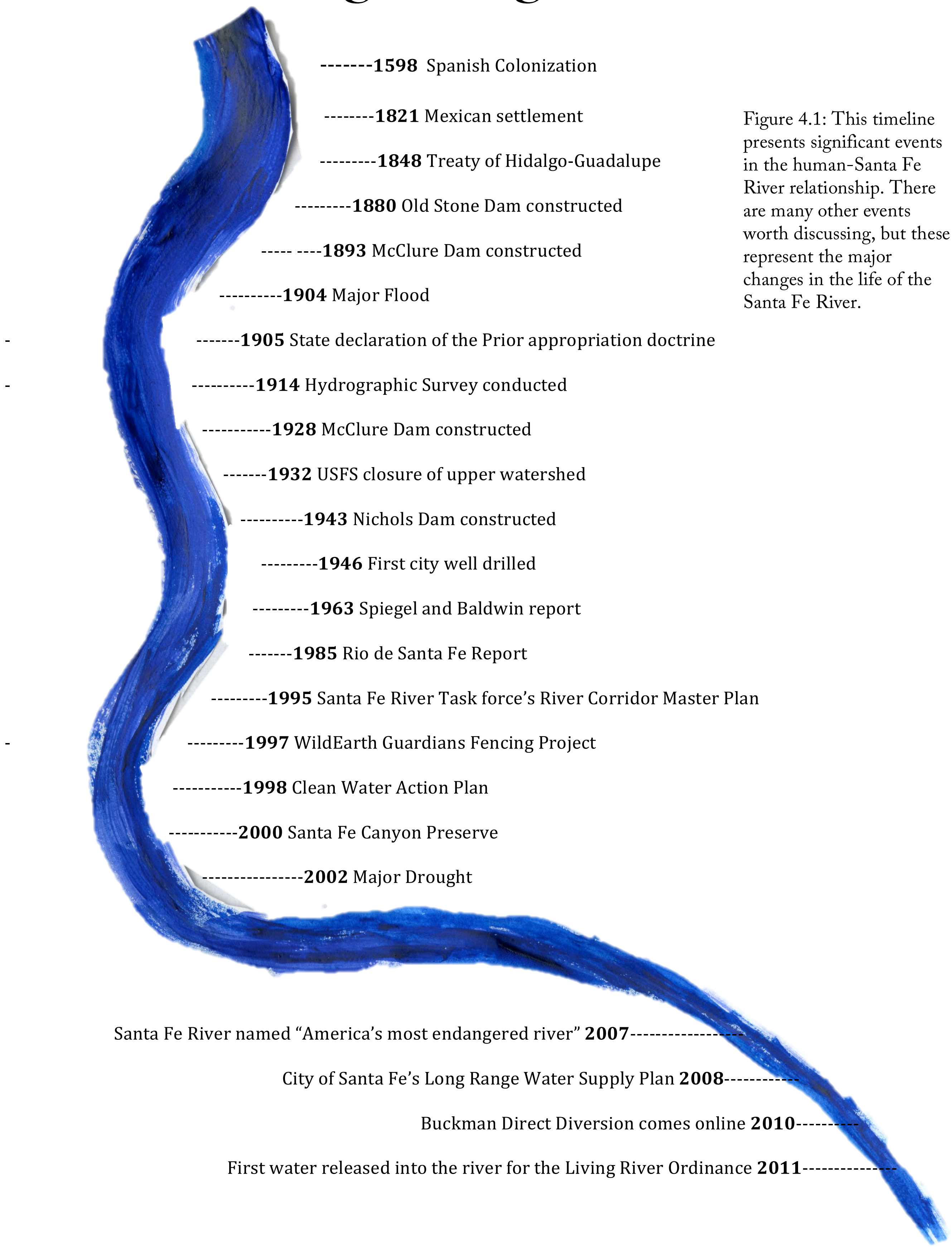


Figure 4.1: This timeline presents significant events in the human-Santa Fe River relationship. There are many other events worth discussing, but these represent the major changes in the life of the Santa Fe River.

❖ Surveys and Reports ❖

Surveys of the Santa Fe River are crucial to understanding its changing state. The reports published from these surveys inform water managers and the citizens of Santa Fe of the river's role in the community. Various organizations and people have conducted surveys each having differing impetuses to start them. These reports and surveys are important in understanding how people view the Santa Fe River and why they may be concerned about it.

In 1913, the water users in the Santa Fe Creek Valley signed and presented a petition to the Attorney General of New Mexico requesting a hydrographic survey of the Santa Fe Creek as it was then called (State Engineer's Office 1919). They wanted to know exactly where, how and by whom the Santa Fe River surface water was used. Water was scarce and their crops and property values depended upon it. Therefore, they pleaded for a hydrographic survey that would "enable you [State Engineer James French] and the Courts to fix and determine the extent, character and proportionate part to each in the legal right to said waters as in such cases the law warrants"(State Engineer's Office 1919, 5). The State Engineer's Office conducted the survey in 1914 and compiled the results in a report published in 1919.

The 1919 Hydrographic Survey of the Santa Fe Creek was the first report that tracked the use of the river water and made suggestions for more efficient water management. It found that 5,701 acre-feet of river water irrigated a total of 1,267 acres of land in 1914. That sum of water should have been able to irrigate 1,900 acres assuming that the normal duty of three feet of water per acre was employed. The report states that some of this water may be lost through seepage and evaporation in the ditch channels. To combat the issue it suggested that some channels should be eliminated and others extended to make the system more effective.

The report also pointed out that the city of Santa Fe with a population of 7,000 was consuming 223 gallons of water per day per capita. In 2013, Santa Fe had over 80,000 residents, but only consumed 101 gallons per day per capita (see figure 3.3). The fact that per capita use decreased by more than half in the past century is a testament to Santa Fe's long-term commitment to conservation and water use efficiency. It also speaks to the decrease of Santa Fe's dependence on local, water-intensive agriculture.

The 1919 hydrographic survey of Santa Fe Creek was a landmark in the citizens' relationship with the river. They sought to protect their crops and properties through better understanding of where and to whom all the river water flowed. The end result was a report that exposed mismanagement and inefficiencies in the usage of the Santa Fe River water. This report brought awareness of how the evolving organic machine of the Santa Fe River propelled the city's life.

In 1976, the State Engineer's Office produced an updated Santa Fe River Hydrographic Survey Report. This survey not only investigated all the uses of the Santa Fe surface water, but also the groundwater usage and surface water of the tributaries to the Santa Fe River. The survey was published in two volumes. Volume one completed in 1976 looked at the La Bajada-La Cienega reach. Volume two was finished in 1978 and focused on the city of Santa Fe area.

Changes in Santa Fe are evident in the 1976-1978 report. There were only 36.45 acres irrigated by Santa Fe River surface water out of the 1,267 acres that were in 1914 (State Engineer's Office 1978). This decrease points to a movement away from agricultural towards urban life. Acequia culture and irrigational practices have dramatically decreased in Santa Fe with three acequias remaining today. These hydrographic surveys have been crucial in understanding the 'evolving lifestyles of Santa Fe and keeping the city aware of its relationship with the river.

Zane Spiegel and Brewster Baldwin (1963) conducted a comprehensive study of Santa Fe River. This U.S. Geological Survey (USGS) paper from in 1963 explained the Santa Fe River dynamics through a geologic and hydrologic lens. This scientific data had never been collected before and was crucial in understanding the condition of the Santa Fe River. The survey was conducted in response to a severe 1950-51 drought that revealed the need for information on Santa Fe's water resources (Baldwin and Speigel 1963).

Today, the Surface Water Quality Bureau (SWQB) of the State of New Mexico's Environment Department (NMED) tracks the quality of New Mexico's surface water. Among other regions of the state, the SWQB monitors the Middle Rio Grande tributaries, which includes the Santa Fe River. SWQB first collected data on the Santa Fe River in 1967 and does so every seven years (Seva Joseph 2014). The most recent monitoring survey was conducted in 2014. I had the fortune to accompany the SWQB crew on a field day of 2014 monitoring of the Santa Fe River. The data collected on that day will be published in a 2015 report. They checked eight sites along the Santa Fe River, the furthest upstream being in the upper watershed above McClure Reservoir and the most downstream in La Bajada above Cochiti. Figures 4.2-4.6 are photos taken on that monitoring trip at various locations along the river corridor. The difference in water quality and ecosystem health at the sites is evident in comparison of the photos.

A:

B:

C:

Figure 4.2 (A) SWQB checking the monitoring site in the upper watershed. Pictured: Seva Joseph, Greg Huey, Eric Perramond, Alan Hook and Christian Lejeune (B) Santa Fe River in the upper watershed near the monitoring site.
(C) Caddisfly found in Santa Fe River in upper watershed.
Photos by author (2014)

The United States Forest Service (USFS) closed the upper Santa Fe watershed to the public in 1932. This preserved section of the watershed is in David Coss's words, "one of the highest quality streams in the state"(2014). In figure 4.2 (C) Christian Lejeune of Wetwater Environmental services shows a Caddisfly he found in the Santa Fe River in the upper watershed. Caddisflies are indicators of a healthy stream (Lejeune 2014). SFWA now leads guided tours through the upper watershed to expose citizens to its beauty and educate them about the watershed.

A:

B:

C:

Figure 4.3 Santa Fe River in urban stretch near Sandoval St.
(A) Greg Huey testing waters (B) Santa Fe River (C) View of Santa Fe River corridor from street
Photos by author (2014)

The Santa Fe River in the urban stretch of Santa Fe looks vastly different than it does in the upper watershed. Figure 4.3 (B) shows the murky green water of the Santa Fe River in this stretch while in (A) Greg Huey collects data on the water quality. The depth of incision of the river channel and its concrete walls can also be noted in figure 4.3 (A). Nevertheless, while at the urban monitoring site, a child walking along the road exclaimed, “oh, it’s a pretty river!” and her mother responded with a sarcastic tone, “sure is a pretty river”. Figure 4.3 (C) shows a view of the Santa Fe River corridor from the street looking down at the section where SWQB monitored. The river corridor is landscaped and vegetated, which may be what the child appreciated. While figure 4.3 (B) shows the actual unappealing state of the river itself, which the mother may have been commenting on. This anecdote demonstrates the differing views citizens have of the Santa Fe River.

Further downstream the WWTP releases treated, effluent water into the Santa Fe riverbed. Upstream of the WWTP at El Camino Real Park the river is nonexistent as pictured in figure 4.4. Figure 4.5 shows Seva Joseph of SWQB testing the effluent water that is flowing out of WWTP, which is shown in the upper right of the photo.

Figure 4.4 Looking upstream at the dry Santa Fe Riverbed at El Camino Real Park. Photo by author (2014)

Increase in vegetation below the WWTP shows the impacts of the large quantity of effluent water sent down the river channel (see figure 3.4 for release amounts). The running river and lush riparian corridor below the WWTP is a direct construct of human waste. The city created this flow that is only considered the Santa

Figure 4.5 Seva Joseph testing effluent water flowing out of the WWTP. Photo by author (2014)

Fe River, because it fills the Santa Fe Riverbed. This part of the River best reflects Santa Fe's influence in the local hydrosocial cycle. The Santa Fe River as a whole including this perennial stretch is being recognized as unhealthy and in need of restoration.

In 1998, President Bill Clinton announced the Clean Water Action Plan, a nationwide initiative to protect America's waters (United States Environmental Protection Agency 2015). Among other requirements, each state had to produce a Watershed Restoration Action Strategy (WRAS) for the priority watersheds identified in their statewide Unified Assessment (Grant, 2002). New Mexico's Unified Watershed Assessment classified Santa Fe River watershed as Category I watershed, designating it as one of the state's watersheds that most urgently needs restoration (Grant 2002). In 2002, the first edition of Santa Fe's WRAS was published. It was primarily authored by Paige Grant, the founder of Santa Fe Watershed Association (SFWA), but was developed through public outreach, watershed assessment/inventory, monitoring and evaluation, defining specific water quality problems and goals, defining actions to obtain water quality goals, outlining an implementation schedule, and funding (Grant 2002). It provided recommendations for restoration efforts and created impetus for them to be achieved.

❖ Ecologic Restoration ❖

Many restoration projects focus on improving the health of the Santa Fe River corridor. These efforts are led by different groups: the USFS, the City of Santa Fe, WildEarth Guardians, Nature Conservancy, Santa Fe County, SFWA, and Bureau of Land Management (BLM). The majority of them are aimed at improving specific sections of the Santa Fe River, not the watershed as a whole. Unfortunately, the lack of coordination between the projects hinders the overall restoration process, “the different levels of involvement create a river that lacks coherence and efforts are less effective, given the need for continuity within functioning stream systems” (Plewa 2009, 295). Collaboration to restore the river system as a whole is necessary to have a Santa Fe River that has a unified corridor. Regardless, these restoration efforts have been influential in improving the life of the Santa Fe River. I will discuss two ecologic restoration efforts that delivered real, observable outcomes, one led by the WildEarth Guardians and the other by the Nature Conservancy.

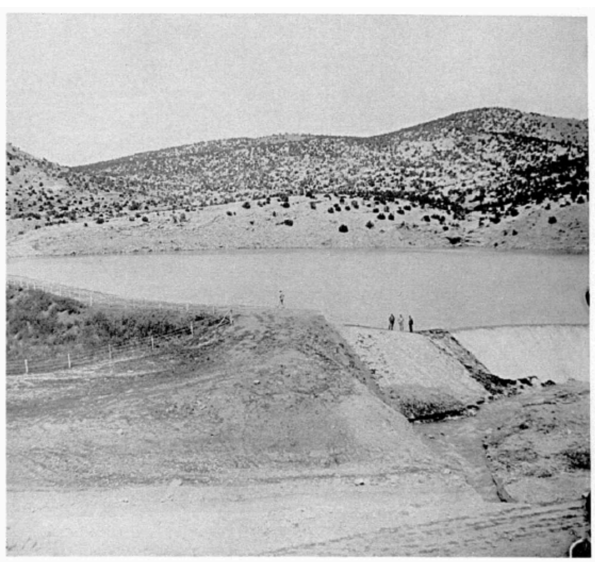
The Santa Fe River was impaired with significant water quality issues in the reach below the WWTP. Cattle grazing and WWTP discharge contributed to the contamination marked primarily by unacceptable pH, sedimentation and dissolved oxygen levels (Guevara 2011). In 1998, the WildEarth Guardians collaborated with the Municipal Airport to fence off livestock grazing from the riparian zone. In 2000, WildEarth Guardians expanded the fenced area onto city of Santa Fe land (Guevara 2011). Since then, with continual restoration work the once barren riparian zone has blossomed into a flourishing, healthy one. Even a beaver pond was reestablished as

Figure 4.6 Beaver pond along Santa Fe River below WWTP, looking East from highway 56. Photo by author (2014)

picture in figure 4.6.

In 2000, PNM donated land in the upper Santa Fe River watershed to the Nature Conservancy. With an additional donation from developer Ralph Brutsche, the Nature Conservancy obtained ownership of 525 acres of land just below Nichols Reservoir (The Nature Conservancy 2015). They converted the land into a preserve and have been working to restore it since. This preserve, the Santa Fe Canyon Preserve, includes the ruins of Old Stone dam and the remnants of Two Mile Reservoir. Figure 4.7 (A) shows Two Mile reservoir in 1914 and (B) displays the same area but in 2014 as the Santa Fe Canyon Preserve. The Nature Conservancy established a 1.3-mile hiking loop through the beautifully revived riparian zone and around the dam ruins. This trail is open to the public and includes informational signs about the history of the area. Figure 4.8 features a couple enjoying a walk on the loop trail.

A:



B:

Figure 4.7 (A) photo of Two Mile reservoir taken in 1914 looking Southeast. Source: Fray Angélico Chávez History Library (B) photo of Santa Fe Canyon Preserve in 2014 looking Northwest. Photo by author (2014)

Figure 4.8 A couple walking the loop trail in Santa Fe Canyon Preserve.
Photo by author (2014)

The Nature Conservancy has made the Santa Fe Canyon Preserve a space for people to reconnect with the Santa Fe River by reviving this section of the river corridor and making it accessible to the public. The children in figure 4.9 are examples of how the Canyon Preserve allows them to build relations with the river corridor. They are in an art and nature camp that uses the Santa Fe Canyon Preserve as an outlet for experiential education.

Figure 4.9 Children constructing a shelter and playing in the Santa Fe Canyon Preserve. Photo by author (2014)

❖ Outreach ❖

Restoration can be defined as "the act of bringing back something that existed before" (Merriam-Webster.com). Restoration of the Santa Fe River not only aims to bring a river corridor back to a life, but also strives to bring back the relationships between the humans and Santa Fe River that existed previously. Early Pueblos, the Mexican town, Spanish colony, and early U.S. settlement that existed around the Santa Fe River all recognized the river as the artery that sustained life in the area. As the city of Santa Fe grew, the Santa Fe River diminished into a silent ravine and human's relationships with it dissipated into forgetfulness. Restoration efforts mark a remembrance of these past versions of relations with the river and a desire to bring them back to life.

Many restoration efforts on the Santa Fe River incorporate an outreach element that attempts to bridge the gap between people and the river. These efforts like the Santa Fe Canyon Preserve create avenues for people to establish relations with the river. In the past few decades, a full-length river trail has been sought after by several organizations. Figure 4.10 is a map of the Santa Fe area displaying the completed sections of the Santa Fe River Trail. The map includes the San Ysidro, Frenchy's Field, Alto Park, Patrick Smith Park, Adam Armijo Park, and Santa Canyon Preserve trailheads.

There is also an annual Kid's fishing derby on the Santa Fe River where children and families get a chance to recreate on the river. The event first occurred in 2008 and is organized by a collaboration of groups including SFWA, the city and county of Santa Fe. The river is stocked with about 500 trout for the event (Mueller 2013). Many elders fondly remember fishing trout on the Santa Fe River as a child. The local trout

population no longer naturally lives, but the derby allows today's youth to share the experience. This event can occur because the city releases water from the reservoirs into the river. The sole purpose of theses releases is recreation in the fishing derby. However, in the past decades there have been plans and projects to conduct larger, more sustained releases to support a living Santa Fe River.

Figure 4.10 Map of Santa Fe River Trail. With blue lines indicating trails

Trailhead: 

Source: https://www.google.com/maps/d/viewer?oe=UTF8&ie=UTF8&msa=0&mid=zlEMyR2jDPtY.kVvSjogqhzQk

❖ Reviving the Santa Fe River ❖

Humans have always had a take relationship with the rivers in the West. Giving some of the water back to the rivers or even leaving some in it for the river's sake is seldom considered in water management. The climate is arid, water is scarce and rivers are the veins of life. However, the western inhabitants cling to the river water so tightly that leaving any water in the channel is seen as wasteful.

The 19th century anthropocentric ideals engrained in prior appropriation left no room for 20th century instream water rights. This close-minded view began to give way as environmentalism grew in the West in the 1970s. However, New Mexico was especially opposed to leaving water in the river as Denise Fort (2000, 155) explains, "New Mexico has often been cited as the last holdout in the West against instream flow rights". In the past couple decades, a crack has been forming in this mentality in New Mexico. Santa Fe has been working towards building a *give* and take relationship with the Santa Fe River. The city is figuring out how to include water rights *for the river* into their water management in a manner that is sustainable for the city and the river. Santa Fe's progress thus far has made it an example for the rest of the state to follow.

In 1985, the first recommendations for rehabilitating the river came in the Santa Fe River Committee's Rio de Santa Fe report (Plewa 2009). This plan included several ideas for projects to stabilize banks, restore vegetation and emphasized the importance of having water flowing in the river. Unfortunately, this plan was never sanctioned and has been criticized for presenting beautified depictions of the Santa Fe River with concepts that did not properly fit its natural hydrology (Plewa 2000). Regardless, the Rio de Santa

Fe report brought to light the need to take care of the Santa Fe River and established a precedent for creating projects that focused on its health.

The Rio de Santa Fe report was released after the Attorney General's office issued an opinion that instream flows were beneficial under state law in 1984. The informal opinion came from an assistant to the Attorney General, but the Office of State Engineer still held that instream flows would not be recognized under New Mexico law (Fort 2000). The Rio de Santa Fe report and the informal opinion from the Office of the Attorney General made no real changes; however, the crack in the wall that impounded instream flows was growing.

The next big step in river revitalization came in 1995 with Santa Fe River Task Force's River Corridor Master Plan. The plan strove to "develop a diverse and aesthetically pleasing corridor along the Santa Fe River from Two-Mile Reservoir to the wastewater treatment plant"(Santa Fe 1995, 3). It was one of the starting points for the river walk, which I previously outlined (see figure 4.10). In total, the plan outlined ten goals including riparian restoration, storm water retention, erosion control, and river projects to facilitate interaction between the public and the river. These goals were innovative and brought new perspectives to the relationship between the citizens and the Santa Fe River. It also stated "an adequate amount of continuously flowing water to maintain a reasonable and steady level in the river is absolutely essential" (Santa Fe 1995, 3). This demand for instream flows was a key moment in the life of the Santa Fe River.

The 1995 Santa Fe Corridor Master Plan was adopted by the City Council but never enacted (Groenfeldt 2010). It still provided a template to revive the Santa Fe River.

How to actual bring water back to the river was not yet conceived as Claudia Borchert (2014), a former city of Santa Fe planner, explains,

> [The 95 master plan] was all about the infrastructure, about the corridor itself, but nobody was addressing the water piece. We could put boulders in here; we could make it look like this; we could revegetate. Certainly there was the desire, 'Wouldn't it be great if we had water'. There wasn't really an understanding of what that would take.

The desire and call for a living Santa Fe River was present in the 1995 Master plan but the structure to bring the flows wasn't yet understood. Regardless, the plan brought fresh ideas for river restoration and garnered momentum to bring life back to the Santa Fe River.

Another important moment for Santa Fe River occurred in 1995 when the city purchased the private water utility. The new publicly owned Sangre de Cristo Water Division allowed for more cohesion in the city's utilities. Tara Plewa describes, "improved coordination was now possible between the city's land, water and planning offices" (Plewa 2009, 304). This coordination provided the potential to collaboratively construct a plan to revive the Santa Fe River.

In 2004, the city of Santa Fe drafted a long-range water supply plan to secure a reliable water supply that could sustainably support Santa Fe's needs (City of Santa Fe 2008). The city waited until 2008 to finalize the plan when key federal and state permits for the BDD were obtained (City of Santa Fe 2008). The 2005 findings were updated to include analyses of the 2008 supplies. The city realized that the primary change in those three years was the immense increase in water conservation (City of Santa Fe 2008). The intensive conservation program and the citizen's impressive commitment created a new supply for the city. This conserved water opened doors in Santa Fe's water management. Borchert (2014) describes this newfound flexibility,

> The conservation programs were so successful that it actually allowed me as a planner to say 'you know we have saved so much water that people are not using anymore that the idea of putting some into the river is actually somewhat feasible. Let's analyze it. The long range supply plan analyzed it.'

For the first time, the city of Santa Fe had the ability to analyze their water supply with the thought of possibly assigning a portion of the water to improve the life of the Santa Fe River.

The city of Santa Fe's 2008 Long-Range Water Supply Plan included analyses of the city's water supply and plans to ensure that the city had a reliable water supply up to 2045. Figure 4.11 displays the historical and projected water resources for the city and shows that the Santa Fe River surface water (represented as Canyon Reservoirs) plays a significantly diminished role in the city's water supply, because the water supply has diversified and greatly expanded. Figure 4.11 also includes new supplies from the BDD (orange and red) coming in around 2011. The increase in BDD water replaces much of

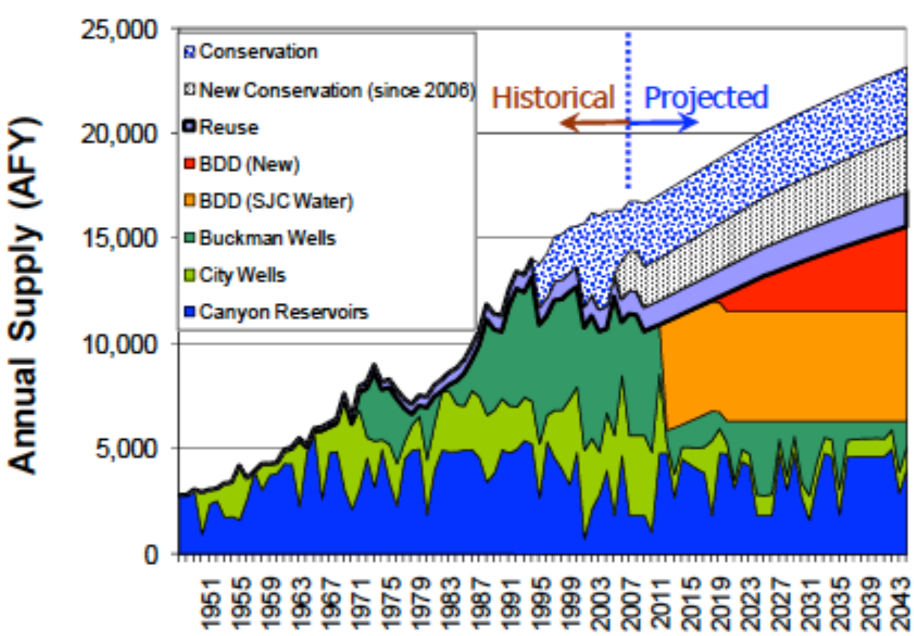


Figure 4.11
Historical and future sources of water supply (1950-2043)
Source: City of Santa Fe 2008

the water supply received from the city wells. The supply from new conservation (dotted gray line) is expected to continue, becoming a reliable source. Figure 4.11 is a reflection of the city of Santa Fe's conjunctive water management strategy.

The 2008 Long-Range Water Supply Plan outlined eight major policies including a commitment to continue and improve the conservation program, and also stated, "the city will provide water to maintain a living Santa Fe River, except under drought of emergency conditions" (ES-4). The city concluded that there was enough water to place some of it back into the Santa Fe River. The plan called for the release 1,000 acre-feet of water from the reservoirs that could not be diverted or consumed. The plan states that the releases are "for aesthetic, ecological and recreational purposes"(1-7). This was the first time in New Mexico history that instream flows were respected in a city management plan. The capital city and its citizens proved that they are dedicated to a small, but living Santa Fe River.

❖ A Living River ❖

The dream of having the Santa Fe River flow freely through the capital city has been in the minds of citizens for decades (Bello 2010). In the past several years, the pieces to actualize their desires for a living Santa Fe River have been coming together.

The water releases outlined in the 2008 Long-Range Water Supply Plan were first implemented in 2011 after the BDD went online. The city aims to return 1000 acre-feet of water per year to the Santa Fe River. This plan is referred to as the Target Flow Ordinance or the Living River Initiative. The amount of water released can be adjusted depending on how full McClure and Nichols reservoirs are and can be completely halted in times of drought. For example, in 2014, the city expected the water supply to be 30 percent of full capacity; therefore, they planned to pass 300 acre-feet of water by the reservoirs for the living river (Rick Carpenter 2014). Prior to 2011, the city had actually granted independent resolutions in 2008 and 2009 to bypass seasonal flows for the Santa Fe River (Borchert 2010); however, the Target Flow Ordinance was the first long-term legal commitment to environmental flows. This was an unprecedented policy change for Santa Fe and most of New Mexico. It provides an unique opportunity to see "what makes policy changes happen because the Living River is a big policy change" (Claudia Borchert 2014). The political steps taken to create the Living River should be scrutinized for lessons that other dry regions can learn from.

It is important to understand how this historic initiative was realized before discussing how it affects the life of Santa Fe River, the city and relationship between the two. The decades long conversations about a living Santa Fe River built the drive and anticipation for a change in the human-Santa Fe River relationship, but several questions had to answered to create the desired flow. What would initiate the campaign to revive the river? Who would provide the political will to respect instream water rights? Would citizens rally around the cause? Where would the water come from? How much water would be released? When and how would it be released? Why should there be water in the river? What benefits would it bring?

Crises are catalysts for change. Santa Fe experienced droughts in 1996, 2000, 2002 and 2004. The 2002 drought was especially threatening for Santa Fe. David Coss (2014), a city councilor at the time, depicts the period, "we were a few million gallons away from not being able to meet demand in the middle of the summer [of 2002]". Santa Fe barely skirted a complete water crisis. According to Coss, the city overreacted in its immediate response to the drought. They told the citizens they couldn't water their lawns; the citizens responded, "'if we can't water our yards, then the city can't water its parks'"(David Coss 2014). The city listened. They ceased watering the parks, which ended up nearly killing the vegetation of sixty city parks (David Coss 2014). The capital city's water supply appeared to not be resilient enough to face climate change. Santa Fe needed to construct long-term solutions, not momentary reactions. The city and citizens of Santa Fe decided to improve the water supply's resilience through diversification of water resources and conservation.

The city of Santa Fe strengthened and expanded their water resources. Rick Carpenter and the city began aggressively revamping the city's water utility, "we started hiring people. We started planning. We spent a lot of money" (Rick Carpenter 2014). The city upgraded the canyon road treatment plant, built the Buckman Direct Diversion and added four Buckman wells among other works. Those major projects cost the city 12.5 million, 221 million and 12.5 million dollars respectively (Rick Carpenter 2014). The money came from federal and state grants, and high water rates. Figure 4.12 shows the water rates of 30 major U.S. cities from 2010-2013. Santa Fe's prices surpass the rest to an extent that the Santa Fe graphic has a different scale (0-400$) than the rest (0-200$).

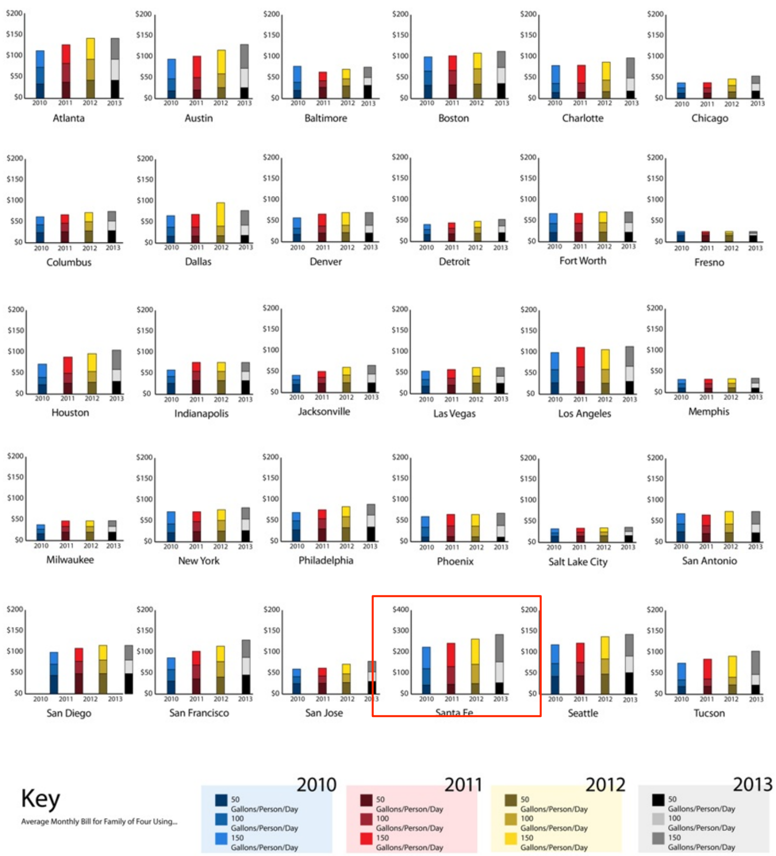
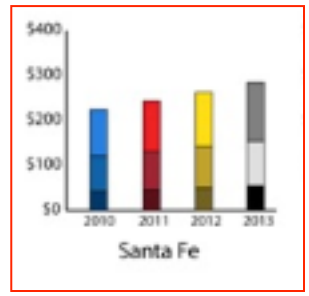


Figure 4.12
Water prices in 30 major U.S. cities 2013. Source: Infographic © JInah Park/Circle of Blue



The burden on Santa Fean wallets funded an expansion and diversification of the water supply. This monetary commitment has made the capital city more resilient to climate change and helped loosen up water for a living Santa Fe River.

The droughts of the 2000s not only aroused the Water Utility into action, but also the conservation programs. The city and NGOs increased the intensity of their conservation campaigns and the citizens positively responded. Figure 4.13 compares the gallons of water consumed per capita per day of 16 major cities in the West for 2013. Santa Fe consumed 101 gallons per capita, the fewest of the selected cities. These rigorous conservation programs made Santa Fe a leader in water conservation. The water saved from conservation became a new resource for the city, which decided it would allocate some of it for the Santa Fe River. Claudia Borchert (2014) states, "if it weren't for those crises there would have been no conservation programs. There would have been no extra water".

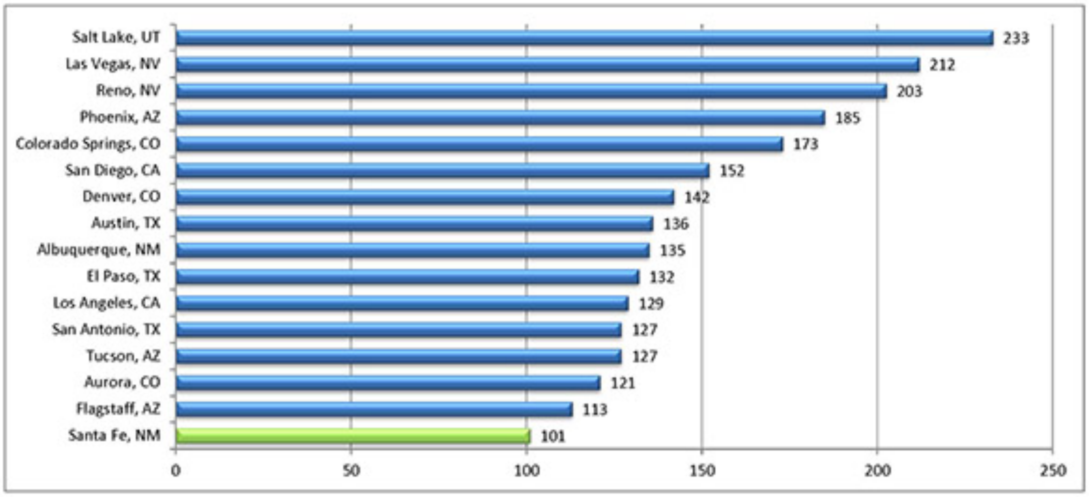


Figure 4.13 Gallons of water used per capita per day for select western cities
Source: City of Santa Fe website

This extra water went towards the Living River Initiative. Ironically, droughts initiated the city of Santa Fe's Water Utility improvement and conservation programs, which led to returning water to the Santa Fe River.

Another piece to the story came in 2007 when the non-project organization (NGO) American Rivers named the Santa Fe River "American's Most Endangered River" of the year. This NGO releases a highly respected annual report of American's top ten most endangered rivers. This national recognition seems nearly over-quoted in Santa Fe River literature. However, David Groenfeldt (2014) who submitted the proposal to American Rivers believes that it provided an impetus for the Living River Initiative. This argument appears to hold water considering that American Rivers described the threat to the Santa Fe River as a "severe lack of water in the river" (American Rivers 2007, 8). This small-scale local problem was pulled onto the national stage, providing even more social pressure for change to occur in Santa Fe's relationship with the river.

The citizens of Santa Fe engaged in the political decisions that led to the Living Santa Fe River Initiative. They spoke for the river in the forming of the Long Range Supply Plan of 2008 and the election for mayor. Claudia Borchert (2014) described a consistent voice at the public meetings about the Long Range Supply Plan of 2008 asking about the future of the Santa Fe River and what could be done for it. According to Borchert (2014), a lot of the people forming that voice were those involved in creating and supporting the 1995 Master Corridor Plan. Active citizens' drive to revive the Santa Fe River flowed from the old plans to the construction of new ones.

The public voice speaking for the Santa Fe River was echoed in the 2010 election for mayor. Mayor David Coss ran for reelection in 2010 with a platform that included a Living Santa Fe River. Coss grew up in Santa Fe and is an environmental scientist; therefore, he had a personal interest in reviving the river. Nevertheless, the residents' desire for a Living Santa Fe River played a large part in making it one of Coss's administration's main priorities. In a pre-election poll, 70-75% of citizens approved of restoring the Living River, a higher approval rating than either his living wage or affordable housing initiatives received (Coss 2014). The citizens of the capital city fervently supported giving a political voice for a living Santa Fe River. Whether they actually cared about the river's health or just economic and aesthetic value that water in the river would bring, the citizens still supported a living Santa Fe River. Mayor Coss won reelection in 2010, a victory in part, for the Santa Fe River.

The Buckman Direct Diversion is frequently believed to be the change that allowed the Living River to happen. That statement has some merit, but is not entirely true. Rick Carpenter (2014) explains," We don't use BDD water for the Living River. But because the BDD is supplying an additional source of water, we have freed up water from the Santa Fe River to send down the Living River". BDD was not formed to revive the Santa Fe River, conversely the Target Flow Initiative was not designed because of the BDD. The water gained from the BDD gives the city flexibility in their water supply, providing water policy space to consider environmental flows.

Others contend that the BDD water is not necessary for there to be water in the Santa Fe River. Paige Grant, founder and former head of Santa Fe Watershed Association (SFWA), is a proponent of this mindset and argues that city always tries to keep the reservoirs at full capacity when they could sustainably manage them with less water retained. Grant and others believe that it is important to keep the reservoirs lower than full capacity so they do not spill over from heavy storm flows (2014). The water not stored would run down the river replenishing the riparian ecosystem while recharging the aquifers.

Groenfeldt (2014) expresses a more radical view on the situation. One of his management ideas includes decommissioning the dams and allowing the Santa Fe River to flow free aside from the present acequia diversions. He (2014) states, "I think that the only way to bring the river back to life is to change the paradigm as the river is supplying the aquifer and we depend on the aquifer. That is our drought insurance. We need drought insurance". This idea sees the Santa Fe River as a hose that feeds the water tank of the aquifer from which the city fills its needs. Although the Target Flow Initiative doesn't bring the groundwater recharge that a dam-less river would, it is a step in that direction. Groundwater recharge is one of the benefits that the Living River Ordinance is expected to be bring to the Santa Fe watershed.

Water in rivers seeps into the soil, water in concrete city systems does not. By releasing environmental flows, a new organic machine could work for not only the watershed, but also the city. The water soaks through the riverbed and snakes down to the aquifers, replenishing the city's natural, underground water tanks. Andy Otto (2014), the executive director of the SFWA, explains, "the environmental flows were designed towards helping out the riparian zone. The first groundwater if you will, right at the riverbed, and then the bigger groundwater recharge".

The Living River Ordinance has only been in operation since 2011. It is hard to ascertain the impact it has had on the groundwater if any. Aquifers take years not days to refill. The path for water to reach an aquifer is long and differs greatly by location. Technology has not yet advanced to provide accurate data of where water seeps to and at what rate. Therefore, the exact impact the Living River initiative is having on groundwater is currently vague at best. Nevertheless, it is widely understood that environmental flows recharge aquifers so results from the Santa Fe River flows should be expected.

The trickle of water released as environmental flows for the Santa Fe River is reviving the riparian corridor in areas. Biologist Jerry Jacobi (2014) notices benefits to the river's health primarily below the Two Mile pond in the Santa Fe Canyon Preserve. Jacobi (2014) observes an increase in Mayflies, Stoneflies and Caddisflies in this region. The riparian ecosystem is resilient and responses quickly to water. Jacobi (2014) explains, “if there is water, critters will come.” There isn’t much recuperation to the riparian ecosystem noted in the urban stretch of the Santa Fe River. The minimal environmental flows from the Target Flow Ordinance are not creating a flourishing, perennial river corridor. But, that may be an unattainable goal for the initiative. Regardless, the environmental flows are attracting some life back to the Santa Fe River.

Perhaps the most apparent change resides in the relationship between the citizens and the Santa Fe River. The citizens have expressed a heightened awareness of the river and its health. If there is water in the river Rick Carpenter’s (2014) phone line becomes busy, “when the River is flowing we get lots of calls, lots of compliments”. This was not an unanticipated consequence of the Living River Initiative, but actually an intention of the project. Andy Otto (2014) explains, “the goal was to connect people to their watershed and their water and to recharge the aquifer. Both of those goals are being met”. Water in the river revives the riparian zone while reconnecting the river and the people it supports.

Photo 4.14 Upper reach of the Santa Fe River between Nichols and McClure Reservoirs, looking west.
Photo by author (2014)

The residents aren't only happy to see the river's new life, but know what it means if water isn't there. Rick Carpenter (2014) describes the situation:

> [The residents] certainly like it when the river is flowing. I think it does [heighten awareness of the river]. They actually see it right before their eyes. When the river is not flowing, they know that it's because there is not enough water to pass through. They are reminded that it's a drought that it's not always going to be there that we need to be good stewards of the environment.

Carpenter echoes Otto's belief that the Living River Initiative is increasing people's awareness of the Santa Fe River and its health. Carpenter also contends that it is helping them understand why there isn't water in the river at times.

Photo 4.15 View of Santa Fe River Bed from the El Camino Real Park, looking east. Photo by author (2014)

The human-Santa Fe River relationship is evolving. Actions in favor of the river's health are being made. New life is trickling into the river, changing the nature of this organic machine. It has gained right, albeit a small right, to its own water. These flows are reviving the riparian corridor of the Santa Fe River and to perhaps a greater extent its presence in the community. However, the living Santa Fe River's future is uncertain. Will the river continue to be granted environmental flows? Will a voice speaking for the river be sustained in water governance? In the face of a potentially drying climate, is it possible to support a living Santa Fe River and growing city?

Increased temperatures, reduced stream flow, diminished snowpack, early spring melt of existing snowpack, intensified climatic events, and more severe and frequent droughts are anticipated in the Santa Fe Watershed according to a report published by Hydrologist Amy Lewis, Karen MacClune and Kari Tyler (2013). These predictions are echoed in assessments of the climatic future of the Southwest. These bleak, dry horizons will usher in a new meaning of water scarcity.

Santa Fe has always felt pressed for water, as David Coss (2014) states, "we've been close to the edge since we've been founded. It seems like we've been adapting for four hundred years". Growing populations in semi-arid and arid environments like Santa Fe has perpetually altered the landscape in search of water to support their expanding demands. Climate change is tightening the water supplies further forcing life to adapt once again.

Some believe that there will not be enough water to continue the Living River initiative. Gray Schiffermiller (2014) of the Surface Water Quality Bureau expresses this opinion, "as much as I'd like to see water in the river…I don't think it's sustainable. The water is over allocated and there has to be some question about prioritizing". There is already not enough water to meet the city's and ecosystem's needs. As water becomes even scarcer, tough decisions will be made choosing who will get it and who won't. Schiffermiller and his colleague Seva Joseph believe that humans are prioritized over the Santa Fe River and environment, and that the flows into the living rivers will eventually be extinguished.

Rick Carpenter bears the burden of making these decisions. His opinion on climate change and the living river does not dispel Schiffermiller and Joseph's argument, "if it [climate change] really affects flows in Rio Grande so that the BDD isn't as productive as it otherwise would have been. Then we're not going to have the *extra water* to release. We will just keep it in the reservoir and use it". The water for Living River is *extra water* meaning that human's needs must be met first then if there is water to spare it will be released into the Santa Fe river. Unfortunately, the BDD can be and has been shutdown. During these periods, water cannot be diverted to Santa Fe. This occurs when the water is polluted with sediment or ash after wildfires, or has high turbidity due to storm flows, making it too difficult and expensive to clean (Rick Carpenter 2014). Increase in fires and large precipitation events from climate change could increase the frequency that the BDD is non-operational.

Climate change could also force the implementation of Article VII of the Rio Grande Interstate Compact. Article VII states that if water in an irrigation project below Elephant Butte reservoir drops below a certain volume then all tributaries of the Rio Grande River must release an indicated amount of surface water (Lewis et al. 2013). The Santa Fe River is technically a tributary of the Rio Grande (although its flow never reaches the Rio Grande); therefore, it is contractually obligated to follow the stipulations of Article VII of the Rio Grande Interstate Compact if it is exercised. Santa Fe has a right to 1,069 acre-feet that would not have to be released, but the rest of the stored surface water would (Lewis et al. 2013, Rick Carpenter 2014). Santa Fe could fulfill this requirement with other water resources such as water gained from the BDD (Lewis et al. 2013). The implementation of Article VII of the Rio Grande Interstate Compact would be immensely detrimental to the city of Santa Fe, the Santa Fe River and New Mexico as a whole.

Aside from the enforcement of Article VII, the fact that environmental flows for the Santa Fe River now have a legally established place in Santa Fe's legislature may be reason enough to keep the Living River flowing. David Coss (2014) elucidates this opinion, " [the 1000 acre feet releases] will stick around. Now that it's a law and they have been through five years of it, staff will just do it". Being authorized as a law the releases will be automatically implemented. This line of thinking understands that policy change is arduous; therefore, the Target Flow Ordinance will remain. Coss' opinion seems to contrast with Carpenter's that states if the BDD isn't productive the environmental flows will be cut off.

On the other hand, Coss (2014) ends that statement saying, "if somebody says, 'Hey, we want to change that law'. Game on". If the Living River does get contested who in the governing body would defend it? That question is what truly concerns Coss, "no one's advocating for the river in the governing body. They are not hostile to it, but it's not their issue"(2014). Coss doesn't see any elected official championing the Santa Fe River. Political will was one of the driving forces that lead to the Living River. During his time as major, Coss spearheaded the governing body in putting water back into the Santa Fe River. If no one in the governing body fills Coss's shoes as a river advocate the Living River ordinance and the overall health of the Santa Fe River may suffer.

Water management in Santa Fe is an art of organizing the use of a limited supply in a sustainable manner while planning for and adapting to uncontrollable climatic behavior. To meet the expanding water demands of urbanization, Santa Fe invented strategy after strategy to squeeze every drop from the water-scarce region. Diversions, dams, reservoirs, pipes, wells and the BDD altered the landscape and placed the control of the environment in human hands.

Santa Fe's recent climatic adaptation resulted in the decision to return some water to the river. Drought motivated the political will, creative policymaking and grassroots momentum that actualized the Living Santa Fe River. Santa Feans proved that to them the well being of the Santa Fe River is important to the community's overall health. Will Santa Fean's sustain their commitment to keep that breathe of life flowing in the Santa Fe River? Claudia Borchert (2014) says the Living River's future "depends on the choices people are willing to make". What Santa Fe decides to do, as policy makers, citizens and humans will ultimately determine the future of the Santa Fe River's life.

Chapter 5
Bridging Rivers: Comparative study of the Wimmera River

"Santa Fe illustrates the larger challenge faced in global governance of giving a fair hearing to the multiple and often conflicting values that affect water in social-ecological systems particularly in the face of climate change"

-David Groenfeldt and Jeremy J Schmidt, 2013

The story of the Santa Fe River is filled with the complex, changing elements of human-river relationships. The lessons from it can be highlighted and expanded when placed in the context of other river systems. The dry climate, long history with human communities and drive to revive the river are a few of the aspects that make the Wimmera River in the state of Victoria in Southeast Australia an appropriate subject for a bi-regional comparative study. I applied the same hydrosocial/organic machine dialectic to investigate the Wimmera River's relationships with the surrounding communities.

During my three week academic excursion to the state of Victoria and the Wimmera region (see figure 5.1), I met and interviewed present and former government officials at federal, state, regional and local levels as well as other water experts and academics. From these interviews and first-hand experience with the Wimmera River system and the communities of the region, I gathered a glimpse of human-Wimmera River relations. Although portions of the environment, culture and history of the Wimmera region differ from that of Santa Fe, common themes and elements in the lives of these rivers became evident. The differences between the Wimmera and Santa Fe Rivers highlight the importance of the pieces that they do share to our core understanding of human-river relationships.

Figure 5.1 Map of Australia with State of Victoria highlighted in red. Source: Google maps

Figure 5.2 Map highlighting Wimmera region in the state of Victoria.
Source: http://www.depi.vic.gov.au/__data/assets/image/0017/263600/wimmera_map.gif

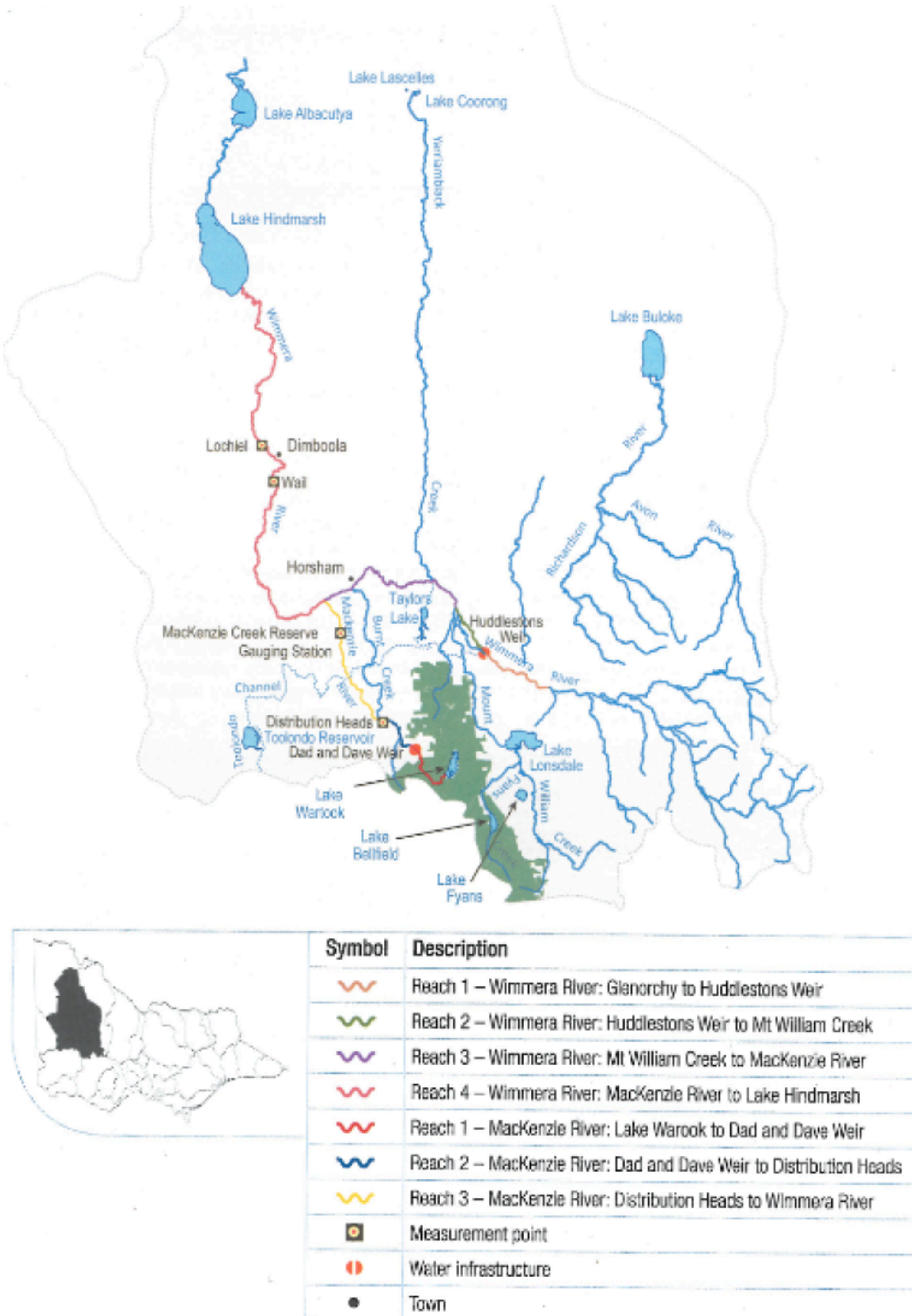


Figure 5.3 Map of the Wimmera River System
Source: Victorian Environmental Water Holder 2012, 106

❖ The Wimmera River ❖

The Wimmera River flows down from Mount Cole and the Pyrenees Range snaking in land through the western section of the state of Victoria. It passes through three townships: Horsham, Dimboola and Jeparit before concluding its journey at Lake Hindmarsh and Lake Albacutya. The Wimmera region hosts about 55,000 people (Victorian Environmental Water Holder 2012). Lake Hindmarsh is Victoria's largest natural freshwater lake and Lake Albacutya is a wetland of international significance according to the Ramsar Convention. These lakes represent only a portion of the unique environments the river system forms. The Wimmera River is listed as a heritage river due to its "myriad of environmental and social values"(Victorian Environmental Water Holder 2012, 104). Investigating how the Wimmera River fits in the communities that reside along it will give insight into what the river's life means to them.

The waters that fill the Wimmera River's flow come from various streams, reservoirs and channels. Many of the tributaries of the Wimmera River flow inland out of the Grampians Mountains including MacKenzie Creek, Fyans Creek, Burnt Creek and Mount William Creek (see figure 5.3). MacKenzie Creek is the largest tributary to the Wimmera River. It originates from releases out of the Lake Wartook, which was constructed in 1887, becoming the first reservoir in the Wimmera-Mallee headwaters and the first irrigation storage in Australia (GWMWater). Lake Lonsdale on Mount William Creek and Lake Bellfield on Fyans Creek round out the three on-stream reservoirs in the Wimmera System (Victorian Environmental Water Holder 2012). There are several off-stream water storages the largest being Taylors Lake from Mount

William Creek and Fyans Lake channeled from Fyans Creek (Victorian Environmental Water Holder 2012).

The Wimmera River system is linked with the neighboring Glenegl system. The Wimmera-Glenegl is the only regulated river system in the western region of the state of Victoria (Department of Sustainability and Environment 2011). Water can be transferred between the two systems, usually the water is stored on the upper Glenegl River and sent north to supply the drier Wimmera region (Department of Sustainability and Environment 2011). Rocklands Reservoir on the Glenegl River is the largest reservoir in Wimmera-Glenegl system. The Wimmera-Glenegl River system is only part of the organic machine that moves water throughout the western region of Victoria.

The Wimmera River is also interconnected to the Wimmera-Mallee system, which is crisscrossed with channels and diversions. The Wimmera-Mallee system is "one of the largest schemes of its kind in the world"(Hallows and Thompson 1995, 57). It is principally a domestic and stock supply system, but includes some irrigation (Hallows and Thompson 1995). In 1995, the system supplied water to about 22,000 farm storage tanks on over 15,000 rural properties, and to fifty towns and villages scattered across an area of 28,500 square kilometers (Hallows and Thompson 1995). Water traversed this region through 9,600 km of Government-owned open channels and 6,500 km of open farm channels (Hallows and Thompson 1995). This system was constructed in the 1880s and connects three river basins: the Wimmera-Avon, Avoca and Glenelg (Department of Sustainability and Environment 2011).

Greg Fletcher (2014), the Water Planning and Policy Officer for the Wimmera Catchment Management Authority[1], acknowledges that the river system is a human construct, but states that it has to be. The farms, towns, and people who exist in this region would not be able to live in the harsh climate if they hadn't engineered a way to have the water where and when they needed it. This story of engineering water systems to survive is reflected in Santa Fe, and in most if not all, human settlements in arid, semi-arid environments. Human ingenuity alters the natural water system into an organic machine that feeds our expanding needs. However, as Santa Fe illustrates, climate change can diminish the functionality of a system and threaten to leave the region's life dangerously thirsty.

❖ Saved by the Pipes ❖

A drought in southeastern Australia starting in 1997 ravaged it for a dozen years. It is referred to as the 'Big Dry' or the 'Millennium Drought' (Askew and Sherval 2011). Figure 5.4 provides key facts on the 13-year drought's impacts on the Wimmera water system. Similar to Santa Fe, the authorities reactively decided to cut off all water that didn't serve the people's needs (Greg Fletcher 2014). The environment and human settlements struggled to hold on. The Wimmera River didn't receive a drop of water and all but died. Jeparit, the town at the end of the line, hardly received any water. The entire town had to go to the Australian Football clubhouse to bathe (Greg Fletcher 2014). This climatic crisis forced the Wimmera citizens and government officials to create and implement a change to the system.

[1] Victoria is divided into ten catchment regions each governed by a Catchment Management Authority (CMA). The Wimmera CMA is in charge of the Wimmera catchment's resources (http://www.wcma.vic.gov.au/about-us/WhatIsCMA).

The expansive dry channel network of the Wimmera-Mallee system had always been inefficient, consistently losing more than 80% of its water to the evaporation and seepage (Miller 2010). This extreme inefficiency had been long recognized and change was always in the discussion. However, the Big Dry created the necessity for immediate adjustment to the system. The meager 20% that was usable before was hardly present during the 13-year period. In an interview, Ross Davies (2014) stated that the changed that eventually came was driven by the drought. but it took the arranging of many pieces to make it happen.

Big Dry Facts

- **1997—**Drought hits the Wimmera Region
- **2002—**Wimmera River system is officially recognized as the most flow-stressed river in the Murray Darling Basin based on the proportion of inflows that reach the end of the river.
- **2007—**Water storages drop to 6% of capacity. Wimmera River diminishes to dry, crack riverbed with scattered stagnant pools.
- **2008—**Grampians water storage levels plummet to a record low of 3.3% capacity
- **September 2009—**Rainstorms break drought, life flocks back to the Wimmera River system.

Figure 5.4 Overview of 13-year drought in Southeast Australia
Source: Wimmera Catchment Management Authority 2013

Engineering solutions of replacing the channels with pipes have long dominated the region's water managing conversation. Anne Longmire (1985) explains, "initiatives to promote pipelining of the channel system date back over one hundred years"(2). The first call to pipe the system came in the 1890s (Longmire 1985). Although this idea remained present in the minds of people of the Wimmera-Mallee region, action to pipe it did not commence for over a century. The eventual combination of community leadership, media advocacy and intragovernmental collaboration generated the construction of what is known as the Wimmera Mallee Pipeline Project (WMPP).

Andrew Barton, a former Grampians-Wimmera-Mallee Water[2] employee, describes the community's commitments to their rivers, " the community will protect the river; water in the [Wimmera] River is why they live there" (2014). The widespread community distress over the Wimmera River system inspired *North to Nowhere*, a series on the Wimmera River started in 2002, which concluded with the message, 'pipe or perish' (Wimmera CMA 2013, 2). This series provided a significant boost in support for the WMPP (Wimmera CMA 2013). *North to Nowhere* is only one example of the media's contribution to the pipeline. The community and media's dedication to 'piping it' was answered by policy change spearheaded by the local authorities and Wimmera CMA (Ross Davies 2014).

In 1992, pipeline construction began with the Northern Mallee pipeline, which converted the northern portion of open channel system to enclosed pipes (see figure 5.5). It was completed in 2005 and replaced 2,500 km of inefficient channels, saving 50 GL of water (~40,536 acre-feet) a year in the Wimmera and Glenelg rivers (Department of Sustainability and Environment 2011). The Wimmera-Mallee Pipeline Project (WMPP) started in 2006 when the first pipe replacing a channel was laid (GWMWater). The Wimmera-Mallee Pipeline was finished in 2010 with a total of 9,159 km of pipeline in ground (GWMWater). The WMPP and the Northern Mallee Pipeline are improvements to the expansive engineered water system of the region.

[2] Grampian-Wimmera-Mallee Water (GWMWater) is the governmental water utility for the Grampian, Wimmera, and Mallee regions

Figure 5.5 Map of Wimmera-Mallee Supply system and pipeline
Source: Department of Sustainability and Environment (2011).

In total, the WMPP cost the Victorian Government, the Commonwealth Government, and GWMWater and its costumers 688 million Australian Dollars, about 534 million USD (Department of Sustainability and Environment 2011). Together the pipelines "give reliable water supply for 34 towns and more than 30,000 farming enterprises and return flows to the stressed Wimmera and Glenelg rivers" (Victorian Environmental Water Holder 2012, 146). Investment in these pipelines not only provides a secure water supply but also elicits cascading benefits for the western region of Victoria.

❖ New Life ❖

In 2010, for the first time in 90 years, Wimmera River ran with its natural flow (Miller 2010). The Wimmera-Mallee Pipeline helped make this feat possible. It saves 83 billion liters of water a year for environmental flows for the Wimmera and other rivers of the region (Miller 2010). However, how and why the environment received this large allocation of water is another important element to the story.

Water allocation in Victoria follows a priority system that bases the size of a water entitlement on the 'reliability' of the user. (Andrew Barton 2014). Reliability refers to how likely the consumer is to use the water efficiently. The WMPP made the environment's reliability rise; therefore, so did their entitlements (Bill Hansen 2014). On the other end, irrigation farmers of the Wimmera were losing their water allocations. Due to lack of water to farm with, the irrigators proposed to the federal government that the government buy out their water entitlements (Culture Victoria 2009). Most of the irrigators' entitlements were transferred to the environment (Hansen 2014). Figure 5.6 is the table from GWMWater's Bulk Entitlement Order 2010 that dictates the water allocation for the Wimmera and Glenelg River systems. The difference in the rate of decline of water allocated when supplies diminish (A→F) between 'irrigation product' and the environment's share of the Wimmera-Mallee Pipeline Product displays the trade of entitlements from the irrigators to the environment. In total, the environment received nearly all of the irrigators' entitlements and its reliability increased to the same level as humans' (Barton 2014).

WATER AVAILABLE (ML)	A	B	C	D	E	F
	125,550	97,550	75,971	53,459	45,253	0
Grampians Wimmera Mallee Water						
System operating water:						
Irrigation losses	9,000	0	0	0	0	0
Pipeline and balancing storage losses	2,960	2 960	2 960	2 960	2 960	0
Irrigation product	19 000	0	0	0	0	0
Glenelg compensation flow	3,300	3 300	825	50	50	0
Recreation	2 590	2 590	648	0	0	0
Wimmera-Mallee Pipeline product	44 720	44 720	36,352	25 725	21 540	0
Coliban Water						
Wimmera-Mallee Pipeline product	300	300	244	173	145	0
Wannon Water						
Wimmera-Mallee Pipeline product	2 120	2 120	1,723	1,220	1 021	0
Environment						
Wetlands	1,000	1 000	250	0	0	0
Wimmera-Mallee Pipeline product	40 560	40 560	32,970	23,332	19 537	0

Figure 5.6 Table of water allocations for the Wimmera and Glenegl River systems.
Source GWMWater 2010.
Green and red boxes added by author

With the water saved from the pipelines and the acquired entitlements, flows returned to the Wimmera River. The revival of the river reveals its importance to life in the Wimmera region. Not only was the riparian and aquatic life of the Wimmera region revived, but also the health of the communities. Andrew Barton (2014) observed a change in the communities' well being when water return to the Wimmera. Barton felt a communal sense of despair during the drought; however, once water began to flow there was a tangible, emotional improvement within the communities. This improvement in well being is accompanied with benefits to the local economy and recreation.

Wayne Schulze (2014), the Waterway Manager for the Hindmarsh Shire Council[3], explained that returning water to the Wimmera River increased local recreation and tourism. Water skiing is the primary recreational sport; there are 10,000 boats in the Dimboola ski club (Wayne Schulze 2014). Economic revenue from water skiing, other recreation and tourism has increased since the WMPP. The social and economic importance of the Wimmera River became apparent to me as I followed (as close as possible with a car) the watercourse of the Wimmera River from the headwaters of its tributaries in the Grampians to Lake Hindmarsh. I realized that not only is the river central to the communities, but the weirs built upon the river also play prominent roles. Weirs provide the citizens a place to relax, to socialize, to recreate, to have a barbeque with family and friends. They are a common space that rejuvenates the life of the communities. Understanding the social and economic impacts of these weirs and lakes, the government augments the environmental flows with 3 GL (~2,432 acre-feet) entitled directly for the local economy and recreation (Victorian Environmental Water Holder 2012).

The environment and community can expect to enjoy a flowing Wimmera River for years to come. Wimmera Catchment Management Authority chief executive, David

[3] The Hindmarsh Shire Council is the governing body for the Hindmarsh Shire, which is located south of Mallee and north of the Grampians. The shire has a population of 6,200 with Dimboola being its largest town.

Brennan says, “environmental water releases made possible by pipeline water savings are keeping this river system healthy even when times are dry”(Pouliot, 2). The Wimmera Mallee and North Mallee pipelines mark significant victories for the region.

Nevertheless, these pipes did not change the climate. Brennan explicates, “even with a fully-piped system, our landscape remains subject to the forces of nature, particularly in drought”(Pouliot, 2). Humans can shape the environment, but the climate remains out of our control. Changes in the climate affect the hydrosocial machine. This balance of power has to be remembered especially after adaptive successes and periods with favorable climate.

❖ Flowing Onwards ❖

"You can't put borders on rivers"
—Ross Davies, 2014

This critical comparative analysis of the Wimmera and Santa Fe Rivers examines what elements in human-river relationships help drive policy change and reveals the benefits and potential paradoxes involved in river restoration.

Grassroots momentum, political will, community involvement and innovative planning were central pieces to bringing water back to the Santa Fe and Wimmera Rivers. The environmental flows were bi-products to policy changes that increased the water supply either through acquiring a new source (BDD) or saving water (conservation, WMPP). These changes require careful planning, time, money and collaboration. The BDD cost 221 million USD (Rick Carpenter 2014) and the WMPP 534 million USD (Department of Sustainability and Environment 2011). These projects demonstrate that large-scale structural adjustment to a water system is expensive and that returning water to rivers can be. However, in both the Wimmera region and Santa Fe money was only one of the many pieces that aligned to produce living rivers. As Claudia Borchert (2014), head of County of Santa Fe Public Utilities, explains,

> There are many puzzle pieces that make up our water dependence and our overall water supply. It's not just us humans, but it's our world. I think the solutions lie in the rearranging of them. What has made the Santa Fe River possible is just kind of playing with the different parts.

Experimentation in water management can produce innovative, sustainable solutions. This study shows what pieces Santa Fe and the Wimmera region arranged and rearranged to produce environmental flows.

Since each environmental flow regime has only been enacted for 4 or 5 years, it is are hard to decipher the real, lasting benefits that water in the rivers bring. However, at least some improvements are already being observed in both regions in the riparian environment, economy, recreation and well being of the community. These initiatives are also attempting to revive relationships between the Rivers and the people of their respective regions. Borchert explains, “Eventually, the Living River initiative will not only be restoring the water to the river, but restoring people and their access to the river corridor”(2014). Andy Otto (2014), executive director of the Santa Fe Watershed Association, expresses the same reconnecting goal of the Living River. Restoring human-river relationships should be considered in future water management plans especially when adapting to climate change.

The bi-regional study on the Wimmera and Santa Fe fits within a growing field of studies on the local experiences of drought. Louise E. Askew and Meg Sherval (2011) are proponents of this approach. They conducted a study on two rural towns in Victoria, Australia to understand these communities' experiences of the Big Dry drought. The towns, Donald and Mildura, were both devastated by the drought. Askew and Sherval discovered that both towns are emotionally, socially and psychologically tied to water (2011). This intimate tie shows that in water-scarce environments people are dependent on water for more than just its life-giving nature. As Barton stated, “the community will protect its river; water in the [Wimmera] River is why they live there” (2014). The river plays a larger role in the community than just the faucet, and as this study shows the community will protect it even in times of drought.

Local studies can reveal how droughts impact communities and rivers. Askew and Sherval (2011, 363) state that "listening to the lived experiences of those experiencing drought and more at a local and regional level is not only paramount to developing an appropriate government response but also key to driving future adaptation strategies in Australia and perhaps globally". Droughts stress hydrologic systems and societal function alike. The hydrosocial conceptual framework illustrates that water and society are perpetually impacting each other and producing new forms of organic machines. I contend that in times of drought the implications of the hydrosocial cycle are exacerbated, and that analyzing local experiences of drought reveals the aspects of society and water that are altered.

Drought served as a catalyst for the reviving the Santa Fe and Wimmera Rivers. The influence of drought in both river histories offers an interesting analysis on the dimensions of human-river relationships at play. The health of each river was poor prior to their respective droughts, and desires (and even ideas) to improve it were present, but action was minimal. The Big Dry drought pushed the WMPP into action. The droughts of the early 2000s instigated Santa Fe's conservation programs and the BDD. A new paradigm of water scarcity can be understood from this comparative study. The paradigm demonstrates that ironically, droughts have sparked plans to revive rivers and restore relations. The inclusion of environment flows in crisis management is crucial for establishing plans that sustain the health of society and rivers. However, it should be argued that preemptive strategies to revive the rivers would be potentially more effective than reactive responses.

Another intriguing part to the story is that the immediate responses from both governing bodies to the droughts were reactive and resulted in cutting off all water to public parks and the environment. Nevertheless, the fact that the chosen long-term adaptive strategies of each region included an unprecedented amount of environment flows indicates a quick adjustment in mentality. The initial drought responses removed water from anything outside of essential human needs, but the long-term plans intentionally allocated more water than ever for causes outside of human survival.

There is little doubt that the primary reason for the implementation of WMPP, the BDD and Santa Fe's conservation programs was to secure a water supply for anthropocentric needs. These changes reflect both regions' eternal grapple with water scarcity. Dry periods or increased water needs reinitiate the search for water. The water acquired whether by engineered systems or saved through conservation was usually allocated to support current human populations and development. Marc Reisner (1986) explains that in the western U.S. anything outside of human use was considered wasteful:

> In the West, lack of water is the central fact of existence, and a whole culture and set of values have grown up around it. In the East, to "waste" water is to consume it needlessly or excessively. In the West, to waste water is *not* to consume it—to let it flow unimpeded and undiverted down rivers (12)

So, why has Santa Fe and the Wimmera region individually elected to give water back to the river if it has been largely considered as wasteful? Does it indicate a new mentality in water scarcity culture? Is an ethical element influencing water management as Groenfeldt and Schmidt (2013) advocate for? Or as Tharme (2003) believes, is the recognition of humans' impacts and the declining health of rivers initiating the rising trend of environmental flow management? Conversely, is it driven by the economic benefits towns like Dimboola enjoy from having water in the river? These questions facilitate a conversation about what the definition of water waste is today and if water flowing down rivers fits into it.

Rivers and the local environment are caught between the forces of society and the climate. Human adaptation to climatic changes has transformed our rivers into organic machines whose nature is so intertwined with society that neither rivers nor society can be understood without considering the hydrosocial implications. Human control over water and rivers has never been stronger than it is now. As Jamie Linton and Jessica Budds (2013) say, "virtually all water sources on earth now bear a human imprint". How we decide to redesign our rivers and the environment will determine not only our health, but also the health of water and rivers.

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