

Ancestral Puebloan Water Handling

Kenneth R. Wright, P.E.

Ancestral Puebloans, Climate and Reservoirs

The ancient Ancestral Puebloan people of Mesa Verde, popularly known as the Anasazi, reconciled their lifestyle to the semi-arid and changeable climate. These dryland farmers who lived at Mesa Verde from about AD 550 to about AD 1300 contended with periods of drought and occasional cool growing seasons. Dealing with climate variability was tough for people living in an already harsh environment with few resources. One of the ways the Ancestral Puebloans adapted to their difficult surroundings was by becoming reservoir builders.

Wright Paleohydrological Institute, a team of scientists, engineers, and archaeologists devoted to the study of prehistoric water use, began investigating Ancestral Puebloan water handling in 1995. Over the past 13 years, we have studied five Ancestral Puebloan water storage facilities at Mesa Verde (Table 1) and learned that these people were good engineers and hard workers who persevered in spite of the variable climate.

Mesa Verde Climate

Mesa Verde is located near the Four Corners region of Southwest Colorado (Figure 1). Average annual rainfall is about 18 inches, while the average annual maximum temperature is about 62° F. The terrain is semi-arid, with many flat mesas and steep, rocky canyons. The people who lived in this environment did not have an easy life, even during times when the climate was favorable.

Paleo climate evaluations using dendrochronology (tree rings) provide estimates of precipitation and temperature going all the way back to AD 500 (Figure

Table 1. Mesa Verde Storage Structures.

Structure	Identification	Location	Time Span (AD)
Morefield Reservoir	5MV1931	Morefield Canyon	750-1100
Far View Reservoir	5MV833	Chapin Mesa	950-1180
Sagebrush Reservoir	5MV1936	Unnamed Mesa	950-1100
Box Elder Reservoir	5MV4505	Prater Canyon	800-950
Mug House Cistern	5MV1586	Wetherill Mesa	1200-1290

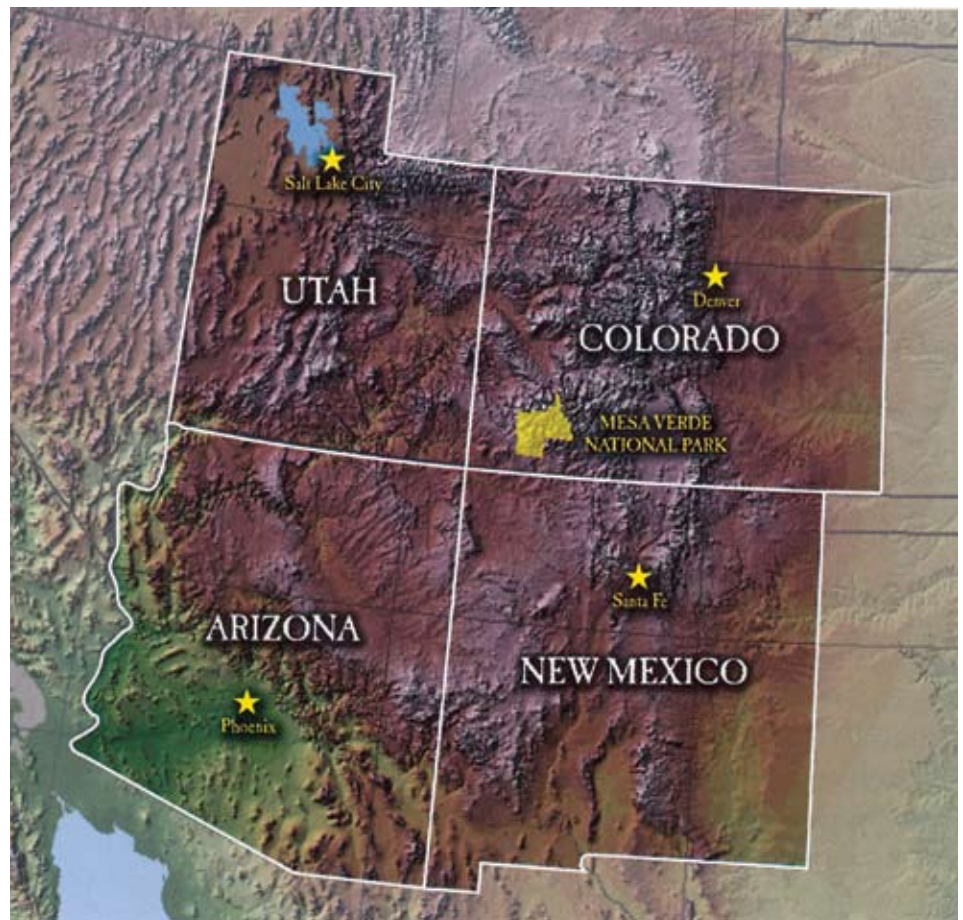
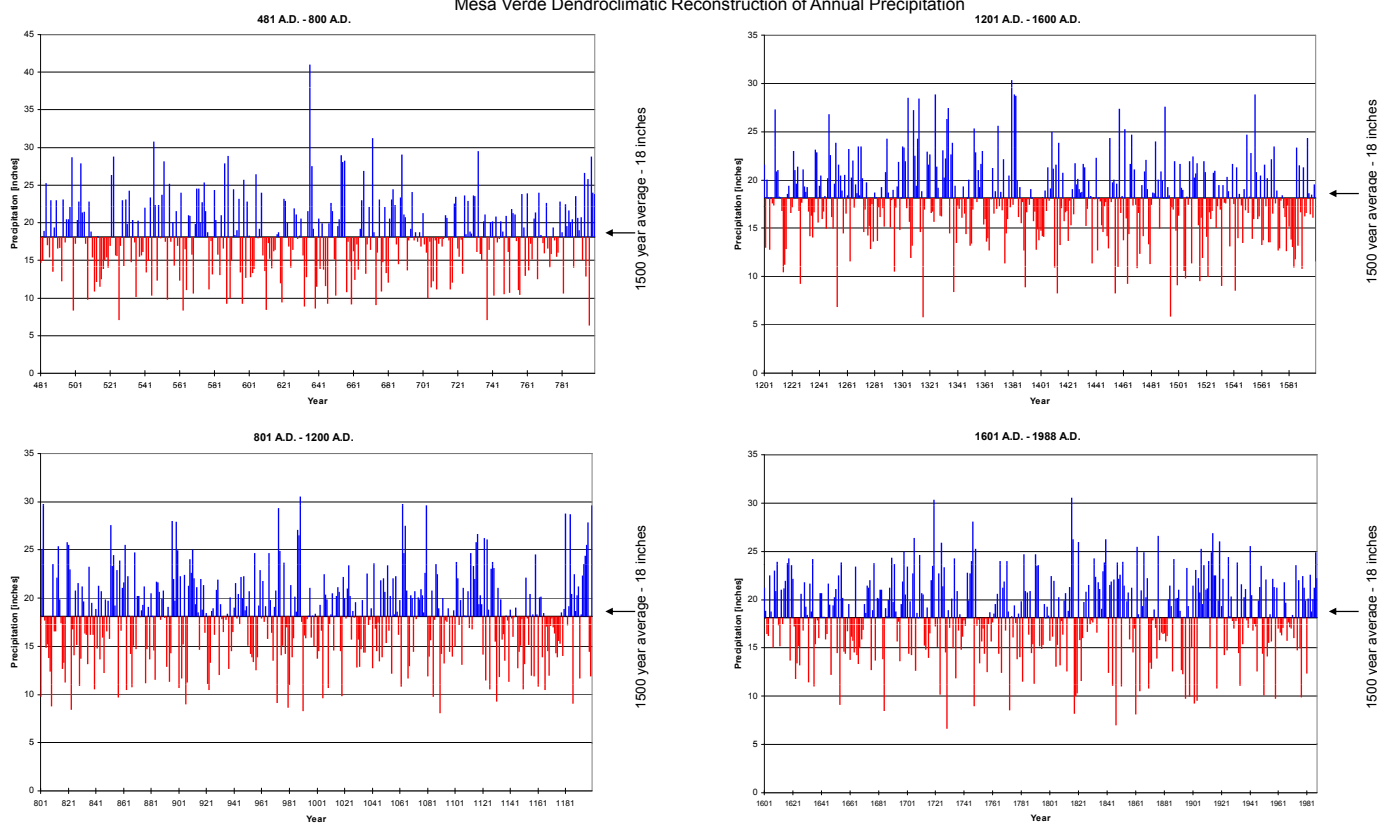


Figure 1. Mesa Verde National Park is located in the Four Corners area of southwestern Colorado.

Mesa Verde Paleohydrological Survey Project - Site 5MV1931 Morefield Canyon
Mesa Verde Dendroclimatic Reconstruction of Annual Precipitation



Wright Water Engineers, Inc.

Source: Dr. Jeffrey Dean, Dept. of Dendrochronology, Univ. of Arizona

Figure 2. The dendrochronology record by Dr. Jeffrey Dean shows periods of drought at Mesa Verde.

2). This climate record includes the years of the Ancestral Puebloans' inhabitation of Mesa Verde, from about AD 550 to AD 1300. The records show that the ancient people of Mesa Verde could not rely on consistent weather patterns. One of the worst drought periods at Mesa Verde within the dendroclimate record started in AD 1135 and ran to AD 1180. Then, in AD 1275, another major drought struck that lasted until AD 1300.

Cooling trends may also have had an impact on the Ancestral Puebloans. Kenneth Peterson and others have estimated that the southwestern United States experienced its own "Little Ice Age" beginning around AD 1200 until about 1850 (Peterson 1988). Average temperatures of 2–4° F cooler are thought to have caused shorter growing seasons and less successful crops at Mesa Verde. Tree ring expert Matthew Salzer noted "significant volcanic activity" in AD 1259, which likely chilled the atmosphere and shortened the growing season (Salzer 2000).

Background on Ancestral Puebloans

The residents of Mesa Verde and their time frames are shown in Table 2. Starting about AD 550, Basketmaker III farmsteads sprang up in southwest Colorado wherever there were good soils, streams and relatively adequate rainfall. They were lucky; between AD 570 and 700, southwestern Colorado had decent climate conditions, and this area took on a decided agricultural character. Their homes – pit houses – were half dug into the soil and half above ground (Figure 3). By the end of the period, southwestern Colorado was the home of many villages

and several thousand occupants. With 130 years of somewhat reliable rainfall, an agricultural lifestyle was begun in southwest Colorado that still exists today.

There was a population expansion by AD 750. By this time, the resident population of southwestern Colorado was well over 3,000 people, known as Pueblo I. For the Pueblo I community, the biggest challenge in Mesa Verde was its change to relative aridity. Their dryland farming atop mesas and in canyons relied on soil moisture, snowmelt, and occasional summer rains. The people of Mesa Verde were accomplished dryland farmers with a record of success. We know there was no irrigation at Mesa Verde (Wright 2006). Fortunately, maize, their staple, is adaptable to a wide variety of environmental conditions.

The Pueblo I people started building rooms aboveground, and their pit houses transitioned into kivas (Figure 4). This allowed a larger grouping of people into communities with organized social order and its related benefits. Over the next century, the Mesa Verde population

Table 2. Periods of Mesa Verde.

Period	Time Span (AD)
Basketmaker III	550-750
Pueblo I	750-900
Pueblo II	900-1100
Pueblo III	1100-1300



Figure 3. A Basketmaker III pit house shows their use of wooden poles. They entered through a hole in the top.



Figure 4. The Great Kiva of Morefield was built about AD 860.

increased to about 1,000. Housing improvements and kivas made life somewhat easier, but the relative scarcity of water remained. Community life meant that amenities could now be developed that had been impossible for small isolated groups.

Water Harvesting

The Pueblo I people of Mesa Verde clearly knew how to excavate. A Great Kiva they built in Morefield Canyon

between AD 829 and 865, left almost intact for modern scientists to study, measures 55 feet in diameter and 7 feet deep. It is carefully designed and constructed and must have made a fine place for religious rituals, meetings, and winter shelter. It is an extraordinary accomplishment of many people striving toward a common goal.

Near the Morefield kiva is a mound about 200 feet in diameter at the base, about 16 feet high, with a

3:1 slope. Starting in 1995, Wright Paleohydrological Institute performed excavations and paleohydrologic analyses on the mound, establishing that it was actually a reservoir (Figure 5). When we analyzed and dated the reservoir, we realized that its commencement predated the Great Kiva by 80 years, indicating that a water supply was the first priority. With the water supply secured, the Pueblo I then used their organizational and building skills to create a more developed and well-rounded society.

Morefield Reservoir began with the digging of a shallow pond in Morefield Canyon about AD 750, in the canyon's normally dry bottom, the thalweg. The land cover had changed over the years because of forest fires, considerable clearing of timber for building and fuel, and the planting of maize in the upper part of the valley. The result of these changes was that the earth absorbed much less water, and there was more runoff than in earlier days. This worked well for filling their pond, although erosion increased.

The rains that came, especially late summer rains from the monsoon phenomenon, now flowed down the canyon bottom, or thalweg, filling the pond. This flow also brought the silt and sand from hillside erosion into the water hole, which the people dredged using sticks, antlers, stones, and baskets. These dredged sediments eventually formed a berm. Dredging took a lot of organization and energy, but was necessary for maintaining this water resource. Pretty soon the elevation gain meant that water would no longer flow into the pond. Rather than digging another pond, the early settlers did a smart thing – they built an inlet canal to bring in water by gravity flow. Addressing and finding a solution to this hydraulic challenge required creativity, leadership, and organized community effort. These and similar technological developments led to an overall southwest Colorado population increase to about 9,000 by the mid-850s.

The success of the technology of the Morefield Canyon people inspired their "cousins" in Prater Canyon one mile to the west. Box Elder Reservoir in Prater Canyon was started in AD 800, using precisely the same technology as Morefield Reservoir. The Prater Canyon community grew to about 300 residents



Figure 5. Trenches were dug at Morefield Reservoir to study sediment layers.

who enjoyed the land, water and sunshine of the west slope of the canyon bottom. Our pollen studies showed that maize agriculture was extensive. We found large amounts of maize pollen in all the layers of Box Elder Reservoir.

Between AD 900 and 1150, Chaco Canyon, 162 miles southeast of Mesa Verde, was a major center of culture for the ancient Puebloans. The Chacoan relatives of the Mesa Verde people developed major complexes which remained the largest buildings in North America until the 19th century. Their influence can be seen in many aspects of the Mesa Verde culture, artifacts and architecture. Interestingly, evidence of reservoirs in or around Chaco Canyon indicates that the people of Mesa Verde were ahead of the Chacoans in this respect.

Change on the Horizon

Around AD 900, the Mesa Verde area population seems to have decreased. We do not know why, but emigration likely played a part. The whole Southwest also had a population decline at this time, but our evidence shows that Mesa Verde was hit less hard than elsewhere. We know this because operation of Morefield Reservoir and Box Elder Reservoir continued

without interruption despite periodic water shortages. This Pueblo II culture, even with fewer people, kept operating and maintaining the reservoirs like their predecessors had done. By AD 950, Morefield Reservoir stood much higher than the bottom of the water hole of 150 years before, and the inlet canal had been extended upstream in the canyon to reach the higher elevation required to fill the reservoir by gravity (Wright 2006).

By AD 950, Box Elder Reservoir had been in use 150 years, and it had risen 20 feet up from its original base. Likely, it became too costly in effort and manpower to maintain, and the residents ceased to store water in the reservoir. However, they continued to occupy the canyon bottom. Also in AD 950, mesa top pueblo “relatives,” some four miles away on Chapin Mesa and on another mesa one mile west of Chapin, noted the success of Morefield Reservoir and built domestic storage ponds of their own, but they did so on mesa tops rather than in canyon bottoms. These reservoirs are called Far View (Figure 6) and Sagebrush Reservoirs (Figure 7), respectively.

Modern engineers would not have attempted the construction of these reservoirs. It would have been judged that there simply was no water supply that could be stored. Yet, both of them

did work. We know this because our field investigations show that the silt, sand, and maize pollen left in the two mesa-top reservoirs were waterborne, carried in by ditches that intercepted water harvested from packed down areas. The Puebloans knew more about the hydrology of mesa runoff than we modern engineers. The silt and clay particles, when puddled with rainfall, bare feet and sandals, would float upward to form an impervious surface. The soil surface would then become as tight as a parking lot with nearly 100 percent runoff. Even a small area of half an acre could be successful for water harvesting.

Abandonment

By AD 1100, Morefield and Sagebrush Reservoirs were abandoned. Mesa Verde residents transitioned into a new phase called Pueblo III. The nearby timber was being depleted and the increased runoff had gullied the lush valley bottoms, resulting in less groundwater being readily available. Intense use of Chapin Mesa, for instance, had resulted in deforestation and soil erosion. Disease played a part in the survival effort of the population, and life was less certain.

Then in 1135, a great drought commenced that was so extensive that

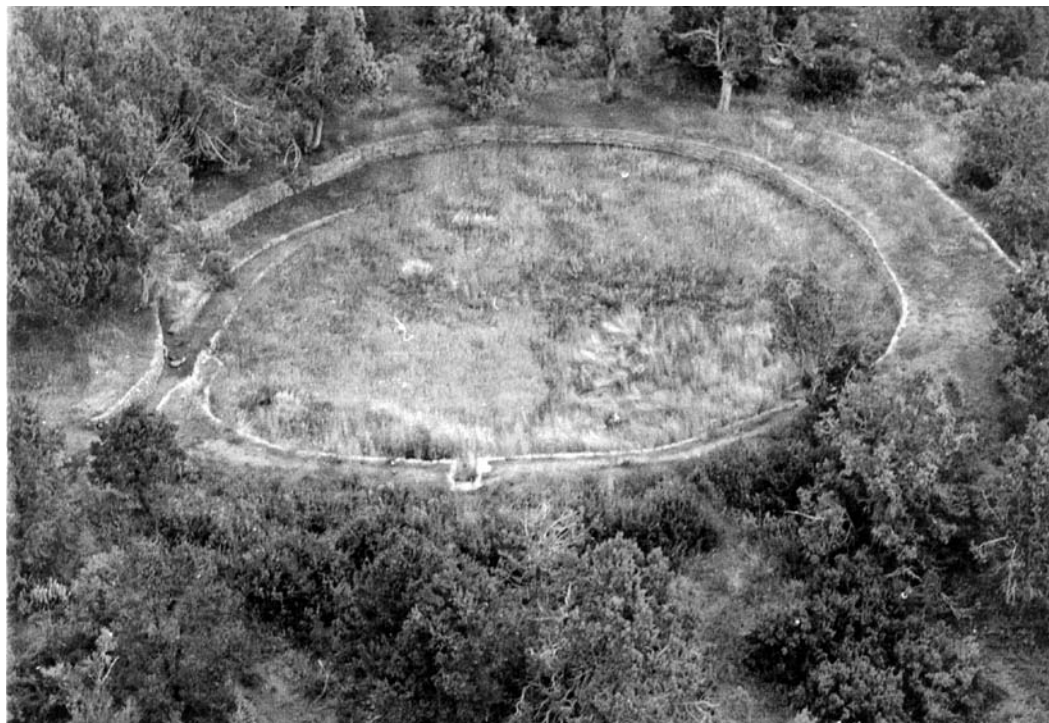


Figure 6. The remains of Far View Reservoir are easy to make out because of its stone walls.



Figure 7. The "X" on the hillside marks trenches at Sagebrush Reservoir excavated from 1972-1974.

even the central U.S. experienced it. The drought, which lasted until AD 1180, spelled the end of the Chaco Canyon development in New Mexico. The social influence of Chaco had been extensive, reaching all the way to Mesa Verde. The last building timbers at Chaco were carbon-dated to about 1140 (Diamond 2005). Concurrent with the disintegration of Chaco, the way of life changed at Mesa Verde. By AD 1180, even Far View Reservoir was abandoned as a domestic water supply. The people of Far View Village, Pipe Shrine House and Coyote Village now had to trek down into the canyon to gather water.

During the late 12th century, mesa tops and canyon bottoms ceased being the best places to live. Evidence suggests that violence was a problem for the Pueblo IIIs, based on the condition of human remains found. Between AD 1150 and 1175 an outbreak of cannibalism occurred at nine Mesa Verde area sites, with the remains of bodies that had not been eaten showing signs of malnutrition (Billman et al. 2000). The people began moving into large cliff overhangs, where they transferred their public works building technology to cliff houses while still farming on the mesa tops (Figure 8).

Cliff houses provided good defensive positions from marauding strangers, and there were plenty of cliff recesses that caught the winter sunshine that brought warmth. Cliff Palace, Spruce Tree House, Balcony House, and many other cliff

dwelling took shape. Construction methods were good; they planned to stay a long time, even though they did not. The cliff houses are judged to have been actively occupied from roughly AD 1180 to the late 1200s, finally being abandoned by 1300.

Both Cliff Palace and Spruce Tree House had springs. In some places, several cliff dwellings centered around one good spring. Other cliff houses did

their best with canyon bottom excavations to the water table and the use of small seeps. The Mug House Cliff Dwelling settlement, as another example, developed a 4,000-gallon cistern to catch water from the six-acre drainage basin above (Figure 9). Mug House research has shown that the people were poor and that they left in a hurry around AD 1290.

Some families had already left for places to the south when the drought of AD 1275 made life in Mesa Verde even tougher. The last timber, according to Dr. David Breternitz, was placed at Cliff Palace in AD 1287. By 1300 Mesa Verde was totally abandoned.

Reservoirs Tell the Story

Droughts and cold spells surely took their toll on the struggling Ancestral Puebloans. The collapse of the thriving center of Chaco, with its attendant social organization, was a direct result of the great 55-year drought. This coincided with area-wide civil unrest and uncertainty. People moved into cliff houses for defense and abandoned their exposed mesa-top and valley-bottom communities. They became poor and life was difficult.

The chain of events beginning with the drought that started in 1135 slowly



Figure 8. This Mesa Verde cliff dwelling represents the Pueblo III period, a time of stress resulting from a 12th century drought.



Figure 9. The author stands in the Mug House Cistern, which collected water from a drainage notch 85 feet above. Its capacity is 4,000 gallons.

and methodically changed the lifestyle of the people of Mesa Verde. Even before the 1275-1300 drought, they were moving away. By 1300 they were all gone. It can be concluded that the Mesa Verde way of life was a victim of the 1135 drought that initiated area-wide civil unrest.

The Ancestral Puebloans deserve a lot of credit for their fortitude and advanced water supply engineering skills in the face of a discouraging climate. Their reservoirs are a testament to their ingenuity and their drive to make themselves at home in an indifferent environment.

References

- Billman, Brian R., Patricia M. Lambert and Banks L. Leonard. 2000. Cannibalism, warfare, and drought in the Mesa Verde Region during the twelfth century A.D. *American Antiquity*, 65(1):145-174.
- Diamond, Jared. 2005. *Collapse: How Societies Choose to Fail or Succeed*. Viking Penguin; New York: 152.
- Petersen, Kenneth Lee. 1988. Climate and the Dolores River Anasazi: A

Paleoenvironmental Reconstruction from a 10,000 Year Pollen Record, La Plata Mountains, Southwest Colorado. Anthropological Papers No. 113. University of Utah Press; Salt Lake City.

Salzer, Matthew W. 2000. Temperature variability and the northern Anasazi: possible implications for regional abandonment. *Kiva* 65:295-318.

Wright, Kenneth R. 2006. *Water Mysteries of Mesa Verde*. Johnson Books; Boulder, CO.

Kenneth R. Wright is chief engineer of Wright Water Engineers, a water engineering firm he founded in 1961. He is also president of Wright Paleohydrological Institute, a nonprofit organization aimed at understanding the water handling practices of ancient people. Wright Paleohydrological Institute has sponsored the study of ancient water systems at Mesa Verde, Colorado; Barbegal, France; Olympia, Greece; and Machu Picchu, Ticon, and Moray in Peru.

