Two Mile Reservoir
On the Santa Fe River
At the Intersection of Upper Canyon Road
and Cerro Gordo Road
City of Santa Fe
Santa Fe County
New Mexico

HAER No. NM-5

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NM
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain System Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

NOTE: REFERENCES TO PHOTOGRAPHS SHOULD READ "HAER No. NM-5- ," NOT "NM-4- ."

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HISTORIC AMERICAN ENGINEERING RECORD
TWO MILE RESERVOIR
Santa Fe, New Mexico

I. INTRODUCTION

Location:	Two miles east of the plaza in Santa Fe, New Mexico near the intersection of Upper Canyon Road and Cerro Gordo Road, Santa Fe County.
Quad:	Two Mile Dam, New Mexico
UTM:	East 419080, North 3949400
Date of Construction:	1893
Present Owner:	Sangre de Cristo Water Company, a subsidiary of Public Service Company of New Mexico

Present Use:

Prior to the initiation of Historic American Engineering Record (HAER) documentation, the reservoir was drained, sludge was removed, and plans for the emergency breach were in progress. Currently the dam has been breached, and a 10 acre foot (12,335 m^3) pond has been created on the upstream side. Most water runs through the diversion channel at the southern edge of the reservoir, but some runs through pipes in the Old Stone Dam and a small tri-level, stone filter system down the natural river channel to the pond (Drawing 2/4). Water is expected to run through the breach only when there is a standard project flood or other such emergency flow situation.

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Significance:

Two Mile Dam, constructed in Santa Fe, New Mexico in 1893, embodies the distinct characteristics of a tamped earth dam, through its design and construction techniques. These methods began in the 18th century and with some modifications are still being used today. The dam was designed to reduce interior hydrostatic pressure and was constructed using goats to puddle the earth.

The engineered design incorporated methods, including seepage collars and variation of material, to reduce the amount of water inside the structure. Concrete seepage collars stop water from travelling along the tunnel underneath the dam (Drawing 2/1). Earthen material was varied to slow the movement of water through the dam. The upstream portion of the dam was constructed using small particle fill, such as silt and clay, and was packed to achieve high density and the downstream portion of the dam was constructed using larger fill, consisting of sand and gravel (Drawing 2/1). Earthen dams have a line of saturation that should exist in relative equilibrium (Drawing 5/6). Varying the material to create a relatively impervious upstream slope and a pervious downstream slope aids in protecting the dam from failure through saturation.

Two Mile Dam is one of the largest embankment dams in New Mexico, was the largest dam constructed at the time, and was used for both irrigation and potable water supply. Montezuma Dam, an earthen dam near Las Vegas, New Mexico, constructed after Two Mile, was approximately 20-25 ft (6-7 m) high and retained water for ice skating and ice supply.[1] The construction of Two Mile Reservoir was a large undertaking which created substantial water supply for the City of Santa Fe, gained national attention, and was a catalyst for the urbanization of Santa Fe.

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II: ADMINISTRATIVE SUMMARY

Historian: Karen Lewis, Mariah Associates, Inc.

Date of Research: May and June 1994

Sources Searched:

American Society of Civil Engineers, New York City
Bureau of Land Management
Linda Hall Library, Kansas City
Museum of New Mexico, Records and Archives
New Mexico State Engineer's Office
New Mexico State Records Center & Archives
PNM Forerunners
Public Service Company of New Mexico Archives
Randall Davey Audobon Society
Sangre de Cristo Water Company Archives
Santa Fe City Library
Santa Fe County Courthouse
SHB AGRA Reports and Drawings
State of New Mexico Library
University of New Mexico, Engineering Library

Methodology:

Mariah Associates, Inc. (Mariah) was contracted on May 16, 1994 by the Public Service Company of New Mexico (PNM) to complete the work stipulated by the Two Mile Dam and Reservoir Memorandum of Agreement between the New Mexico State Historic Preservation Office (SHPO) and PNM. At that time, the State Engineer had required an emergency breach to be completed by the end of May for public safety reasons. The dam had been deemed unsafe

due primarily to excessive rodent and tree root holes on the downstream slope. The tight deadline left little time to secure proper documentation before the demolition began.

Prior to initiation of the Mariah HAER contract, Environmental Compliance and Development Corporation (ECD) had been hired to remove years of sediment which had been washed into the reservoir from the treatment plant decant ponds. While engaged in pumping sediment from the bottom of the dam to pools on the southern edge near the spillway, Chava Trucking, ECD's sub-contractor, inadvertently damaged the upstream side of the dam (Photographs HAER No. NM-4-2, NM-4-5, NM-4-6). Also, when the strainer inlet was being cleaned by ECD divers (Photographs HAER No. NM-4-7, NM-4-8), water rushed through the tunnel and disturbed earthen areas on the downstream side of the dam around the tunnel and gate valves, as well as pulling one of the divers against the outlet.

Thus, prior to visiting the site, there was damage to the cultural resource; each day Sangre de Cristo Water Company hoped to begin demolition in order to meet the State Engineer's deadline. Given this situation, the Mariah team immediately began on-site documentation, in order to retrieve as much information as possible prior to demolition. Ms. Lewis consulted the Corps of Engineers (COE) and the SHPO, and developed a list of important features to document, since there was not time to conduct archival research to identify these elements. The site was mapped with a total station and data collector, 4 x 5 large format photographs were taken of the dam and site features, and important features were mapped with the total station and further dimensioned with a 100 ft (30 m) tape measure.

The impacted features were documented prior to the initiation of demolition. In addition to the dam itself, the Mariah team mapped two groups of stone alignments inside the reservoir. The features that were not completely documented for the emergency breach but were completed at a later date, included the spillway and the diversion channel. Once demolition began, Ms. Lewis was on-site to monitor the work. It was expected that the contractors would unearth the concrete

seepage collars that were shown in the 1893 drawings. The collars were not located, but some small artifacts, such as shovel heads, leather straps, and miscellaneous metal tool parts were recovered during the breach excavation.

A foundation on top of the dam, not integral with the structure of the dam, was noted prior to initiation of the breach (Drawing 3/6). Before the breach demolition began, the foundation was unearthed and documented. It appears that the small building may have been a powerhouse or small gate valve control facility. The top of the dam also had two "brass caps" that were removed during demolition. One was a USGS section corner and the other a Santa Fe Control Monument.

Once the earth moving for the breach had been completed, Ms. Lewis began the archival research. *Daily New Mexican* articles contained more information about construction of the 1881 Old Stone Dam than about Two Mile Dam. The Sangre de Cristo Water Company archives revealed historic drawings, many photographs, *Daily New Mexican* transcripts, a history manuscript, reports, letters, and meeting minutes about Two Mile Dam throughout its history. There were no original construction drawings giving sections or dimensioned details at Sangre de Cristo Water Company, PNM, or the City of Santa Fe. The Santa Fe City Library collection consisted primarily of resources about the acequia systems and laws in northern New Mexico, and the State of New Mexico Library provided various planning documents. The New Mexico State Records Center & Archives provided additional newspaper clippings with reference to the breach, maps, deed information, and census data. The Santa Fe County Courthouse provided historic deeds, agreements, and other legal documents. The University of New Mexico, Engineering Library provided a microfilm copy of the *Engineering News and American Railway Journal* article and historic books on the construction of earthen dams. SHB AGRA reports and construction documents were used to trace dam failure and develop HAER documentation graphics. The Museum of New Mexico, Records and Archives provided documents about dams in New Mexico, and photographs and maps of the reservoir area. The State Engineer provided

some historical data and information about earthen dams in New Mexico. The Bureau of Land Management (BLM) provided some plat information and PNM provided some maps of the dam and surrounding area. The PNM Forerunners provided some oral history and knowledge of the dam systems. The Randall Davey Audobon Society is housed in one of the old mills but could not provide much information.

The American Society of Civil Engineers (ASCE) recommended the Linda Hall Library in Kansas City. The Linda Hall Library is an independent library in the areas of science and technology. The library will be receiving the ASCE collection at some point in the future. ASCE does not have an operational library, since they are planning to send their collection to the Linda Hall Library, and apparently the transfer is tied up in the New York Supreme Court. Although Linda Hall searched for information on the Two Mile Dam engineers and did not turn up any sources, they believe when they receive the ASCE collection they may have relevant information.

Deed and Plat information gathered at the Santa Fe County Courthouse and the BLM was used to develop base maps to trace ownership of the Reservoir Land. Unfortunately, plat and deed drawings and descriptions did not lead to a comprehensive layout or history of the land and land transactions.

III: HISTORICAL INFORMATION

Date of Erection:	1893
Engineer:	J. M. Howells, C.E. (Chicago)
	P. E. Harroun, C.E. (Santa Fe)
Developer:	Santa Fe Water and Improvement Company

Historical Narrative:

In October of 1880, the Board of County Commissioners, Santa Fe, in the Territory of New Mexico, executed a legal instrument which provided the Santa Fe Water and Improvement Company with the exclusive right and privilege of erecting dams and reservoirs for impounding water on the Santa Fe River. The commissioners felt that a water system would be beneficial to Santa Fe's image through its civilizing effects. The water company board consisted of Dr. E. Andrews, President; Fred Sandoval; J. P. Kennedy; P. F. Herlow; S. H. Lewis; and Enos Andrews. The grant to the water company included exclusive rights to impound water in "an easterly direction of ten miles," to erect roads and railroads to provide transportation to and from the dam and reservoir, and to construct telegraphic, telephonic and phonographic lines. The grant also allowed for the "...construction, introduction, distribution, maintenance and operation of electric lights, sewers, sluices, drains, aqueducts, conduits and waterways...provided that this grant shall in no manner be construed to affect the rights of private individuals."[2]

In return for the above, the Santa Fe Water and Improvement Company was required to furnish an adequate water supply to the city by completing a series of three reservoirs and installing water pipes within 3 mi (4.8 km) in every direction from the center of the monument in the Santa Fe plaza. In addition, the water company was to supply the water at reasonable rates. It was the rights of private individuals initially, and later the high rates, that caused controversy over the reservoir system and the water company. Early on, there was a disparity between those who

supported the development of the water company and those who wanted water rights to remain as they had since the founding of Santa Fe. This developed into on-site altercations during the construction of the Old Stone Dam in 1881. By the time Two Mile Dam was constructed, the residents had either accepted impoundment of water on the Santa Fe River or become quietly resigned to the fact, since there is no evidence of controversy through the newspapers or legal documents.[3]

The differences in opinion were split basically along the lines of the older families and mayordomos of the acequias, and newer settlers in Santa Fe. Water rights in New Mexico began with the mayordomo/acequia system, established by the Royal Ordinances given to Don de Peralta in 1609 when he laid out Santa Fe. The system called for irrigation water to be available to all residents.[4] Irrigation water was made available through open channel waterways, called acequias. The water was distributed from the acequias in direct proportion to the quantity of land to be irrigated, larger plots received more water than smaller plots. Each acequia was shared and maintained by the community that had access to the water, and each community was headed by a mayordomo who coordinated the acequia upkeep, water distribution, and the arbitration of disputes. The mayordomo was usually a highly respected, older member of the community and had significant political and social power.[5]

In the late 1800s, the Anglo population of Santa Fe "...predominated among merchants, military personnel, and government officeholders...their role in agriculture was almost nonexistent."[6] The desire for a water company to supply water to the city was to modernize Santa Fe, but those whose families had settled Santa Fe and who had inherited the acequias and water rights policies had no reason to change. In fact, those who were most affected by the construction of the dams published a notice to the water company in the *Daily New Mexican* stating that the residents would resist any encroachment on their rights. The following statement is from the June 1881 public hearing about water rights and building dams in Santa Fe canyon, which was translated from Spanish to English, transcribed in both and given to the *Daily New Mexican*:

We, the majority of the people of Santa Fe, declare and maintain that whereas we have been entitled to the water in the Santa Fe river since the conquest of this country, have used it for the purpose of irrigating our fields and quenching the thirst of our families, that the water has been given to us by the sublime will of God, and

Whereas some individuals have associated with a view of controlling the water of said river by building dams in Santa Fe Canon and to interrupt the free course of the current with the purpose of retaining and speculating with the water by selling it to the poor people of Santa Fe, thus damaging the whole community, and Whereas the people of Santa Fe will in no way permit such proceedings, be it:

Resolved that the people of Santa Fe will by all legal means cause the said water works company to stop abusing and appropriating the rights belonging exclusively to the people, will prevent their converting the same to their own pecuniary welfare, leaving the community helpless and subject to their charity, and depriving them of all the sacred rights which nature has given them merely to satisfy ambition. The people of Santa Fe in meeting assembled and in view of the injustice and prejudices which the said company will cause to Santa Fe people by stopping the free course of the water in the river and prevent them from irrigating their lands hereby. Resolved that the water company is hereby cautioned to stop all work in the canon of Santa Fe river interrupting the current of the stream and injuring the community, which action is hereby declared an outrage on the people and that said community will in no way permit such action.

Resolved, that the people of Santa Fe are and will be opposed to consenting that the water works company shall abuse the people and appropriate to themselves their rights which they consider a legal and divine gift from Almighty God, and which rights belong and shall belong to the people, and who will in no way permit that any company shall jump their rights. Resolved that the Hons. Sol Spiegelberg, Jas. Donovant, Nasario Gonzales, Board of County Commissioners and Hon. Gaspar Ortiz, Probate Judge in and for Santa Fe County, are authorized to represent the people of Santa Fe and are required to arrange the matter with the water works company, avoid their control of the water of Santa Fe river which they resolved to do in prejudice of the community and to caution said company to let the said waters run for the benefit of the people, who will use all legal rights with this object in view.

Resolved, that the Hon. Juan Garcia, C. Martinez of Precinct No. 3, Aniceto Abeyta and B. M. Reed of Precinct No. 4, and Jose Antonio Romero of Precinct

> No. 5 are hereby appointed a committee to cooperate with the County Commissioners and the Probate Judge in reference to the settlement of the matter.
>
> Resolved that we will employ all legal means to defend our rights and will, if necessary, ask the protection of the executive department.
>
> Resolved that we swear to stand by the constitution and the form of government and protest against violence, and request the proper authorities to enforce the laws.
>
> Resolved, that if said company persists in carrying out their works they shall be considered open enemies of the public.[7]

The reaction to the water company was over more than water for irrigation; most residents had their own water-operated grist mills and carding machines, which could not function without a running river. Some of the residents with property to the west of the Old Stone Dam would not allow the right-of-way for the pipes that were to take water into the city of Santa Fe. The committee noted above met with the water company and was able to gain the company's assurance that the flow of the river would not be reduced to the extent that it would shut down the acequias.[8] This assurance did not calm the fears of the canyon residents. On June 23, 1881, an altercation between residents and the stone dam laborers was reported in the *Daily New Mexican*.[9] Eventually, the canyon residents allowed the pipes to run through their property, and by October 14, the public was so anxious to have water, it was introduced into houses by residents of the City of Santa Fe rather than by the water company as scheduled.[10]

By December of 1881, the original water company had gone bankrupt and was sold to a new group. The new company was called the Santa Fe City Water Works, and its officers were Alexander G. Irvine, President; Q. Monier, Treasurer; and S. D. Lassier, Secretary. The new company was granted a franchise to operate the water works. Following incorporation in 1891, the City of Santa Fe granted a new 25 year franchise to the water company.[11]

The first dam, the 1881 stone dam, was 28 ft (8.5 m) high and held 25.33 acre feet of water (Photographs HAER No. NM-4-17, NM-4-18, NM-4-19, NM-4-23). In February of 1893, the water company began construction on Two Mile Dam by placing concrete for a tunnel. This second dam provided an additional 387 acre feet of water to the City of Santa Fe (Photographs HAER No. NM-4-1, NM-4-22). There is no evidence of public outcry over its construction, apparently due to a variety of factors, such as the public having grown accustomed to the old reservoir, the involvement of different individuals, and the fact that the second reservoir was planned to provide surplus water to irrigate up to 1000 acres of fruitland.[12]

The main controversy during the construction of Two Mile Dam was the drought of 1893. In March of 1893, the President of the water company posted a notice to the people of la Acequia del Cerro Gordo that the water company would continue to supply their acequia with water throughout the construction of Two Mile Dam. By June 9th, water was being supplied through a concrete tunnel, but by June 26th water restrictions limited irrigation to the hours of 6:00-9:00 a.m. By July 5th, the water company had ended the use of water for irrigation until further notice. On July 17th, the company met with citizens and agreed to alternate water use: four days for acequia use then four days for water company supply.[13] On August 17th, the rain finally came, and the water in the reservoir rose 7 ft (2 m) in one hour. The water filled the reservoir's "flat area," topped the spillway and damaged the old reservoir.

The only available technical information about the construction of Two Mile Reservoir is the 1893 *Engineering News* article. The construction began with excavating to and cleaning bedrock on the northern side of the dam and pouring a concrete trench and seepage collars, which were referred to in the Engineering News article as "heart walls." The concrete trench acted as the base of the dam tunnel, protected the existing water main during construction, and allowed water to flow during the construction of Two Mile Dam. The "heart walls" were made of hydraulic cement, and one inch thick boards were used for triple sheeting that rose above and were perpendicular to the tunnel. The article also describes an 80 ft (24 m) tall stone intake chamber,

or well, as tall as the dam that was to be used to allow different levels of water to enter the distribution system (Drawing 2/1). There is no other mention or evidence of this intake chamber; currently the intake is a metal strainer outlet raised three to four feet above the top of a concrete dome, which is the upstream end of the tunnel under the dam. The earliest evidence of this concrete dome is a 1938 drawing of the pipe system (Photographs HAER No. NM-4-11, NM-4-12, NM-4-13). In 1893, the downstream toe of the dam had a 60 ft (18 m) diameter, circular basin into which a 10 inch pipe discharged as a fountain (Drawing 1/1). This provided the water with final aeration before it travelled through the city mains.

The 1893 article also notes a 5 ft (1.5 m) circular tunnel "...through rock, part or all of it lined with 7 to 12 ins. of concrete..."[14] was being constructed from the Old Stone Dam to convey water to discharge below the new spillway. This was designed to provide water downstream when desired, or when the water was running muddy, and was converted to a channel in 1904 to become the existing diversion channel (Drawings 1/6, 2/6). The tunnel under the dam was of similar construction, but its diameter was 8 ft (2.4 m), and it rested on a 1 ft (0.3 m) bedrock wall (Drawings 3/5, 4/5). Gate valves were installed at both ends of the tunnel to provide control of the water flow (Photographs HAER No. NM-4-14, NM-4-15, NM-4-16).

As described previously, the construction method for the dam was divided: the downstream portion was primarily sand and gravel, and according to the 1893 article, was not puddled, while the upstream portion of the dam was clayey earth puddled by a herd of goats. The goats were kept in motion from "12 m. to 1 p.m. and from 5 to 6 p.m."[15] According to J. M. Howells, in a letter to the editor of *Engineering News*, the schedule for using the goats changed once they discovered that the puddling did not interfere with the material delivery teams. When they discovered they could use the goats during regular hours, as opposed to the odd schedule already noted, they were able to reduce the required number of goats. The number was reduced from several hundred to 115 and they were able to keep the work on schedule.[16]

In the same letter to the editor, Mr. Howells described some of the aspects of puddling the dam. The goats were able to puddle for 30 wheel scrapers (Field Photograph: 1893 Construction) and averaged 14 ft^3 per load on a 500 ft (152 m) haul. The earth was spread as it was being dumped, levelled into a three inch layer by a dragged beam, then sprinkled, and finally puddled by the goats. The surface of each layer was left rough so the next layer could key into the last. Mr. Howells also stated that the goats tired easily at the beginning, because they had only been scantily fed on juniper brush, but once they were fed a diet of peas and refuse, they perked up and even butted each other around the corral after a full day's work.

On July 3, 1894, the *Daily New Mexican* reported that the mayor had officially accepted the work as being in compliance with the franchise. The next step was the development of hydroelectric power. The company developed a plant near Talaya Hill[17], which consisted of a service basin, "power pool," and a power house. Water from the reservoir and a power ditch uphill from the reservoir travelled through a 15 inch diameter pipe to the power house and was then forced uphill by pressure into the Talaya Hill "power pool." When power was needed, the water flowed downhill to the powerhouse to create electricity and was then discharged into the service basin (Drawing 3/2). In February of 1895, the hydroelectric plant was complete.

The series of three reservoirs that were required in the original grant were not completed until 1943. In fact, it was this requirement for three reservoirs that caused the foreclosure of the first two water companies, through financial burdens. In 1900, the Santa Fe City Water Works was turned over to the Santa Fe Water and Light Company. On March 14, 1900, the new company was incorporated in New Jersey.

In October of 1904, New Mexico experienced an enormous flood, which affected most of northern New Mexico and resulted in communities being virtually cut off from the outside world. The flood destroyed buildings, railway lines, and communications lines, and resulted in loss of life. The *Daily New Mexican* praised Two Mile Dam for protecting Santa Fe from extensive

flooding and reported that many pipes required replacement. The main problem at the time, in terms of the water supply, was that the water turned brown. The water system relied on still water from Two Mile Reservoir, so organic matter and debris would sink to the bottom leaving the potable water on top. With the tumultuous flood, water in the reservoir was turbid and required time to settle again.

In 1919, the city made its first unsuccessful attempt at a water company buyout, spurred on by dissatisfaction with service, supply, and the fear of how city growth would affect the supply. In 1921, a series of city council meetings addressed how to purchase the company or at least to ensure reasonable rates. At this time, the company was without a franchise and was unresponsive to the letters from the city council. During a special meeting, the city council asserted that the water company:

> ...is ineffective, uneconomical and unsatisfactory; and in connection with such investigation...has come to the conclusion that the rates charged by the Santa Fe Water and Light Company are unfair, excessive, exorbitant, unjust and discriminatory...[18]

By 1925, the company was again in receivership. U.S. District Judge O. L. Phillips took control of the situation, required meters to be installed, and also developed criteria for the next owner of the water and light company. Under Judge Phillip's guidance a new franchise was drawn up, and performance bonds were secured for the new purchaser. In 1926, the New Mexico Power Company (NMPC) was incorporated in the state of New Jersey, authorized to do business in the state of New Mexico, and merged with the existing water company.[19] As a result of Judge Phillip's efforts and the NMPC merger, by 1930 the entire city of Santa Fe was metered, McClure Reservoir was constructed (1926-28) and Nichols Reservoir was constructed (1942-43).

In 1929, the City of Santa Fe, the New Mexico Power Company, and the Forest Service worked together to close the Two Mile Reservoir watershed. The effort was not entirely successful, so in 1932 the Secretary of Agriculture legally closed the watershed through a Closing Order. This

order excluded "...bathing, fishing, camping, picnicking, and other forms of human occupancy of the Santa Fe watershed..."[20]

In 1946, the Public Service Company of New Mexico (PNM) came into being through the merge of the Albuquerque Gas and Electric Company, the Deming Ice and Electric Company, Las Vegas Light and Power, and NMPC. The company operated on an even keel until 1971, when there were complaints of poor water quality. Until 1971, the water provided to Santa Fe was from Two Mile Reservoir and was purified primarily by natural settlement. The reservoir water was treated with an acceptable algicide and required long periods of sedimentation in the Spring and Fall to reduce turbidity. In response to the water quality complaints, PNM hired an Aquatic Biologist to analyze the water coming from Two Mile Reservoir. Samples were taken in town, and it was determined that copepoda and nematoda worms, some as large as 2 mm, as well as a small quantity of rotifers and protozoans of the genus *Ceratium* existed in the water supply at Two Mile Reservoir. The sedimentation process was supposed to allow these plankton to sink to the bottom, keeping top layers of water clean and potable. The determination was that the natural purification processes were not working.[21]

In August of 1971, a letter from Black & Veatch Consulting Engineers to the Vice President, Division of Operations at PNM outlined recommendations for the treatment plant system that is in operation today. Treatment includes addition of floculants to aid in sedimentation, filtration to remove particulants, disinfection and fluoridation, and stabilization by the addition of polyphosphate. The system used included a check dam below Nichols Reservoir to divert water to the treatment plant, chemical building, two clarifloculators, four dual-media filters, two five million gallon tanks, waste wash water reclamation basins, two earthen lagoons to receive sludge from clarifloculators and a four million gallon pump from Two Mile Dam to permit the use of its water (Drawing 2/2).[22] The water from the upper two reservoirs was the primary source, and water from Two Mile. Reservoir became the backup supply. During this 1971-72 conversion of

the water supply, the stone spillway was grouted as a safety stabilization effort (Drawings 1/5, 2/5).

Again in 1973, the City of Santa Fe contemplated the purchase of the water company. The city hired R. W. Beck and Associates to determine whether purchase was feasible. It was determined that if the city purchased the company, the rates would double,[23] so the city did not pursue purchase. In 1974, a five year franchise was granted, and in 1976, a Water System Task Force was developed to analyze whether purchase or condemnation of the water system was feasible. PNM made it clear that it would not be a willing seller. The City pursued condemnation, but even with condemnation, it was determined that the cost would be too high.[24]

In 1978, the SHPO notified PNM that Two Mile Reservoir had been placed on the State Register of Cultural Properties,[25] and in the same year, the National Dams Safety Program inspected Two Mile Dam since it was listed as a high-hazard dam on the National Dam Inventory. The report recommended a "watch and warn" inspection system, the primary concern was the overflow of the upper dams affecting the stability of the earthen dam.[26] In 1985, Two Mile Dam and Reservoir were nominated and accepted as an American Water Landmark.

In 1992, the reservoir was drained for safety reasons, primarily rodent holes and tree-roots had caused the downstream slope to destabilize.[27] The water company had discovered a 40 ft (12 m) long crack along the top of the reservoir and a 20 ft (6 m) slump on the downstream slope the line of saturation had exceeded safety levels. Draining the reservoir resulted in a twenty million gallon loss in the cheapest water source for the City of Santa Fe. After the reservoir was drained, Councilor Steven Farber called for the repair of the dam to maintain the "historical, cultural and economic well-being of Santa Fe and its present and future water supply."[28] The fact that the reservoir marks the eastern boundary of the city was as much a concern as the water supply. Preserving the reservoir would preserve a cultural resource and an inexpensive water supply, as well as provide a boundary for development at the end of Upper Canyon Road.

In March of 1993, PNM announced that it had plans to sell Sangre de Cristo Water Company as part of a reorganization,[29] and in May, the Santa Fe voters decided to purchase the water company. After eighty years, the City of Santa Fe had finally succeeded in buying the company. The purchase of the water company only included the water and appurtenances, not the land. Once plans to breach the dam were announced, there was public concern over what would happen to the reservoir land. In June of 1993, PNM announced that they were offering 100 acres of the 240 acres that comprise the Two Mile Reservoir property area to the City of Santa Fe.[30] It had been determined that the cost to repair the dam would be prohibitive, and the breach of the dam would be cost effective as well as eliminate the concern that the earthen structure might fail in the future.[31] The Sangre de Cristo Water Company decided to retain less than 10 acre ft in the reservoir area for aesthetics, and in preparation to turn the land over to the City of Santa Fe.

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IV. ENGINEERING INFORMATION

Construction:

Two Mile Dam was engineered by J. M. Howells, C.E. of Chicago and P. E. Harroun, C.E. of Santa Fe and was constructed from 1893-94. A drawing of the dam, which appeared in both *Engineering News and American Railway Journal* and the *American Society of Irrigation Engineers Annual* in 1893, shows a series of four concrete seepage collars running parallel to the longitudinal centerline of the dam (Drawing 2/1). These collars were described as being set into freshly broken bedrock, made of the "very best hydraulic cement," and topped with triple sheet piling. The collars were to serve partially as a foundation and primarily as waterproofing to aid in the stability of the dam over time.

Modern earthen dam construction began in the late 18th century,[32] and the development of design elements was fairly standard by the late 1800s. In fact, "...the design principles had evolved leading to safe and fairly reasonably economic large earth dams."[33] The elements which had become standard details include variation of material, impervious cores, seepage collars, and puddling of clayey materials. The building of the dam included not only the proven design details, but sound construction techniques. The use of goats to puddle the clayey earth provided a roughness in the layers of earth in the dam, which aided in the prevention of water flow through the structure. Modern equipment provides a fairly even surface that can allow water a passage through the dam, and requires other techniques to minimize water flow.

During the 1994 demolition of the dam (Photographs HAER No. NM-4-3, NM-4-4), Karen Lewis, a preservation specialist was on-site throughout the work to monitor demolition and document the concrete core and seepage collars when they were uncovered. The top of the dam was at elevation 7,348 and the breach occurred at 7,285, the depth of the breach was 63 feet and according to the Engineering News drawings the center seepage collar should have been

unearthed at approximately elevation 7,295. No concrete collars were uncovered, so the collars are not as tall as the 1893 drawing suggested. At least one collar exists under the remaining portion of the dam as the Engineering News photograph shows a collar during construction. The collar in the photograph is formed concrete running over the top of the stone tunnel. There is no point of reference to identify where this concrete wall is along the tunnel, but it appears to be approximately 3 ft (1 m) above the tunnel (Field Photograph: 1893 Construction).

During demolition there were seemingly unrelated, horizontal lenses of clay and rubble. In retrospect, these may have defined a core, but the bulldozer and scraper method of earthwork made it difficult to distinguish a pattern. These lenses varied in length and color, but were usually near the centerline and approximately 2 to 3 feet wide. The lenses were usually green (Munsell, 5Y 6/2, light olive gray) or almost white (Munsell, 8Y 8/1, white), while the regular layers of earth were reddish (Munsell, 5YR 5/4, reddish brown) or dark brown (Munsell, 10YR 5/2, grayish brown). Some of the darker, greenish clay took on the appearance of cement as it dried. Often cement and/or lime is added to soils to act as a stabilizer. Lime, calcium carbonate, is an element of cement and will react with HCl.

Ms. Lewis tested several samples of earth taken from the lenses and the regular layers with HCl. The darker, greenish clay and the white clay from the lenses reacted positively, with the white giving the most vigorous reaction. The reddish and brown soils did not react with the HCl.

All earthen dams have some kind of core, as well as collars to prevent toe flow of water toward the center of the dam. Many dam cores have been constructed of clay to act as seepage barriers;[34] the reaction of the centerline lenses with HCl suggests the lime-containing earth was placed deliberately at the center of the dam. Although calcium carbonate, may occur naturally, judging from the levels where the reactive soils began to appear, it seems that there was a stabilized core of lime or light soil cement. Conclusive results could be gained through continuous borings, soil analysis, and specific tests for lime in the remaining southern portion of

the dam. Results from the "Dam Embankment Stability Investigation" borings are located in Appendix A.

Although there was not a visually discernable core during the demolition, the variation of materials from the eastern to western side was distinctive. This did match the 1893 drawing, in that the downstream side was primarily gravel and the upstream puddled earth. During certain points of the demolition, stratigraphy could be seen, and was photographed, but Ms. Lewis was unable to create a continuous profile. The visible layers were 3-6 inches and alternated from the reddish soil (Munsell, 5YR 5/4, reddish brown) to the brownish (Munsell, 10YR 5/2, grayish brown).

The original drawing also showed a concrete well tower located on the upstream side of the dam, with openings for different stages of water to enter (Drawing 2/1). There is no documentation or evidence of this ever having been built. What exists today is a concrete dome with a metal screen inlet; the metal inlet has been shortened to be just above the dome and is covered with stone, known as riprap. The original design pool elevation was 7,340 ft and the existing pond elevation is 7,290 ft. The original drawing also showed a 1.5:1 slope on the downstream side of the dam and a 2:1 slope on the upstream side. The upstream slope was covered with 3 ft (1 m) of riprap to reduce erosion on the interior of the dam. At the toe of the downstream slope there was an aeration basin. This was a 60 ft (18 m) circular concrete basin with a fountain to provide aeration. This aeration basin is described in an 1895 article in the *Daily New Mexican*:

> The water now served Santa Feans is thoroughly aerated before it enters the companies supply pipes. A pipe below the great dam shoots the water twenty feet into space and thence it falls into a huge basin. The sight is a very pretty one.[35]

The original drawing also shows the stone tunnel that runs under the dam. This tunnel was set into the bedrock and arched to create approximately 8 ft (2.4 m) clearance on the interior. As noted in a 1915 plan of the reservoir, there were 2 pipes that ran through the tunnel (Photograph

HAER No. NM-4-21). A 10 inch pipe was laid in 1881 to provide continuous service during construction and a 15 inch pipe was laid in 1894 to provide service from the new reservoir. Water entered the 10 inch pipe from both the Old Stone Reservoir and a metal strainer on the upstream slope of Two Mile Dam, and the 15 inch pipe took in water solely from the strainer on the top of the concrete dome (Drawing 1/3), or the tower if it was constructed. In 1913, a 36 inch sluice gate was added to the front of the upstream concrete dome (Drawing 3/2), and in 1938, the 10 inch pipe was permanently shut off (Drawing 2/3). In 1953, both pipes were replaced with a 36 inch diameter pipe with a series of geared gate valves (Drawing 3/3). One valve was on the upstream side of the dam, and two were on the downstream side. All valves remain in place, and the two on the downstream side of the dam had extensions added in 1994 to make them operable at the new height of the infill riprap (Drawing 4/3).

The aeration basin seems to have been out of use by 1915, since the 1915 drawing shows a "sluiceway" rather than a basin. In 1994, the tunnel archway and what would have been the aeration basin were filled with riprap to aid in erosion control for the breach. Prior to being filled in, the valves, tunnel opening, and a grouted stone channel were visible, and were recorded as part of this HAER documentation.

Site:

Two Mile Reservoir is one in a series of three reservoirs along the Santa Fe River. McClure, the reservoir farthest upstream, was constructed in 1941-42 and can retain 3,059 acre feet, or 997 million gallons of water. Nichols was constructed in 1926-28 and can retain 684 acre feet or 223 million gallons of water. Two Mile, the farthest downstream, was constructed in 1893-94 and can retain 387 acre feet or 126 million gallons of water (Drawing 1/2).[36]

Two Mile Dam is situated in Precambrian granite and granite gneiss, with some Paleozoic limestone, while the reservoir area consists primarily of alluvium over the geology noted above. The reservoir vegetation consists primarily of piñon and native grasses. Riparian vegetation runs along the southern boundary of the reservoir. The oldest dam along the river is at the upper edge of Two Mile Reservoir, the 1881 Old Stone Dam. The reservoir behind the Old Stone Dam was silted in during the 1904 flood and is currently swampy and vegetated.

When the dam was intact, Two Mile Reservoir could retain 387 acre feet of water.[37] Site elements included a metal silt fence running along the northern edge of the watershed, a 150 ft (46 m), semi-circular spillway (Photograph HAER No. NM-4-9), a masonry tunnel under the dam, and an 1881 stone dam, which marked the upstream boundary. Other elements included a 147 ft (45 m) long concrete weir between the diversion channel and the reservoir near the stone dam, various gate valves, a pumphouse, decant ponds and an upstream checkdam. The concrete weir prevents flood flows from exceeding 5,000 cubic feet per second (cfs) in the diversion channel, by allowing water to overflow into the reservoir. The existing diversion channel is on the site of the 5 ft (1.5 m) diameter concrete tunnel that was constructed to allow water to flow downstream when needed or when muddy. The stone weir, to the south of the spillway, is the remains of the concrete tunnel (Photograph HAER No. NM-4-10). It is believed that after the flood of 1904, the tunnel was opened to allow greater flow for more substantial storms.

NOTE: REFERENCES TO PHOTOGRAPHS SHOULD READ "HAER No. NM-5- ," NOT "NM-4- ."

Character:

Two Mile Reservoir is no longer recognizable as a reservoir, it has more the feel of a canyon. The earthen dam itself has been breached, with only the southernmost portion intact. A new hill has been created on the southwestern portion of the site, near the spillway, with the sludge and earth taken from the reservoir and dam. The breach is lined with riprap and is being seeded above the riprap to the top of the slope; the curve of the dam does show in the breach (Drawing 2/4). The tunnel and both downstream and upstream valves are still operational, but have been covered with riprap. The spillway, diversion channel, and the Old Stone Dam were not impacted during the emergency breach. Ruins that were discovered in the basin have been left relatively undisturbed (Drawings 2/4, 4/6); some damage occurred prior to the initiation of the preservation portion of the work.

Condition:

The 1893 earthen dam has been breached, leaving a 3:1 slope on the northern portion, a 4:1 slope on the southern portion and a 50 ft (15 m) breach at the center (Drawings 1/4, 2/4). The reservoir has been cleaned of sludge, the earth from the dam has been moved to the southern side of the reservoir, and a new pond containing 10 acre feet of water was created on the upstream side of the old dam. The sediment ponds, located in the reservoir area of the Old Stone Dam, have been cleaned. Also, three stone/filter fabric retaining walls were installed just downstream of the Old Stone Dam to clean the stream before it enters the pond at the toe of the dam breach. The breach was lined with a thick filter fabric and then covered with large riprap. The riprap continues past the previously existing toe of the dam, covering the tunnel opening and the outlet pipes. The final outlet is also lined with filter fabric, so the water that continues downstream is clear.

V: RESERVOIR RUINS

This section will discuss the available archival information with reference to land transactions, census data, and maps of Two Mile Reservoir that may lead to an understanding of the ruins within the reservoir basin. There are two sets of stone alignments in the reservoir just below the Old Stone Dam. These are fully silted and appear to have been in place prior to the construction of Two Mile Dam. The first stone alignment is approximately 100 ft (30 m) long, with what appear to be rooms at either end (Photograph HAER No. NM-4-20). There are some structural wood elements protruding vertically through the silt at various locations. The second ruin is "L" shaped, with rooms that would have been 12 ft (3.7 m) wide and two round structural wood members protruding through the silt. Without excavation, it cannot be determined exactly what these structures were, but due to the scale, the first seems to be of an industrial nature because of its large scale and the second appears to be a small residence (Drawing 2/4).

In 1880, there were three mills in Santa Fe Canyon that were large enough to be included in the 1880 *United States Census Records, Schedule 3 - Manufactures,* and one that was under construction. The three mills were owned by James A. Donovant, David H. Catanach and Herman Strelow. The mill under construction was owned by Teodoro Martinez. An 1883 map shows three mills: one at the eastern corner of Talaya Grant on the southern side of the canyon road; another in the area of Two Mile Reservoir on the northern side of the canyon road; and the final one west of the reservoir on the northern side of the canyon road. An 1894 map identifies the westernmost mill as belonging to a Mrs. Catanack; although the name was spelled differently, it seems that Catanach and Catanack are the same family.

In 1883 the Water and Improvement Company won a suit against Herman Strelow; his land was purchased for $400 and he was given the rights to water to continue running his grist mill.[38] From this information, it seems that the second mill, on the north side of the canyon road, belonged to Herman Strelow, because it is within the boundaries of the land purchased by the

water company. If these conclusions are correct, then the third mill belonged to James A. Donovant. The three mills were of comparable size, with overshoot wheels, and a production capacity of 90 bushels per day. All operated four months full-time and six months half-time, with two idle months.[39] The Strelow mill had a 24 ft (7 m) fall, and the other two mills had falls of 15 ft (4.5 m) and 16 ft (4.9 m).

There are also photographs of three mills in the Santa Fe Canyon from the early 1900s, on file at the Museum of New Mexico. One of the structures is a relatively small adobe "molino," which has a vertical axis wheel, rather than the larger horizontal axis overshoot wheels. One of the other mills is on the northern side of the river and is one story with a gable roof. The third mill is constructed of random rubble, is two stories tall, and has a flat roof. The wheel on this mill is a horizontal axis, overshoot wheel. The section with the wheel is two stories and is approximately 16 ft (4.9 m) long, as the building continues it drops to one story and then the photograph ends. The ruins in the reservoir define rooms at both the eastern and western end, which are similar in size to the structure shown in the third photograph.

At this point, the origin of the ruins in the reservoir is unknown, speculation may lead us to believe that the structure is either a mill or an associated building. The pieces of evidence are not conclusive, but rather suggest a need for additional research. More information could be gathered through archaeological study of the sites and an intensive search for information through oral histories and more intensive research of the architecture of Upper Canyon Road.

1. Interview with Don Lopez of New Mexico State Engineer's Office, September 19, 1994.

2. Santa Fe Water and Improvement Company. 1880 Grant Application from Santa Fe County Commission.

3. The exception would be Herman Strelow, who it appears did not object so much to the impounding of water as he did to losing his land.

4. David Snow, *The Santa Fe Acequia Systems* (Santa Fe: Santa Fe Planning Department, 1988), p. 9.

5. Phil Lovato, *Las Acequias del Norte* (Taos: New Mexico State Planning Office, 1974), p. 28.

6. Terry Jon Lehmann, *Santa Fe and Albuquerque 1870-1900: Contrast and Conflict in the Development of Two Southwestern Towns* (Indiana: Indiana University, 1974), p. 22.

7. Dean Sanborn, *History of Sangre de Cristo Water Company* (Santa Fe: Sangre de Cristo Water Company, 1982), transcribed hearing statement June 1881.

8. Ibid., *Daily New Mexican*, June 14, 1881.

9. Ibid., *Daily New Mexican*, June 23, 1881.

10. Ibid., *Daily New Mexican*, October 14, 1881.

11. Ibid., *Daily New Mexican*, December 22, 1881.

12. Ibid., *Daily New Mexican*, May 6, 1893.

13. Ibid., *Daily New Mexican*, March 14 through July 17, 1893.

14. *Engineering News*, 1893, p. 346.

15. Ibid.

16. Ibid., p. 399.

17. Talaya Hill is referred to as Atalaya in modern documents.

18. Sanborn, Santa Fe City Council Meeting, July 15, 1921.

19. Ibid., *Daily New Mexican,* May 26, 1926.

20. Department of Agriculture, "Santa Fe Watershed Closing Order," November 3, 1932.

21. Mike Snavely, undated letter report in response to April and May 1971 water quality complaints.

22. Black & Veatch, letter dated August 6, 1971.

23. R. W. Beck and Associates, p. I-2.

24. Carole Christiano Letter.

25. In the notification letter, the site was referred to as the Santa Fe Waterworks Reservoir.

26. Bovay Engineers, p. 1-1 and 1-2.

27. SHB AGRA, Dam Embankment Stability Investigation (Albuquerque: SHB AGRA, 1992), p. 12.

28. New Mexico State Archives Newspaper Clipping Files, *Albuquerque Journal*, June 10, 1992.

29. Ibid., March 27, 1993.

30. Ibid., *New Mexican*, June 12, 1993.

31. Ibid., *Albuquerque Journal*, May 13, 1993.

32. Institution of Civil Engineers, *Clay Barriers for Embankment Dams* (London: Thomas Telford Ltd., 1990), p. 74.

33. Ibid., p. 31.

34. Ibid., p. 109.

35. Sanborn, *Daily New Mexican*, July 5, 1895.

36. Harman, O'Donnell & Henninger Associates, Inc. (Santa Fe: 1961), p. 12.

37. One acre foot equals 43,560 ft^3.

38. 1883 Deed, Santa Fe County Courthouse, Book M, p. 335-336.

39. *United States Census Records, New Mexico, 1880.* Schedule 3 - Manufactures, Santa Fe County.

GLOSSARY

Breach - A gap created to reduce the amount of water in the reservoir.

Standard Project Flood - Flood used by the Corps of Engineers as a basis for study, defined as discharges that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

Puddle - A method of earthen construction in which bands of soil are compacted and cured to create a structure.

Line of Saturation - The boundary of soil in which the pores are completely filled with water.

Toe - The lowest point on the dam; where the dam meets grade.

Total Station - A field surveying instrument, similar to a transit, with an electronic data collector that enables extremely rapid and accurate collection of locational and descriptive information. The field data points can be loaded into AutoCAD to create digital terrain modeling and contours.

Seepage Collars - Walls parallel to the longitudinal center constructed to prevent water from flowing along a pipe or tunnel that crosses through the dam. These have also been referred to as heart walls.

Appurtenances - A minor piece of property, right or privilege that is considered part of a more important one.

Sluiceway - A channel with a sliding gate to control the flow of water.

Weir - A small dam built in a channel to regulate the flow of water.

NOTE: REFERENCES TO PHOTOGRAPHS SHOULD READ "HAER No. NM-5- ," NOT "NM-4- ."

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ADDENDUM TO:
TWO MILE RESERVOIR
Santa Fe River, intersection of Canyon & Cerro Gordo Roads
Santa Fe
Santa Fe County
New Mexico

HAER NM-5
HAER NM,25-SANFE,11-

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001