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Presas Efímeras of New Mexico

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Las presas efímeras nuevomexicanas, historia y situación actual

Traditional diversion dams of New Mexico, history and contemporary status

A Working Paper

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ABSTRACT

The main title of this paper mimics a groundbreaking investigation by anthropologist Teresa Rojas Rabiela and ethnohistorian Ignacio Gutiérrez Ruvalcaba titled: *Las presas efímeras mexicanas, del pasado y del presente* (Ephemeral diversion dams of Mexico, past and present). Their study inspired the addition of counterpart cases from *Nuevo México*, a former Mexican province directly north of the Juarez-El Paso border. The work here describes the traditional dams of the northern Río Grande region and also serves as a guide to future research and the development of historic preservation projects. After introducing readers to *Las presas efímeras mexicanas*, the rest of the text highlights the early forms of water capture along the rivers and streams of New Mexico with a focus on vernacular construction materials and methods. Most of the works and sources cited are accessible to researchers as starting points for in-depth investigation and historic preservation documentation. The photo gallery at the end illustrates a wide range of still existing diversion works and some that have been modified or replaced by the use of modern and more durable materials.

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Introduction

> *What are presas efímeras? Where can they be found, whether in the past or present day Mexico? How were they built, different from modern irrigation diversion dams? How do they function technologically? Why do they require modifications or renovations year to year? How are they sustained despite continuous repairs by the campesino irrigators who built and maintain them?*

These and other questions were addressed by Teresa Rojas Rabiela and Ignacio Gutiérrez Ruvalcaba when they set out to study the hydro-technology of irrigation in Mesoamerica and its transformation and persistence over time to the present. For their main unit of analysis, they chose to focus on *presas de derivación efímera* (ephemeral diversion dams) as physical structures, along with their technology, social-political organization, and geographic presence in the irrigated floodplains of ancient Mesoamerica and modern day Mexico. The timeline in the study covers hundreds of years during which these ingenious technologies have been in use since before the fifteenth century and how this pre-Hispanic system of irrigation transformed from the past to the present in contemporary Mexico.

The purpose here is to provide readers and researchers a baseline of similar irrigation headworks of the upper Río Grande from the Juarez-El Paso border and into the Taos Valley of northcentral New Mexico. The literature and citations are extensive and are intended as resource materials for use in new studies and to encourage historic preservation projects aimed at safeguarding vernacular systems of water development in the region. Historians agree that acequia irrigation practices in Nuevo México were melded from diverse sources: the Iberian model of canal irrigation from the arid provinces in the south of Spain based in part on traditions from the Roman period; the superimposition of Arabo-Berber customs and operating procedures during seven centuries of occupation of Spain by Muslims from north Africa and the Middle East; the influence of Pueblo agriculture as observed by early Spanish expeditions into the northern region of Nueva España; and the irrigation horticulture of Mesoamerica brought by Mexican Indians who accompanied the Spanish caravans along the Camino Real de Tierra Adentro.[1]

Conditions of aridity required a high level of self-sufficiency among the *pobladores* (early settlers) who petitioned for and were issued grants of land to establish colonies along the northern outposts of New Spain and Mexico during the period of 1598-1846. The colonization policies required them to locate communities in the vicinity of water essential for permanent occupation. Working without the aid of survey instruments or modern tools, waves of Spanish-Mexican settlers and their Indian allies from the central valley of Mexico engineered irrigation works superimposing *zanjas* (hand dug earthen trenches) on the high desert of *La Provincia del Nuevo México* (the New Mexico Province). The first step was to locate a bend in the river or another suitable feature to build a *presa* (diversion dam) from which to capture water and turn it into ditches on one or sometimes both banks of the watercourse. Without a diversion, agriculture and food production necessary to sustain the newly arrived *vecinos* (citizen neighbors) would not have flourished.

In many places, the dam was the first public work in the northern frontier settlements and validates its description as “the birthplace of community.” On larger streams, such as the *Río del Norte* (the name of the Río Grande during the colonial period), the first pobladores built wing dams protruding into the river from one of the banks; these simple structures were usually sufficient to channel water into acequias during the irrigation season when natural flow was the highest. Streams with intermittent flows required the construction of dams across the width of the watercourses to impound portions of the flows and form small reservoir ponds. In the typical case, the presas (also called *atarques* in the region) were constructed of forest timbers, juniper brush, boulders, rock slabs, mud, sod and other local materials, resulting in structures that often resembled beaver dams. These building materials were placed on the riverbed in a layered fashion, gradually raising the level of impounded water closer to a headgate constructed on the banks of the river. Containment of the water by the presa would accomplish the rest of the task, with gravity flow pushing the water into and through the main irrigation canal, the *acequia madre* (mother ditch).

What are presas efímeras and how were they built in Mexico?

In their main text, Teresa Rojas Rabiela and Ignacio Gutiérrez Ruvalcaba include a historical review alongside ethnographic cases and field studies of various rivers and arroyos complete with black and white archival images followed by dozens of stunning color photographs depicting the diversion works both in function and the construction materials utilized in each case. They note that “*presas de derivación efímera*” are also referenced in the literature as *bocatomas*, *represas de tierra*, *bordos*, *diques* and other names, but they are commonly translated in English as “diversion dams.” In function, the dams do not store water, and instead they hold back the current in an elevated pool sufficient for water to enter a canal built on the bank of the stream. According to Rojas Rabiela and Gutiérrez Ruvalcaba, these diversion structures are generally low in height and in the majority of cases are built from materials gathered in the surrounding area and today may also use sacks filled with sand and debris brought by the current of water. They can be as simple as alignments of large or medium sized boulders laid in the riverbed, and others may use logs and tree trunks, or stakes dug into the riverbed as pillars, and sometimes these diversions may include baskets strengthened by brush, willows and rocks. Others are constructed as berms made of dirt, clay, sand, grass or rocks reinforced by rows of stakes or narrow poles, woven branches, willows, bamboo, or rocks.[2]

How do the presas function and where can they be found?

Rojas Rabiela and Gutiérrez Ruvalcaba explain that most of the dams are placed horizontally across the riverbed, or diagonally as a wing, or a straight angle with the objective of forming a small pond and thus elevate the water to force it to enter *acequias de tierra* (earthen canals). After the dry season, and with the coming of monsoons, the presas either remain submerged or are washed out downstream partially or totally, with no major resistance to the flowing waters. This design permits the heavy flows to continue in the same river channel by not resisting, thus preventing the change in river channel often associated with cement or permanent materials in dam construction. Examples of photographs in the book include presas efímeras past and present found in the central valley of Mexico and locations in the states of Tlaxcala, Coahuila, Jalisco, Oaxaca, Guerrero, Sonora, Querétaro, Nayarit, Guanajuato, Hidalgo and others.

For cases in the former northern Mexico territory now in the Southwest United States, the study describes irrigation systems at El Paso, Texas and El Cerrito, New Mexico. For El Paso, Rojas Rabiela and her colleague cite Alexander von Humboldt's description in 1811 of a diversion on the Río del Norte:[3]

> Como el país es muy seco, una acequia de riego conduce al Paso las aguas del río del Norte. Los habitantes del presidio tienen mucho trabajo en conservar la presa que conduce a la acequia las aguas de los ríos, cuando están muy bajas. Durante las grandes crecidas del río del Norte, en los meses de mayo y junio, la fuerza de la corriente destruye casi todos los años esta presa, y es muy ingenioso el modo de restablecerlo y reforzarlo: los habitantes forman unos cestones con estacas entretejidas con ramas de árboles, los llenan de tierra y piedras y los abandonan en medio de la corriente, que en su remolino, los deja en el sitio en donde la acequia se separa del río" (pp. 79-80 citing Alexander von Humboldt, *Political Essay on the Kingdom of New Spain*).[4] [Translation at Note 4]

For the New Mexico case, Rojas Rabiela and Gutiérrez Ruvalcaba draw from a 1941 monograph produced by Olen Leonard and Charles Loomis in their study of El Cerrito, a folk village situated on the Río Pecos, a tributary of the Río Grande:

> En esta publicación se incluye una fotografía en blanco y negro de una represa de tierra y piedras que forma un pequeño estanque o balsa, situada entre la pared de una montaña y la playa de río Pecos, en cuyo pie se lee: "The brush and rock dam raises the water to the mouth of the lateral above the village now as it has for many generations" (p. 106). [In this publication there is a black and white photograph of a dam built of earth and rocks that forms a small tank or pond, situated between the wall of a mountain and the margins of the Pecos River, where the footnote reads: "The brush rock dam…."]

Next, Rojas Rabiela and Gutiérrez Ruvalcaba translate a passage from the El Cerrito monograph describing a photo of the central plaza and its setting on the river:

> A medida que uno se acerca aún más al grupo de casas, casi la totalidad de la zanja de irrigación lleva el agua del río a sus hogares y se pueden ver numerosos campos. La zanja es una hazaña de ingeniería hecha sin la ayuda o el beneficio de la ciencia moderna. Su estilo de construcción y la altura de los bancos, hechos como resultado de las limpiezas anuales, dan amplia prueba de su edad (pp. 106-107).[5] [Translation at Note 5]

In another section of the case study not cited in their book, Leonard and Loomis describe how the diversion at El Cerrito was constructed and its vulnerability to flood events:

> This dam was constructed by means of laying a line of stone across the river and stacking brush and long poles behind it. Thus, the bed of the river, above the dam, has been raised a height of approximately 6 feet. This added elevation enables the water to flow out into the main ditch and on to the valley below. The construction of the dam is such that there is little assurance of its permanency. Any big flood or unusual flow of water might destroy the entire structure. No provision is made for diversion; hence the dam must carry the weight and pressure of any quantity of water that happens to come over it. If the pressure is too great the dam is destroyed as are the crops below which are dependent upon it (Leonard and Loomis, p. 26).

Decades later, geography professor Richard Nostrand conducted a separate study of El Cerrito. He notes that the early villagers of El Cerrito constructed three or four brush and rock *atarques* so the waters could feed their irrigation ditches (*El Cerrito, New Mexico: Eight Generations in a Spanish Village*, 2003). When the annual spring snowmelt flooded the Pecos, however, these temporary dams often sustained damage. Heavy cloudbursts sometimes destroyed one or more dams, such as the floods of October 1904, and again in May of 1937. "Rivers can be treacherous," Nostrand says, "and in less than two centuries, floodwaters have destroyed El Cerrito's main dam half a dozen times" (p. 157). On August 27, 1989, a local cloudburst dumped an estimated seven inches of rain on El Cerrito, and rushing water partially destroyed a second cement-capped brush and rock dam at the intake for the acequia madre. In response to these repeated flood disasters, the El Cerrito Ditch Association joined forces with the U.S. Army Corps of Engineers in 1990 to build a third dam made of concrete poured over rock-filled wire mesh gabion baskets and was placed downstream a short distance from its 1940s location. The intake for the ditch, a design flaw of the Corps, faced upstream and was not parallel on the riverbank. Floods on the Pecos caused debris, including whole trees that dislodged from an upstream bank, and clogged the ditch intake at the dam's end (Eastman and Krannich 1999, p. 25). These obstacles had to be removed frequently during workdays on Saturdays and at times on the following Sunday. On their own, the El Cerrito Ditch Association reconfigured the intake and fixed the problem.

In addition to El Cerrito, where else in New Mexico can we find these traditional presas? How and why are they renovated and sometimes replaced?

To address these questions, we turn to reports in a variety of sources, from traders on the Santa Fe Trail in the 1830s such as the journals of Josiah Gregg, to reports of irrigation conditions in the Río Grande and its tributaries from 1895 to 1928 by Herbert Yeo and other civil engineers, to the more recent inventories of acequia systems throughout New Mexico conducted by Neal Ackerly during the 1990s. For a site closer to El Cerrito, however, we begin with the nearby village of La Cuesta. As with El Cerrito, the Río Pecos also supplies water to La Cuesta (now known as Villanueva), a settlement on the San Miguel del Bado grant just a few miles upstream from El Cerrito. In a detailed account published in the *New Mexico Historical Review*, historians Richard and Shirley Flint teamed up with the long-time mayordomo of the Community

Dam Association of Villanueva, Pedro Gallegos, and revisited the process of construction methods that residents have used to erect, repair and re-erect atarques from the 1770s to the present. As was the case at El Cerrito, heavy downpours often destroyed the community dam that had been built to irrigate the bottomland of Villanueva and each time resulted in annual repairs or reconstruction. The article tells the story of struggles by the Villanueva Community Dam Association in the early 1960s to build a permanent dam designed to last for years and that hopefully would resist the river's onslaught. For materials, the members used medium-sized stones held together by heavy V-mesh woven wire in five layers with the downstream face stair-stepped backward (upstream) with a three-foot rise each step and then a thick cement plaster applied to the exposed surface of the dam. The labor required to build the new dam was massive:

> The weather during the raising of the dam was fairly typical for the season at Villanueva. Frigid spells alternated with near balminess, occasional snow, and high winds. Regardless of the weather, the work went on. Twenty-five of the fifty-five landowners in the association worked personally on the new dam. Together with family members and a few hired hands (a total of more than fifty men and boys), they logged a total of 1,875 man-days of labor on the atarque between October 1960 and February 1961. (Flint et al, "Atarque Duradera," *New Mexico Historical Review*, pp. 370-371).

The dam was completed in February of 1961, and a few days later the community gathered for the dedication and a blessing conducted by the parish priest. For our purposes here the most instructive part of the story appears at the beginning where mayordomo Pedro Gallegos explains how villagers in earlier times designed and constructed atarques before modern materials such as cement and gabion technology became available. He notes that the traditional dams at Villanueva in the past were wedge-shaped weirs built of juniper trees, stones, and silt. Large juniper trees were cut, partially stripped of branches, then dragged by teams of horses to the site of the dam. Because the river was not easily diverted, builders had to slog back and forth through frigid water to wrestle the trees into place. Gallegos continues his description of the construction process:

> Layout of the dam was almost always the same. A single file of junipers was laid head to toe across the river, then weighed down with rocks to prevent their washing away while building was in progress. Another layer of junipers was piled on, this time side-by-side at right angles to the first layer. Resting on the first layer, the butt end of each new juniper was wired down with the remainder of its length extending upstream sometimes as much as twenty feet…. More junipers were stacked in the same manner, with odd-numbered layers positioned like the first and even-numbered layers like the second. Each layer was held down with rocks and additional loose brush was piled into gaps between layers. In addition, each odd-numbered layer was offset two or three feet upstream from the one beneath it, giving a stair-step face to the downstream side of the finished dam (Flint et al, p. 359).

When the work was completed, it stood about fifteen feet high, and the river was backed up enough to feed into the acequia headgates. The builders hoped the dam would last at least a year. All too often, however, a heavy load of debris carried by the river ripped away part of the main atarque in mid-year, and sometimes "a glut of water would sweep around the dam, eating away at the riverbank and then the dam" (Flint et al, p. 359). By 1950, frustration over the fragility of juniper brush dams led to experiments with other innovations. The mayordomos switched to the use of pine logs rather than juniper brush to reconstruct the diversion works. The pine logs, however, softened and rotted, allowing the river to once again tear the atarque apart. More changes became necessary with the use of logs backed by layers of stone face and rubble, and later the final design resulting in the atarque duradera constructed in 1960-1961.

How were other Río Grande presas built and were they all the same?

Throughout New Mexico, hundreds of traditional brush and rock dams such as those at El Cerrito and Villanueva were constructed since the period of the first colonial settlement in 1598. Although the construction materials such as earth, rocks, logs and brush were readily available, the work to gather them and dam the riverbed was intensive, and after completion, these diversions were vulnerable to increased stream flows during the spring runoff and summer thunderstorms that washed them out.[6] Many traditional presas in New Mexico have been modified or replaced with modern structures but a few still function as ephemeral diversions. Examples of traditional and modernized dams along with other associated infrastructure such as *compuertas* (headgates), *canoas* (flumes), *tanques* (storage ponds) and *molinos* (grist mills) are included in Appendix 2 Photo Gallery.

Not all presas efímeras were constructed the same, and in some places there was no need for a structure of any kind. During his field investigations in August 1895, for example, Philip Harroun observed that some canals cut from the eastern bank of the Río Grande between the pueblo of San Felipe and Albuquerque obtained water without and with the reliance on diversion dams:

> The heads of these canals are of two varieties, open cuts in the bank and diverting dams of brush. Of the former class, are the Santa Ana, Sandilla [sic, Sandia], Los Ranchos, Los Griegos and La Varela having no headworks of any description. A cut is simply made in a bend of the riverbank against which the river impinges, and water drawn off. The other ditches have diverting dams of brush directing the current into the ditch. These dams are constructed by driving cottonwood stakes into the sandy bottom of the river and placing fascines of brush between them, which are weighted down by heavy boulders, while sods are distributed along the upper face. These dams are not tight, much of the water finding its way through the body of the dam, but they serve to deflect the current towards the head of the ditch and raise the water level from 0.4 to 1.0 foot (Harroun 1898, pp. 1-2).

Earlier in timeline, the mission acequias of eighteenth century El Paso del Norte also employed direct diversions without needing to dam the riverbed. When Bishop Tamarón y Romeral of Durango conducted an episcopal visitation to El Reino de Nuevo México in 1760, he reported that the town of El Paso was populated by a mixture of people that included Spaniards, Indians and *gente de razón* (Christianized natives). The town's inhabitants had a "*gran acequia con que sangran el río del Norte*" (large irrigation ditch that they use to bled water from the river) which was subdivided into others to irrigate many vineyards and fields of wheat, maize and other grains as well as a variety of fruit trees. In his visit to the mission pueblos nearby Bishop Tamarón observed that the farmlands of the Indians "*son tan fértiles y frondosos como El Paso, con sus acequias que da el río sin necesitar presa*" [were just as fertile and abundant as those at El Paso, with ditches filled by the river without the need for a dam"] (Report of Bishop Tamarón, Reino del Nuevo México, in Alessio Robles, pp. 328-330).[7]

The missions in Bishop Tamarón's visitation report included San Lorenzo, Senecu, La Isleta, and El Socorro, the same ones Fray Juan Miguel Menchero had visited during his term as Visitor General some fifteen years earlier. Fray Menchero's charge was to supervise the proposed conversion of Navajos, but he also participated in several regional explorations gathering population statistics in the Kingdom of New Mexico. His census report in 1744-1745 included a map he titled "*Mapa del Reino de Nuevo México*." In it he located the Presidio del Paso del Norte and the "*Riego de las Misiones*" south of the presidio along the Río del Norte (See Eidenbach, *An Atlas of Historic New Mexico Maps*, 2012). In the map, each of the missions has an acequia around its perimeter and by coincidence, and perhaps the limitations inherent in the map's scale, Fray Menchero did not locate diversion structures on the river, a condition corroborated by Bishop Tamarón in his visit of 1760. To bleed the river and direct part of the current toward previously excavated ditches, all that was necessary was to cut into the riverbank and allow water to enter the mouth of each acequia, the *bocatomas* [The Fray Menchero map is featured in the photo gallery.]

As reported by Neal Ackerly (1994a, 1994b, 1996), however, most irrigation canals on the Río Grande were supplied with water drawn from physical structures laid in the bed of the stream or river. The early diversions were constructed of earth, rocks and *ramas* (branches) gathered from surrounding hillsides and hauled to the riverbank by horses and wagons. At other locations subsequent changes included cedar boughs laid at the riverbed and then weighted down with rocks locking them in place by hand in waist deep water. The dams required extensive maintenance and inevitably were washed out in high water seasons and had to be repaired or replaced. On the larger streams such as the Río Grande, the traditional presas were often replaced with more modern diversion structures consisting of concrete-capped steel risers perpendicular to the main channel with rip-rap on both the upstream and downstream to prevent erosion (Ackerly 1994a, p. 220).

What can we learn about alternative diversion technologies from the studies conducted by Neal Ackerly and his associates?

In a commissioned study prepared for the Historic Preservation Office of the State of New Mexico, Ackerly (1996) summarizes the range of diversion technologies based in part on early observations and historical narratives by third parties. The observers often note the ingenious design of the ephemeral structures, but they also describe their vulnerability to damages caused by seasonal floods. Ackerly's list of technology options include:

No dam whatsoever, a direct diversion when the gradient of a river or stream along with the banks adjacent to the river were sufficiently low, conditions that allowed for water diversions without constructing dams. In essence, the elevation differences between the bed of the river and the intake of the canal were negligible. Here Ackerly cites observations of irrigation in New Mexico during the 1830s by a trader on the Santa Fe Trail, Josiah Gregg: "As the banks of the [Río del Norte/Río Grande] are very low, and the descent considerable, the water is soon brought upon the surface by a horizontal ditch along an inclined bank, commencing at a convenient point of constant-flowing water-generally without dam, except sometimes a wing of stones to turn the current into the canal." In a field investigation conducted in 1895, P. E. Harroun found irrigation works with open cuts and no dams at Santa Ana Pueblo, Sandia Pueblo, Los Ranchos and Los Griegos. Later in 1910 Herbert Yeo described acequias that obtained water without dams near Socorro, Albuquerque and Santa Fe, and in 1928, there were canals operating without dams in the Pojoaque, Nambé and Tesuque basins (Yeo 1910, 1928, cited by Ackerly 1996, p. 112). Even into the 1990s, Ackerly notes there are some areas on the Río Peñasco and the Río Bonito where stream gradients are so low that irrigation can be accomplished without constructing diversion dams. In the photo gallery, examples of the no-dam technology are the *bocatomas* at the Río Hondo for the Prando and San Antonio acequias as well stone alignments used to turn water into main headgates off of El Rito Creek and similarly for the Sandoval acequias on the Río Jémez. In these cases, the gradient of the current and the banks of the streams allow gravity flow to push water into the headgates.

Dams of stone-filled baskets, per Ackerly**,** are also of considerable antiquity. In this case, baskets are placed side by side to form a wing dam that forces water to seek the mouth of the acequia. As described earlier, Bishop Pedro Tamarón observed the use of cylindrical baskets filled with earth and stone in 1760 to dam the Río del Norte at El Paso. This type of ephemeral diversion was still in use when Alexander de Humboldt travelled to El Paso in the early 1800s as was noted by Rabiela Rojas and her colleague. In 1910, a century after Humboldt, Herbert Yeo reported that baskets were in use on the Río Grande at Peña Blanca, New Mexico: "Wickerwork cylinders made of willows, three or four feet long and a foot and a half to two feet in diameter, and open on one end (and very probably open on both ends) were made. These cylinders were placed diagonally to the channel and were set upright and filled with gravel, as it was nearby in the bluffs. Brush was placed on the upper side of these then gravel and sand, and a good diversion was made. It was only temporary, however…. These cross the riverbed in an open cut and are destroyed every time there is a freshet in the river" (Yeo 1910, p. 102).

Brush and Rock dams were in common use during the nineteenth and twentieth centuries. These traditional diversion works were constructed from tree branches, twigs, rocks and other locally available material and were often reinforced with mud and posts. In his visit to Albuquerque in 1890, John Wesley Powell observed: "Each year brush and rocks are put in the bed of the stream [Río Grande] and are filled with silt, forming a rough dam. The water detained in this manner is used for irrigating. But the whole arrangement is washed away in the winter and the process is repeated next spring…. Ditches in this low land are liable to frequent overflow and much damage is yearly done by their being washed out or being filled with silt." Yeo in 1910 described diversions below Albuquerque in similar terms: "The type of diversion structures [Socorro-San Marcial section] consist of the temporary wing dam made of posts, brush and mud or some variation of the same. All of these are destroyed by the high water in the spring and have to be rebuilt every summer…. No sluice gates were noticed. Most of the ditches have no regulation gates, as when there is water in the river of sufficient height to enter the ditch, it can be used" (Yeo 1910, p. 10). Examples in the photo gallery include the brush and rock dams on the Río Pecos 1917, the El Cerrito atarque of 1942 before it was replaced, and two at Jémez Springs that are still currently in use. At El Guique on the Río Grande near Española and also Embudo-Dixon on the Río Embudo, the presas were built of heavy layers of rocks massed on the riverbed to divert river flows toward acequia headgates.

Earthen push-up dams, according to Ackerly's investigation, are characterized by their simplicity and relative ease of construction. In 1910 Yeo described many such devices around the state such as the dam for the Acequia de los Inocentes near Socorro: "The diversion works on the day of examination, September 9, 1910, consisted of a brush and mud wing dam. There was practically nothing but mud in the dam" (Yeo 1910, cited in Ackerly 1996, p. 116). The wing dams at Acequia La Joya and Acequia Las Nutrias were also temporary and consisted of bush and mud. At other locations the wing dams were constructed by pushing rocks, earth and other local materials onto the river to channel a portion of flow to an irrigation canal ready to handle its share of the flow. Ackerly comments that despite their antiquity, earthen push-up dams persisted into contemporary times due to their simplicity but are prone to erosion during periods of progressively higher discharges. For an example, see the photos of Alamosa Creek at Monticello, New Mexico.

Wooden dams were usually built on streams with relatively low discharges. These dams appear in the historic record no later than the early 20th century as reported by Yeo in 1910, and they probably operated before 1900. The dams of this type consisted of a riser constructed perpendicular to the flow of the river and of a height sufficient to gravity-feed water into the canal (Ackerly 1994b, p. 198). Small wooden dams on streams were constructed of milled lumber laid either vertically or horizontally. Wooden dams on streams with higher discharges were often constructed of heavy logs and were generally filled with stone, closely resembling retention dams. Log dams were common in northern New Mexico as recently as 1968 and some remain operating today. For examples, see photos of the diversion of the Río Mora at Cleveland and one of the presas on the Río Jémez at Jémez Springs.

Concrete diversion dams were built starting in the twentieth century. Based on his 1996 inventory, Ackerly notes that some of the brush-and-rock diversions reported by Yeo in 1910 and 1928 have been replaced by more substantial concrete structures. For examples of early modern structures at large scale, Ackerly cites the Leasburg Dam near Hatch, New Mexico built in 1912, followed by others in the Mesilla Valley in 1916, and upstream in the Middle Río Grande Project during the late 1920s, Isleta in 1947, and San Acacia in 1948 (Ackerly 1996, p. 116). For an example of a medium-scale concrete dam, see the gallery photograph of the Río Chama diversion at Chamita-Hernández, and for the small-scale variety, see the modernized presa at Puerto de Luna near Santa Rosa, and the gabion stone wall dam with concrete cap at Rainsville in Mora County.

Reflections and conclusions: Rojas Rabiela and Gutiérrez Ruvalcaba

We began by highlighting the study conducted by Teresa Rojas Rabiela and Ignacio Gutiérrez Ruvalcaba. Their groundbreaking book, *Las presas efímeras mexicanas*, inspired the writing of this paper featuring the counterpart irrigation dams found in the upper Río Grande of New Mexico. In their closing, Rojas Rabiela and Gutiérrez Ruvalcaba educate readers about the value of understanding the role of traditional technology employed for centuries, reminding them of the millennial legacy of these long enduring methods to capture water for purposes of food production in many regions of Mexico. Moreover, the technology to construct ephemeral diversions persists and continues to be transmitted from generation to generation due to the profound knowledge held by the campesinos regarding the topography, soils, and the climate of the valleys and ravines they inhabit, along with their knowledge of the hydrological cycle of the rivers and arroyos they develop for purposes of irrigation.

Of equal importance, Rojas Rabiela and Gutiérrez Ruvalcaba contend, is the level of social organization required to construct the agricultural parcels and the irrigation systems, and also the work to maintain and monitor the systems in normal as well as extraordinary or catastrophic times. These are tasks to be undertaken by familial and neighbor organizations, not individually. The technology is manual and requires minimal capital investment and relies instead on the use of local materials, a voluntary labor force, annual maintenance, and also, simple hand tools and small equipment that often is borrowed or rented. Recognizing that some modernization has been taking place, Rojas Rabiela and Guítierrez Ruvalvaba conclude that the basic elements of persistence nevertheless still apply: (1) flexibility of the structures, (2) low financial cost to build, (3) the small scale of each system, (4) autonomous management distant from control by large administrative structures, and (5) maintenance by familial and neighbor organizations and occasionally, municipalities.

Future investigations and historical preservation projects in New Mexico

For New Mexico, the study of presas efímeras of Mexico offers many possibilities we can use to compare with irrigation works along the upper Río Grande and other major streams such as the Ríos Pecos, Mora, Jémez, Embudo, Nambé, Chama, Mimbres and others in the Taos, Pojoaque and Hondo Valleys. As in Mexico, there are still some diversions that remain as presas efímeras in a unique cultural landscape that reflects the rural character of the region. In addition, by their physical characteristics, the traditional dams of New Mexico do not alter the natural flow in the river, always leaking enough for other uses downstream, what we might call a "minimum instream flow" that benefits fish species and other wildlife in the area. We need field-based studies to identify and inventory the extent to which these early irrigation works are present and evaluate the prospects for their continuity in these times of waning interest in traditional agriculture along with the myriad of external threats such as the commodification of water and pressures to transfer water rights to other uses.[8]

The effects of climate change no doubt will exacerbate the competition for water, where some policy makers will look to transfer water out of agriculture and move water "where it is most needed…i.e., cities and industries." Compared to other irrigation technologies in the Western Region of the country, acequias do not use fossil fuels, and they take surface water from streams only when it available and thus, are uniquely vulnerable to climate change reductions in snowpack runoffs in the spring and rainfall precipitation in the summer (Paula García 2022, p. 16). Under extreme conditions, low flows in the streams will not generate sufficient hydraulic head at the point of diversion to direct water into the acequia watercourse nor the gravity flow to push water to the *parciantes*' (landowners with water rights who are members of the local ditch) headgates along the length of the acequia. Water at the individual headgate is critical to proper and sustained functioning of the system. Under a worst case scenario, the "tipping point" of system failure will be breached when flows remain low and periods of prolonged drought result in a dry riverbed. Without water in the ditch, there is no point to organize spring cleanings, devise water sharing schedules, hold business meetings, pay assessments or elect commissioners and mayordomos.

Some encouragement comes from the growing interest in local food production and revitalization of traditional agriculture by the network and activism of acequia associations at the local, regional and state levels. Increased production, however, will depend on the efficient delivery of water at the compuerta of every acequia irrigator. This means that the physical infrastructure must be kept in working order, starting with the point of diversion and the system of headgates from the main river and from there to the *regaderas* (field taps or on-farm compuertas) that put water into the parcels of cultivated land owned and irrigated by the parciantes. Some acequia organizations might chose to apply for grants and other financial resources to improve and modernize their acequia infrastructure, always a local decision. But incentives could be provided in those communities that opt to maintain a traditional acequia system and presa. A historic preservation program could be initiated to support local efforts along with technical assistance to monitor and evaluate the condition of each presa by creating a register of designated structures and promote guidelines for their preservation and protection.

Model initiatives in support of preservation and local collaboration exist. Advocates in support of the acequia network situated in the heart of the town of Taos, for example, are currently engaged in a campaign to save the Acequia Madre del Río Pueblo, the mother ditch that splits off the three laterals running through the town that keep the valley floor green. The point of diversion is the Acequia Madre headgate located on Taos Pueblo land where the Pueblo and the town's acequias share water by taking turns under a rotation schedule. Saving the mother ditch and restoring the laterals implies keeping the main headgate diversion and the compuertas in the town in working order. Most of the water rights holders, however, no longer irrigate the gardens of the past, owing to urbanization projects that have broken links in the acequia system leaving some families without access to water. To counter the threats of continued deterioration, the commissioners of the ditch have created a community support group called "Friends of the Acequia Madre" that aims to bring awareness, raise funds, keep the water flowing, and preserve the town's water culture and history. The preservation strategy includes an appeal to "artists, writers, environmentalist and water lovers" to submit create ideas on how to educate, illuminate and celebrate the historic and cultural traditions of the Acequia Madre del Río Pueblo (for more information and to view maps of the acequia network see *Acequia Aquí*, The Paseo Project 2018).

At the state level, and as recommended by Kammer and Valdez (1992, p. 79), the Historic Preservation Division of New Mexico should conduct an updated survey of the state's historic acequias to preserve important elements of New Mexico's agricultural history as practiced in the upland valleys for centuries. Following the survey results, acequia communities could take the lead and prepare nomination reports for placement on the State Register of Cultural Properties and the National Register of Historic Places as was done in the 1980s for irrigation systems in La Tierra Amarilla of Río Arriba County (Wilson and Kammer 1989, pp. 110-116). Measures and incentives could be adopted to protect brush and rock dams, log diversion dams, stone alignment dams, earthen push-up dams, and other associated structures such as *tanques* (holding ponds)[9], hand-built rock and masonry headgates, wooden footbridges crossing acequias (*puentes*), *canoas* of hollowed out logs,[10] and *molinos* (traditional grist mills) in situ or where they still exist.[11] [Examples of these associated structures are featured in the photo gallery.]

Importantly, the acequia path itself should remain earthen as much as feasible. The use of gravity flow and flood irrigation in the fields are long-enduring technologies that characterize the acequia-based agriculture of the upper Río Grande region. These zanjas were carved from the landscape by hand, and they are cleaned out every spring during the *limpia*, a ritual that bonds the parciantes as a community. Easements on both sides of the acequia constitute a property right held as a commons that is essential to the operations and maintenance of the irrigation works. The annual cleaning known as "ditch day" affirms the easement right each time the parciantes take shovels to the site and begin the process of clearing silt, rocks and debris out of the channel as directed by the mayordomo. Many irrigation systems elsewhere around the world no longer maintain ditches by community labor or the use of shovels or other hand tools. In New Mexico the iconic symbols associated with traditional agriculture include the *pala* or shovel, the earthen canal or *zanja*, the *compuerta* or headgate, the *presa* or diversion dam, and the *mayordomo* or ditch boss.

The preservation goal, with the involvement of and concurrence by acequia officials and parciantes, would be to maintain the acequia and its associated properties in their original design as much as possible and rebuild in place when necessary due to flooding or other extreme weather events such as prolonged drought. Despite changes over time, these early technologies need to be preserved as examples of vernacular systems of water capture and distribution. Repairs, rebuilding or reconstruction, along with minor modifications of presas have been the tradition for centuries. Projects of this type often do not require capital outlay funding or loans as would be the case if the remaining traditional dams were replaced with structures built with concrete and other costly materials that require heavy equipment and fossil fuels inputs. The investment of community labor is already ingrained in the collective memory and traditions of parciantes as happens during the limpia. Activities and rituals that involve the acequia membership in relationships of mutual support, *mutualismo,* serve to reinforce community solidarity and strengthen the deep-rooted *querencia*, attachment to place and the land.

Inevitably, there will be some sections of the acequia infrastructure that have deteriorated beyond repair, and replacement of these components are the only solution. In most cases, however, modifications and the use of modern materials, will not disqualify the acequia system as eligible for programs of assistance that aim to preserve rural historic landscapes (Kammer and Valdez 1992, p. 74). In any and all rehabilitation projects, the key objective is to keep water flowing into and through the irrigation works, from the point of diversion to the acequia madre, and from there to the laterals and compuertas that take water to the crops in the fields. With dependable water delivery at the headgate, the essential components of the acequia tradition will survive, namely, diversions of surface water when available, gravity flow technology to push water through the system, communal labor to clean, operate and maintain the irrigation works, and adherence to acequia rules and regulations for water distribution and sharing. With or without modernization, acequia resilience, once again will prevail.

NOTES

1. See Thomas F. Glick, *Irrigation and Society in Medieval Spain* (1970) and Tomás Martínez Saldaña, Enrique R. Lamadrid, and José A. Rivera, "Mexican Indians and Genízaros: Soldier-Farmer Allies in the Defense and Agricultural Development of New Mexico" (2019). For irrigation practices by Anasazi and Puebloan cultures prior to Spanish colonization see James A. Vlasich (2005). For the transformation of the Pueblo landscape with the introduction of Iberian canal irrigation and other associated changes see Richard I. Ford (2021).

2. Rojas Rabiela and Gutiérrez Ruvalcaba, *Las presas efímeras mexicanas del pasado y del presente*, pp. 44, 48.

3. In 1760, decades before Humboldt wrote his testimony, Bishop Pedro Tamarón y Romeral of Durango had also travelled to El Paso and observed the irrigation canal

diverted from the Río del Norte. In a visitation report, Bishop Tamarón notes the use of cylindrical baskets filled with rocks as the method of damming up the river much like Humboldt's account. And he too acknowledges the yearly floods that take out the dam in the early summer months:

"*Está El Paso en treinta y dos grados y nueve minutos de latitud y en doscientos y sesenta y un grados y cuarenta minutos de longitud, tiene una gran acequia con que sangran el río del Norte, que cabe la mitad de sus aguas, ésta se subdivide en otras que corren por espacios llanadas, regándolas, con que mantienen gran porción de viñas…; siembran trigo, maíz y otros granos de la tierra, con árboles frutales, manzanos, perales, duraznos, higueras, en el verano es un país delicioso, padece aquel vecindario gran molestia con el río, la presa que hacen para sacarle sus aguas se la lleva todos los años su creciente, dura tres meses, mayo, junio y julio, me lo dijeron antes de llegar…; el modo de restaurar su presa, en cada un año, es fabricar unos cestones redondos de varas algo gruesas, en cesando las crecientes los meten el la corriente, los llenan de piedra y con su rebalso busca el agua la boca de la acequia, lo que ésta no necesita en su crecimiento, antes entra tanta agua que en siendo algo sobresaliente, andan de rebato, porque se aniegan o inundan con gran perjuicio*" (Alessio Robles, p. 328).

[Translation in Eleanor B. Adams *New Mexico Historical Review* vol. 28 no 3:

"El Paso is in latitude 32 degrees9', longitude 261 degrees40'. There is a large irrigation ditch with which they bleed the Río del Norte. It is large enough to receive half its waters. This ditch is subdivided into others which run through broad plains, irrigating them. By this means they maintain a large number of vineyards…. They grow wheat, maize and other grains of the region, as well as fruit trees, apples, pears, peaches, figs. It is delightful country in summer. That settlement suffers a great deal of trouble caused by the river. Every year the freshet carries away the conduit they make to drain off its waters. The flood season lasts three months, May, June, and July. They told me about this before I came….The method of restoring the conduit every year is to make large round baskets of rather thick rods. When the freshets are over, they put them in the current, filling them with stones, and they act as dams and force the water to seek the mouth of the ditch. This is not necessary when the river is in flood. Indeed, so much water flows that if the river is somewhat higher than usual, they are alarmed, fearing that they may be flooded and inundated with great damage" pp. 193-194.]

4. Original text in Humboldt from French translation of *Political Essay*, p. 217: "As the country is very dry, an irrigation canal brings the water of the Río del Norte to the Passo (El Paso). It is with difficulty that the inhabitants of the presidio can keep up the dam, which forces the waters of the river when they are very low to enter into the canal (azequia). During the great swells of the Río del Norte, the strength of the current destroys this dam almost every year in the months of May and June. The manner of restoring and strengthening the dam is very ingenious. The inhabitants form baskets of

stakes, connected together by branches of trees, and filled with earth and stones. These gabions (cestones) are abandoned to the force of the current, which in its eddies disposes them in the point where the canal separates from the river."

5. Original text in Leonard and Loomis, *Culture of a Contemporary Rural Community: El Cerrito, New Mexico*, 1941, p. 2: "As one approaches still closer to the cluster of houses, almost the full length of the little irrigation ditch that brings water from the river to the homes and numerous fields can be seen. This ditch is an engineering feat done without the aid or benefit of modern science. Its style of construction and the height of the banks built by annual cleanings give ample testimony of its age." (See photo by Irving Rusinow in the photo gallery)

6. For a detailed account of types of diversion works and construction materials in use during the turn of twentieth century, 1895-1928, see reports by civil engineers Herbert Yeo and Philip Harroun. Based on field surveys of irrigation conditions and water supply conducted along the Río Grande and its tributaries, they documented the use of a wide variety of temporary diversions: wing dams of brush and cobble stones as the most common, as well as wing dams made of posts, brush and mud. Other materials in use included rocks, posts, sand, sod, mud and gravel. In some locations, the diversions consisted of cuts in the riverbank with no structure in the riverbed. During the period of these surveys, most of the irrigation in place was by community acequias and the Indian Pueblos. Only a few private ditches were found.

7. For Bishop Tamarón's full report on El Reino de Nuevo México, see edited and annotated account published in 1937 by Vito Alessio Robles in Biblioteca Histórica Mexicana de Obras Ineditadas 7, *Pedro Tamarón y Romeral: Demonstración del Vastísimo Obispado de la Nueva Vizcays-1765*, pages 325-360. For an English translation of Alessio Robles, see Eleanor B. Adams, "Bishop Tamarón's Visitation of New Mexico, 1760." *New Mexico Historical Review* 1953 vol. 28, no. 2, pp. 81-114 and no. 3, pp. 192-221.

8. One starting point is to update the studies conducted by Neal Ackerly and associates where they included scores of photographs identifying the location of brush and rock diversion dams, flumes, headgates, check dams, wooden gates, field taps, siphons and wooden bridges along with their relevant characteristics. See Ackerly et al 1996, pp. 112-137; 1994a, pp. 215-246; and 1994b, pp. 197-228.

9. *Tanques* are storage ponds with earthen berms that store water for use by local acequias and are either spring fed such as those featured in the photo gallery (La Cienega near Santa Fe and Placitas near Bernalillo), or are small reservoirs fed by water taken from nearby creeks such as the lower and upper tanques at Paliza Creek near Ponderosa in Sandoval County, or medium-sized irrigation reservoirs as in the example of the Talpa

pond near Ranchos de Taos referred to as the *depósito*. There are also multi-purpose large reservoirs at Morphy Lake State Park in Ledoux near Mora and San Gregorio Lake within the San Pedro Parks Wilderness near Cuba. All of these ponds and reservoirs were created by way of earthen dams built by or at the direction of local acequia members.

10. For a report of still exiting and known to exist *canoas*, see Carol J. Condie et al, *Historic Wooden Water Flumes in New Mexico*. Condie and her colleagues describe the Pecos flume along with others at Lower Colonias, San Antonio de Padua near Cedar Crest, Tijeras Village (acequia molino canoa) and another at the Independent Ditch in Farmington, NM. They also acknowledge two other locations with known canoas: Trampas and Rancho de las Golondrinas. Some of the wooden flumes they examined were metal-lined either wedge shaped with bottom and side boards or constructed as a square box with milled lumber. The one at Lower Colonias was a single log split lengthwise and hollowed out with an adze. The adze is a tool similar to an axe but with an arched blade at right angles to the handle and is used for cutting or shaping large pieces of wood.

11. A few exiting or preserved *molinos* are featured in the photo gallery: the Córdova Grist Mill in situ at Vadito, the Cruz Molino from Trampas relocated to the property of the Cleveland Roller Mill, and the Barela Mill from Truchas and El Molino Viejo de Talpa both relocated to the Rancho de las Golondrinas. By way of historical photographs, at least two others are of record: “Remains of an old Mexican water mill” at a site along Río Vallecitos above La Madera, photo by W. J. Perry FS#183321 at Carson National Forest Historical Photographs/car012.jpg and “Old Mexican mill near Pecos, New Mexico October 1880”, photo by Ben Wittick, Courtesy of School of American Research, Museum of New Mexico, negative no. 15802. At one time, every farming village in northcentral New Mexico planted and harvested wheat as a staple crop and had a grist mill situated along the banks of the river. All mills, traditional and commercial, were powered by water flowing through local acequias as in the example of the Cleveland Roller Mill taking water from the Río Mora. In addition to the Cleveland Mill, other commercial grist mills in the Mora Valley were the St. Vrain and the La Cueva mills. They were major suppliers of flour and milled grain to the U.S. Army and its soldiers at Fort Union during the 1860s and later. The St. Vrain Mill was added to the National Register of Historic Places in 1972. The La Cueva Mill is the main structure in the La Cueva National Historic District.

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Appendix 1: Middle Río Grande Valley Irrigation Reports 1895 and 1910

Acequia heading extended into river channel at Isleta Pueblo July 1930.
Courtesy of the Middle Rio Grande Conservancy District, New Mexico.

"*While quite a large native American population has come into the Río Grande drainage in New Mexico since the construction of the railroads in 1880, it is confined principally to the towns, and today fully 90 per cent of the irrigating in this section is done by Mexicans and Indians. These people pursue their ancient methods of irrigation unaffected by modern progress*."

Such were the words of William W. Follett in a report about irrigation and water use on the Río Grande he presented during a meeting of the International Boundary Commission held in El Paso in November of 1896. His report was based on an inventory he had conducted of the canal systems along the main stem of the Río Grande between El Paso, Texas, and the San Luis Valley in Colorado. Additional investigations followed into the 1900s as the Bureau of Reclamation Service and other federal agencies examined irrigation conditions and water supply along the Río Grande and its tributaries. The civil engineers commissioned to conduct field surveys concurred with Follett's assessment that the acequias built by Mexicans and Pueblo Indians dominated the Río Grande system, but owing to the lack of modern construction materials, the temporary diversion works were found susceptible to damages during periods of high flows in the river.

One of the civil engineers conducted a study for the United States Geological Survey in 1895 and reported that the diversion works in the lower and middle Río Grande were made of "primitive construction." At each flood event, he wrote, these diversions "are washed out and replaced again when the river has fallen" (P. E. Harroun 1895). Later in his 1898 report to the Commission of Irrigation and Water Rights of New Mexico, Harroun was pointedly critical:

> The individual and community systems are crude in the extreme…. The method of irrigation is wholly that of flooding. When water is needed, the sluice boxes are opened, and the water is allowed to flow over the land until the irrigator is satisfied…. Such methods cannot be otherwise than wasteful of the water supply and detrimental to the lands served…. Investigation shows also that much of the great scarcity of water complained of in the middle and lower Río Grande valleys is due, not to a lack of water in the river, but to a failure of the irrigation system, either from high water carrying away the primitive dams, or to breaks in the ditches, rendering it impossible to operate the system (Harroun 1898, pp. 1-4).

For his reconnaissance, Follett first travelled to northcentral New Mexico and southern Colorado before heading to the Middle Río Grande Valley. When Follett left Santa Fe, he noted that through much of the Middle Río Grande, from below White Rock Canyon and as far south as San Marcial, the river enters a long and narrow valley with "a wide, sandy and ever-shifting bed of the river" pp. 19-20. The shifting bed of the Río Grande helps explain why the acequia farmers in the region opted to build temporary diversion works that could be rebuilt with locally available materials and the use of community labor. Modern equipment and more durable construction materials were not readily available or affordable, and even if built, permanent dams in the riverbed would become obsolete with each change of the river channel.

Of interest today are the early technologies used by acequia irrigators to build diversion works despite insurmountable challenges of capturing variable and unpredictable flows in the river. In places where the temporary dams were destroyed, rebuilding took investments of labor, a renewable community asset, and we surmise that abandonment was not an option. Subsistence agriculture was the mainstay economy for most rural New Mexicans since the time of the first settlement and lasted well into the twentieth century. To their credit, the acequia farmers of the Middle Río Grande Valley persisted in their use of diversion headings on the river for generations. The Villa de Alburquerque was founded in 1706 when the Rancho de Atrisco was already in place as a farming community following issuance of the Atrisco Land Grant in 1692. In Follett's inventory of acequias in the upper and lower Albuquerque districts, he dates construction of the Pueblo acequias as "very old," the Bernalillo acequia to 1700, Duranes and Albuquerque to 1706, and the others "before 1800."

When a series of floods between 1897 and 1924 caused severe damage to communities and farmlands along the Albuquerque districts, the state legislature of New Mexico responded by creating a flood control and irrigation authority in the 1920s naming it the Middle Río Grande Conservancy District. Increased development and deforestation upstream on the river basin, rapid degradation of the floodplain from sedimentation, and damages from high groundwater tables on the land had made farming and direct headings from the Río Grande unsustainable. These changed conditions led to removal of the centuries old acequia diversion works on the river, and by 1936 they had been replaced with a system of modern dams, new canal alignments, siphons, and feeder canals.

The acequias were retained as laterals of the MRGCD canals with headings no longer from the river but from the canals managed by the MRGCD. The original acequias stayed under community ownership with prescriptive easements granted to the MRGCD for operations and maintenance. Today most of the acequia infrastructure throughout the Albuquerque area remains in the traditional design as earthen canals, a feature that serves multiple beneficial functions. The irrigation network of leaky ditches recharges the aquifer while keeping the valley floor green with small farms, gardens and pastures, cottonwood trees, willows, and other native plant vegetation growing along the canal banks, a habitat that supports other biological communities and wildlife. Easements along the acequias and associated drainage canals also provide urban dwellers and rural neighbors with nature trails for jogging, horseback riding, bird watching, fishing and other open space recreation. [For a map of the current irrigation network from Algodones to Isleta Pueblo, see the Acequia Field Guide: *Acequias of the Middle Río Grande Valley* by Emily Vogler and Jesse Vogler 2018.]

The reports by Harroun and Yeo below are important sources of information since they document the state of irrigation and crops grown when Pueblo Indian ditches and community acequias in Mexican settlements were in full operation drawing water directly from the Río Grande. In some instances, the Pueblo Indian and the Mexican acequias were intertwined: the Santa Ana acequia discharged its surplus into the Bernalillo canal; the Bernalillo canal discharged into the Sandia acequia; and the Sandia into the Alameda ditch. The diversion works noted in the reports provide snap shots representing not only those historically in use along the Middle Río Grande Valley but also found in other districts of the river as well as acequia diversions on other streams and creeks throughout New Mexico. Today, only the acequias in the Velarde-Alcalde stretch of the Río Grande in northern New Mexico continue to divert water from the main stem of river, by now with modernized dams. Acequias elsewhere, however, such as those on the Ríos Jémez, Chama, Embudo, Nambé, Mora, Pecos, Mimbres and the streams in the Taos, Pojoaque and Hondo Valleys, continue to divert water directly from their river sources. Appendix 2 Photo Gallery includes examples of former and still operating diversion works whether traditional or modernized.

1895 Report: Philip E. Harroun, “Rio Grande Valley Near Albuquerque,” United States Geological Survey. W.S. Paper No. 140. A field investigation of ten acequias along the left (eastern) bank of the Río Grande between San Felipe Pueblo and Albuquerque conducted on August 20-30, 1895. On file at Office of State Engineer Library in Vol. III Doc. 770 of Herbert W. Yeo 1929 Report on Investigations in the Rio Grande Basin in Texas above Fort Quitman and in New Mexico during 1907, 1920, and 1928, pp. 99-111.

From Harroun’s introduction: “*The portion of the valley of the Río Grande on the east side of the river, between Albuquerque and the Pueblo village of San Felipe, affords a typical illustration of the method of irrigation practiced by the Mexican communities of this portion of the territory at the present time…. [T]he Santa Ana and Sandilla [Sandilla] are controlled* entirely by the *Indians of those pueblos, but these canals differ in no respect from those constructed by the Mexicans…. These ditches present many features in common, but their individual discharge, area, velocity and similar details are of interest. The following descriptions are based upon the results of a field examination made between August 20 and 30, 1895*.

Selected Entries:

The Algodones Ditch supplies the lands adjacent to and below the villages of Algodones and Angostura…. The head of this ditch is formed by a wing dam constructed by driving cottonwood stakes into the river bottom and interlacing fascines of brush between them. The brush is then weighted with boulders and the inner slope sodded to make it as tight as possible. This dam extends into the river parallel to and about 25 feet from the east bank for a distance of about 800 feet from the point where the ditch proper begins. Its height averages about 2 feet, and it fulfills the function of a regulator, as when the river rises the water spills over the entire length of 800 feet and enters the ditch at a fairly constant level….At the tail this ditch passes under the Santa Ana ditch through an ordinary box culvert and discharges it surplus water into the Bernalillo Ditch.

The Santa Ana ditch is controlled wholly by the Indians of that pueblo, and is used to irrigate their lands, which extend opposite and for some distance below the town of Lagoons. This ditch has no headworks of any description, a cut being made in the bank of the river and the water drawn off…. At the tail, it discharges into the Bernalillo ditch.

The Bernalillo ditch is the next in order, its head located about 2.2 miles above Algodones. The current of the river is directed toward the mouth by means of a stake and brush dam of the same description as that of the Algodones ditch, except that this dam is carried diagonally across the river from bank to bank. From the head, the ditch extends for a distance of 4.4 miles to the upper edge of the town of Bernalillo, where the first service is required. From there it is carried along the edge of the foothills and finally into the Sandilla [Sandía] ditch, 7.9 miles from the head.

The Sandilla [Sandía] ditch is controlled entirely by the Indians of that pueblo. Its head is immediately opposite the town of Bernalillo, and consists of an open cut, with no dam. Service is first required at the pueblo of Sandilla, 4.2 miles below the head, and it carried from there 3.4 miles below, where the ditch tails into the Alameda.

The Alameda ditch heads opposite the settlement of Corrales on the east branch [sic: bank?] of the river. It has the ordinary brush-diverting dam common to the section…. Irrigation under this ditch first begins one-half mile below the head and is carried nearly continuously to the tail, a distance of 4.3 miles where it is turned loose upon the land, much of its waters forming swamps, and finding its way into Los Ranchos ditch.

Los Ranchos ditch heads immediately above the Rio Grande bridge at Corrales. Its head is an open cut…. From the head, the ditch is carried a distance of 4.6 miles, where it bifurcates, one branch being carried toward the foothills and through the upper portion of the town of Albuquerque, while the other branch turns to the west and discharges into the Varela ditch, after passing under Los Griegos ditch.

Los Griegos ditch [has the] open-cut variety…. It passes through the town of Albuquerque and discharges through the flats below to the river.

The *Varela ditch* heads about one-half mile below Los Griegos, in a bend in the river. At the time of examination there was no running water, as the river had fallen 1 foot below the bottom of the ditch. It was being cleared of silt, deepened, and carried up the river, where a brush dam was to be constructed to overcome the difficulty.

Duranes ditch heads 3 miles above the old town of Albuquerque, passes below the town, and tails about 1 mile further down…. It has a common brush dam diverting about 11 cubic feet per second when at full capacity.

Albuquerque ditch, the last of the series, heads 1,500 feet below the Duranes ditch, and is of the same class…. A dike along the river protects the lands from floods. One-half mile below the head, it crosses under the Duranes ditch, passes to the east and through between Albuquerque and Old Town, tailing out in the same vicinity as the Duranes.

(1910 Report on Next Page)

Wing dam at sandbar. View of Río Grande from Isleta Highway Bridge 1931. Courtesy of the Middle Río Grande Conservancy District, New Mexico. Note the use of posts, willows and mesh to support the structure.

1910 Report: Herbert W. Yeo, Report on Irrigation and Water Supply on the Río Grande and Its Tributaries in New Mexico. In José A. Rivera Papers, MSS 587 BC, at Center for Southwest Research, University of New Mexico Libraries, Box 1 Folder 12, pp. 48-102. A general description of the Río Grande Valley and other irrigation districts of New Mexico with tabulations as to locations of acequia heads, diversion works and other data. Yeo was employed by the United States Reclamation Service from 1908-1917 and later was appointed as the State Engineer of New Mexico, a position he held from 1927-1931.

Selected Entries:

Acequia Las Nutrias: The heading of this ditch is about one mile south of Sabinal station and ends below the plaza of Las Nutrias. The diversion works consist of a brush and mud wing dam.

Acequia La Joya: The heading of this ditch is on the east side of the Río Grande nearly west of the Plaza of Las Nutrias. The diversion works are a temporary dam consisting of brush, mud, etc.

Acequia Sausal: The heading of this ditch is about three miles north of Belen wagon bridge and irrigates land in the small plaza of Sausal. The diversion works were a brush and mud wing dam retained in place by posts which were driven into the riverbed.

Acequia del Pueblo de Isleta, or Acequia de los Indios: The heading of this ditch is on the west side of the Río Grande, east of the plaza of Pajarito. This ditch is probably ancient as it is believed that the Pueblo of Isleta has moved but little, if any, since the time of Coronado. The diversion works are temporary, and when examined on September 9, 1910, consisted of a wing dam of brush, sod and mud…. The area irrigated under this ditch was estimated at 700 acres and the additional area that might be irrigated at 500 acres. All lands irrigated are within the Pueblo of Isleta Grant. The methods of irrigation were quite good. A considerable quantity of fruit, grapes, apples and peaches are raised by this Pueblo and hauled long distances for sale.

Acequia Pajarito: The diversion works were examined on September 14, 1910 and are temporary. They consisted of a long wing dam nearly 2,000 feet in length which was built at an angle of about 45 degrees to the bank. This was made in part by driving posts into the riverbed and placing about them brush and mud, and in part by a dike of sand and mud thrown up by slip crapers [sic, scrapers?]. This was being repaired on the day of the examination.

Acequia Los Griegos: The heading of this ditch is about one and a half miles south of the steel bridge which is below the town of Corrales. The diversion works were of singular construction. A temporary dam was made by driving into the riverbed posts and poles and weaving brush about and between them, and then throwing sods and mud against this brush work. This was made in an effort to divert the river to a channel on the eastern side of the riverbed, but it was not operating successfully at the time of examination but seemed to have so earlier in the season when the river was higher and before any small channel had eroded. The angle was about 60 degrees with the bed of the stream.

Acequia Los Ranchos: The diversion works are a cut in the river with nothing else. At about one-quarter mile below the head is a big regulating gate which regulates the supply when the river is high.

Acequia Alameda: The diversion works on the day of examination were a brush and mud wing dam formed in the usual manner of this section, by driving posts into the riverbed and entwining brush.

Acequia Madre de Corrales: The diversion works were temporary.

Acequia Montoyo [sic, Montoya?]: The heading of this ditch is on the west side of the Río Grande about two miles below Bernalillo. There were no diversion works on the day of examination, September 15. A temporary diversion dam had been made in May, but a flood came down the river and washed it away and no other had been built. The head of the ditch was in a cut bank and was about two feet above the riverbed. There was only very little irrigation this year and that before May.

Acequia Sandía: The heading of this ditch is on the east side of the Río Grande, west of Bernalillo and at the wagon bridge. The diversion works were on the day of examination, September 17, 1910, a ditch running from the proper head of the ditch, through a sand bar to the channel which was carrying the water on the west side of the river. This ditch across the sand bar was run at an angle of about 50 [30?] degrees from the bank. This ditch was quite serviceable, but the ditch was not carrying its full capacity, but probably as much as was needed for irrigation at that time.

Acequia Bernalillo: This ditch has its heading on the east side of the Río Grande nearly west of the plaza of Algodones. It irrigates land mostly in the vicinity of Bernalillo and is about six miles in length. The diversion works are temporary, being of stakes and brush. The ditch was examined September 19, 1910. The cross section is quite variable for a ditch in the floor of the Río Grande. At the arroyo at Costura, the bottom width is 4 feet and the velocity 1.75 feet per second. The method of crossing this arroyo is unique for a community ditch. The ditch is carried under the arroyo in a 4’ by 4’ wooden culvert, and the top of the culvert is flush with the bottom of the arroyo. The bottom of the arroyo had evidently been graded and is comparatively narrow. There are embankments on either side about six feet high and with slopes which are probably 1 to 1 and on the inside faced with concrete which had been mixed rather dry and thrown upon the embankments and then tamped with a shovel or some other tool. There were evidently no forms used and the job was a good one and seemed to answer the purpose very well…. The capacity of the ditch is greater at Bernalillo than at its head. It receives surplus water from the Santa Ana ditch and the Algodones ditch.

Acequia de los Ranchitos del Pueblo de Santa Ana: The heading of this ditch is on the east side of the Río Grande about one mile south of the Pueblo of San Felipe. There are no diversion works. The ditch is constructed to the riverbank and the current being at the opening, water is diverted without any diversion works…. This ditch crosses under an arroyo at Costura in a wooden culvert similarly to the Bernalillo ditch…. The date of construction was not learned, but it is probably one of the prehistoric ditches. The ditch is used by the Indians of the Pueblo of Santa Ana. This pueblo is on the north bank of the Río Jémez about 15 miles as the road is located, from the ranchitos. Each year these Indians raise their crops on their ranchitos and haul them to their pueblo over one of the most sandy roads ever seen by this writer, and use them while they remain in their pueblo over the winter. The reason assigned for this semi-annual migration is, that at the Pueblo of Santa Ana there is a church for the Indians. It is also probable that their secret pagan ceremonies can be more easily observed there. The sentimental associations of the pueblo are incomprehensible to a white person.

Acequia del Pueblo de San Felipe-West Side: The government sometime in the past put a weir for this ditch, but four years ago a portion on the east was washed away, and this damage and subsequent damages have never been repaired.

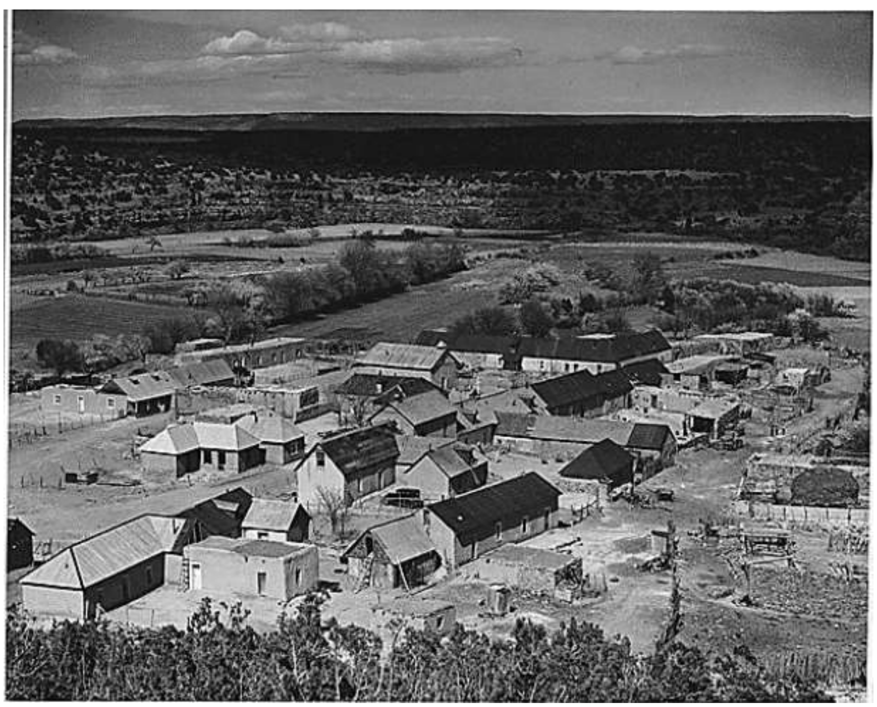
Acequia Algodones: The heading of this ditch is on the east side of the Río Grande about one-quarter mile below the Pueblo of San Felipe. This irrigates lands in the vicinity of Algodones and wastes into the Bernalillo ditch. The diversion works on the day of examination, August 20, 1910, were a wing dam over 1,000 feet long and built upstream with an angle of 50 [30?] degrees to the east bank. This dam was the common one of the poles driven into the sand and brush and sod placed over these poles. A comparatively small amount of water can spill over it without seriously injuring it. Such a dam will stand much more water spilling over, where the riverbed is gravel.

Acequia Peña Blanca: This ditch has its heading on the east side of the Río Grande about 100 feet north of the wagon bridge which is built across the river above the Pueblo of Cochiti, and below the tie plant in White Rock Canyon. The main body of the irrigated land is in the vicinity of Peña Blanca, which is about three miles from the head of the ditch. The diversion works are singular. Wickerwork cylinders made of willows, three or four feet long and a foot and a half to two feet in diameter, and open on one end (and very probably open on both ends) were made. These cylinders were placed diagonally to the channel and were set upright and filled with gravel, as it was nearby in the bluffs. Brush was placed on the upper side of these then gravel and sand, and a good diversion was made…. It is very probable that this ditch wastes into the Santo Domingo ditch. The summer floods from the Santa Fe River are a source of trouble to this and to the Cochiti ditch. These cross the riverbed in an open cut and are destroyed every time there is a freshet in the river.

(Appendix 2 on Next Page)

Appendix 2: Photo Gallery *Photo Credits as Marked. All Others are by José Rivera. Years indicate when photo was taken and may not reflect the current condition.*

Brush and Rock Dam on the Río Pecos NM c. 1917.
Museum of NM Photo



El Cerrito NM 1941. Irving Rusinow Photo in National Archive and Records Administration (NARA)

El Cerrito NM 1941 Old Dam of Brush and Rocks. Irving Rusinow Photo in NARA

El Cerrito Remnant of Cement-Capped Brush and Rock Second Dam. Intake for Ditch at New Dam in Background. Sharon Stewart Photo June 2002

El Cerrito Modern New Dam. Sharon Stewart
Photo February 2012

El Prado Presa of Logs for Acequia del Medio Near Buffalo Pastures
Taos NM. April 2000

El Rito NM Presa of Stone Alignment & Chain Hoist Gate at Low Flow.
October 2010

El Rito NM Presa of Stone Alignment & Chain Hoist Gate during High Flow. March 2012

Encinal & Cañoncito Community Ditches Trans-Basin Diversion
at Alamitos Creek before Modern Replacement. September 2017

Encinal & Cañoncito Community Ditches Trans-Basin Diversion
Gates Dividing Water for Use in Each Community. September 2017

Flushing of La Cuchilla in Early Spring by Desmontes Mayordomo and Crew. April 2013

La Limpia at Embudo Acequia April 2013. Donatella Davanzo Photo

LeDoux Small Dam Dividing Water San José and La Isla Acequias.
Poured Concrete Base & Logs. June 2000

LeDoux Oldest Diversion of Rocks and
Bags Filled with Dirt for Three Acequias.
Harold Trujillo Photo April 2021

LeDoux Oldest Diversion with Three Mayordomos Working to Divide Water. Harold Trujillo Photo April 2021

LeDoux Steel Diversion for Acequias De la Aguila and Otra Banda. Harold Trujillo Photo 2021

Missions of El Paso at Río del Norte. Fray Menchero Map 1745

Missions of El Paso Irrigation Ditches (No Dam).
Fray Menchero Map 1745

Monticello NM Earthen Push Up Dam on Alamosa Creek.
Luis Pablo Martínez Photo March 2013

Monticello NM Earthen Push Up Dam on Alamosa Creek.
Luis Pablo Martínez Photo March 2013

Puerto de Luna Modernized Presa near Santa Rosa NM. Chris Babis Photo October 2013

Rainsville Gabion Stone Wall with Concrete Cap on Río del Coyote near Mora NM. June 2001

Río Chama Modern Presa Shared by Chamita and Hernández Acequias
Near Española NM. May 2001

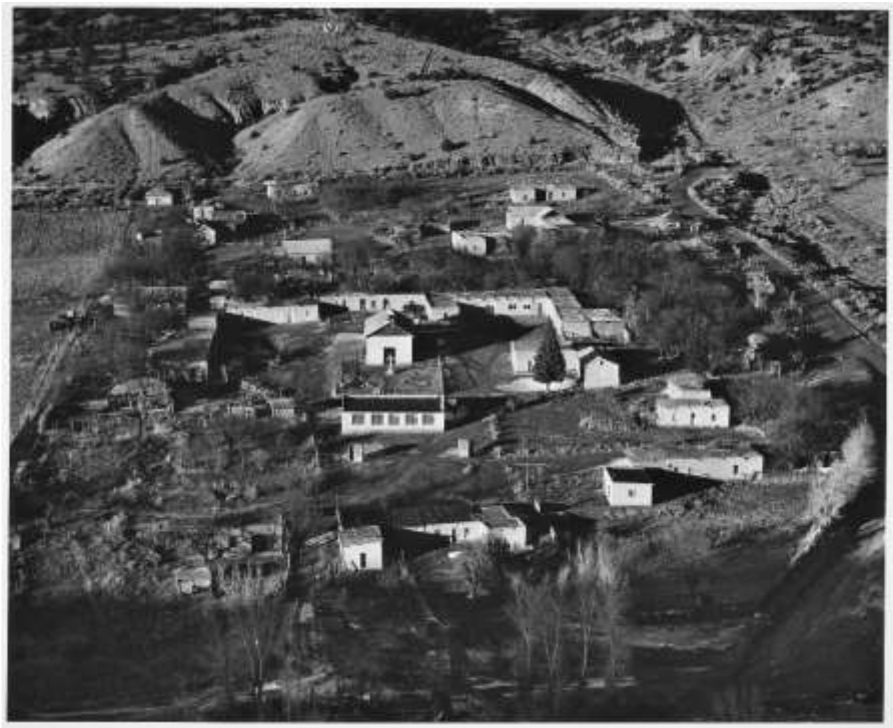
Río Chama Reinforced Ditch and Footbridge at Chamita. May 2001

Río Embudo Rock Diversion at Low Flow. Tom Glick and Estevan Arellano April 2011

Río Embudo Rock Diversion during High Flow. Denise Bleakley Photo March 2005

Río Grande Rocks Topping Concrete Base for Acequia at El Guique NM.
April 2000

Río Grande Rocks Topping Concrete Base for Acequia at El Guique NM.
April 2000



Río Hondo at Valdez Plaza NM 1941. Irving Rusinow Photo NARA

Río Hondo Bocatoma Prando Acequia at Valdez NM. June 2009

Río Hondo Bocatoma & Tapia San Antonio Acequia at Valdez NM.
June 2009

Río Hondo La Cuchilla Diversion at Valdez NM. Mortar and Stones.
April 2012

Río Hondo La Cuchilla Diversion at Valdez NM. New Headgate.
Sylvia Rodríguez Photo May 2021

Río Hondo La Cuchilla Partidor for Desmontes Acequias. April 2000

Río Jémez Presa Logs and Boulders for Jémez Springs South Side Upper Ditch. August 2000

Río Jémez Log Presa for Jémez Springs Community Ditch. August 2000

Río Jémez Log and Boulder Presa for
West Side Ditch at Jémez Springs NM.
August 2000

Río Jémez Stone Alignment for Diversion to Sandoval Ditches East and West. August 2000

Río Mora Presa of Logs Diverting Water for Hydro-Power Roller Mill at Cleveland NM. September 2000

Río Mora Presa Takes Water to Cleveland Roller Mill. September 2000

Río Pueblo de Taos Acequia Madre Old Flume. Sylvia Rodríguez Photo June 1995

Río Pueblo de Taos Acequia Madre New Flume. Sylvia Rodríguez Photo November 2019

Traditional molino at Córdova family property in Vadito NM
July 2000 before remodel. Also known as The Cordova Grist Mill.

Traditional molino at Córdova family property in Vadito NM.
Renovated horizontal wheel after remodel June 2012

Traditional molino footbridge at Córdova
Acequia del Molino Vadito NM. June 2012

Traditional molino from Barela family of Truchas NM at Rancho de Las Golondrinas October 1999. Also known as the Barela Mill.

Traditional molino from Talpa NM at Rancho de las Golondrinas
April 2000. Also known as El Molino Viejo de Talpa.

Traditional molino from Cruz family of Las Trampas NM during
Annual Festival at Cleveland Roller Mill. September 1999

Trans-Basin Acequia de la Presa Old Rock Diversion and Headgate at
La Junta for Chacón in Mora Valley NM. September 1999

Trans-Basin Acequia de la Presa Modernized Diversion at La Junta for Chacón
in Mora Valley NM. Sharon Stewart Photo March 2018

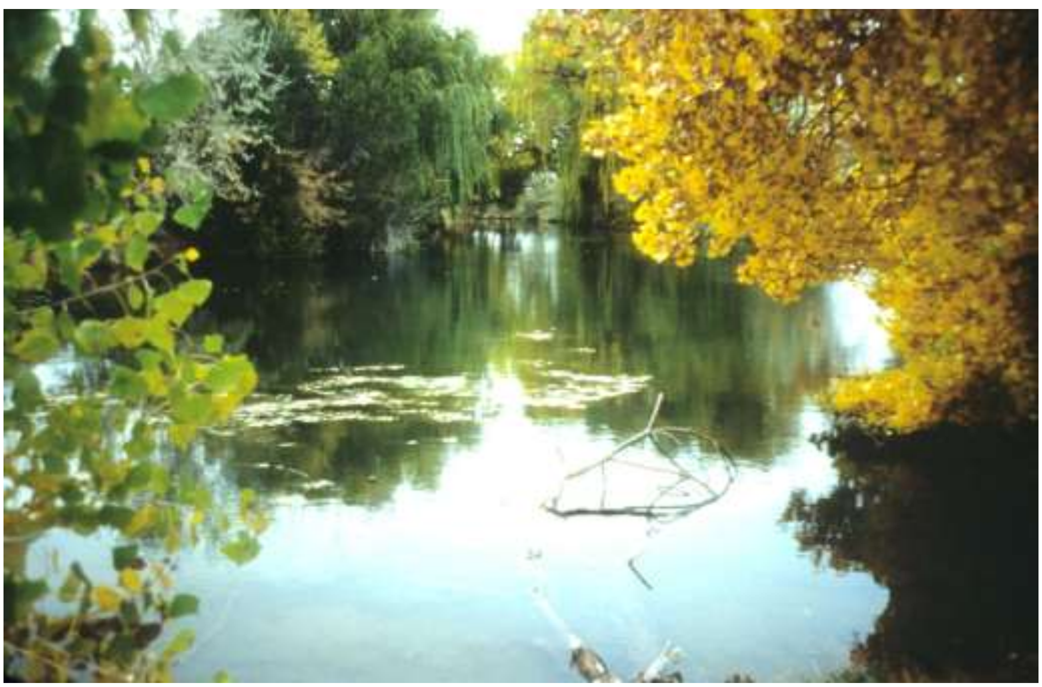
Trans-Basin Acequia de la Presa Waterfall
Gauge and Headgate for Chacón. June 2007

Trans-Basin Acequia de la Sierra Headgate for Holman in
Mora Valley NM. June 2008

Trans-Basin Acequia de la Sierra Waterfall
Cascades for Holman NM. June 2008

Trans-Basin Acequia de la Sierra Gates at Holman NM.
June 2008

Tanque at La Cienega near Santa Fe. May 2000



Tanque at La Cienega near Santa Fe. May 2000

Tanque for Acequia del Oso at Placitas NM near Bernalillo. August 1999

Tanque for Acequia de la Ciguela at Placitas NM near Bernalillo. August 1999

Velarde Old Brush and Rock Dam on the Río Grande. Paul Logsdon Photo
July 1986

Velarde Modernized Dam and Floodgate on the Río Grande. October 1999

Wood Compuerta Rio Arriba County 1938. Museum of NM Photo

Wood Compuerta Río Arriba County 1938. Museum of NM Photo

Wooden Canoa at Córdova NM c. 1938. Museum of NM Photo

Trestle support for community acequia pipeline in a wooden box
at La Bajada NM. Arnold Valdez Photo 2009

Wooden canoa at Las Trampas NM Winter 1979. Alex Harris Photo

Wooden canoa at Las Trampas NM taken down for replacement.
June 2008 Photo

Wooden canoa at Las Trampas NM. Replacement canoa June 2008
Photo