



Figure 1 (photo). Concern over the decline in flow of Vendome Well and the possibility that its unregulated flow might be detrimental to other artesian wells and springs in the region led the National Park Service to renovate it in 1997. A new well was drilled, supplying water to the historic fountain and doubling its flow, and the old well was plugged.

Figure 2 (map). Named in honor of the Chickasaw Indian Nation, Chickasaw National Recreation Area is located in south-central Oklahoma.

Water quantity issues at Chickasaw National Recreation Area

As historic springs diminish in flow, provisions of a water resources management plan aim at understanding the causes and mitigating the decline

By M. NICHOLL¹, T. WIKLE², T. BROWN², J. NORD¹, AND R. PARKER³

The resource management mission of Chickasaw National Recreation Area combines facilitating public recreation with protecting historically significant artesian waters (figure 1). Located in south-central Oklahoma (figure 2), midway between Oklahoma City and Dallas, Texas, the recreation area attracts over 1.5 million visitors annually for picnicking, camping, nature study, and water-based recreational activities. The area is also historically important as a source of fresh and mineralized spring waters that has been used by generations of visitors for drinking and the purported curative powers of the mineralized waters (Brown 1998).

As a means of guiding management activities pertinent to Chickasaw's unique water resources, NPS staff initiated the development of a water resources management plan that began with an "Issues Scoping Workshop" held in December 1996. Among the critical management issues identified by the National Park Service and other stakeholders were the historical and potential future decline in flow from the area's natural springs. Quality of the spring waters was also a concern, but is beyond the scope of this article (see

sidebar, page 32). Here we present an overview of the unique water quantity problems associated with maintaining springs as both natural and historical resources at Chickasaw National Recreation Area.

Historical background

Before its designation as a national recreation area in 1976, Platt National Park (now the Platt District of Chickasaw National Recreation Area—see figure 4) held the distinction of being both our nation's smallest national park and the only unit in the national park system set aside to protect resources at the request of American Indian tribes. Long before NPS management, the region containing the springs was a sacred site and hunting area for resident tribes such as the Wichita and the Caddo and nonresidents such as the Comanche. An 1855 treaty with the U.S. government placed the area containing the present-day Chickasaw National Recreation Area under the control of the Chickasaw Nation.

In the late 1880s, development pressures rising from the popularity of the springs prompted the Chickasaw to cede the area to the U.S. government for protection. In 1902, Congress created the Sulphur Springs Reservation; four years later, it was renamed Platt National Park in honor of Connecticut Congressman Orville Hitchcock Platt. Included within its boundaries were 33 springs used by both local residents and visitors.

During the 1930s, the Civilian Conservation Corps constructed a number of im-

provements within the park, including pavilions, bridges, and weirs (figure 3). While the springs remained popular, visitor activities in the area were beginning to shift towards recreational pursuits. Recognizing the change in visitor interests and seeing an opportunity to better serve the demand for water-based recreation, the Congress redesignated Platt National Park as a national recreation area in 1976. With its change in status, the new Chickasaw National Recreation Area was enlarged to include the nearby Lake of the Arbuckles. In addition to providing recreational boating, swimming, and fishing opportunities, the lake serves as a flood control reservoir and water supply for surrounding communities. The recreation area was enlarged again in 1983 to its present size of 4,050 hectares (10,000 acres) through the acquisition of Veterans Lake (27 hectares; 67 acres) from the city of Sulphur (figure 4).

Groundwater at Chickasaw

A significant problem facing resource managers at Chickasaw National Recreation Area is that the underlying rock formations have yet to be studied in sufficient detail to fully understand the subsurface flow system that feeds the natural springs. South-central Oklahoma has a very complex geologic history that includes the building and subsequent erosion of the Arbuckle Mountains, located to the south of the recreation area. As a result, rock for-

¹ School of Geology, Oklahoma State University (OSU), Stillwater, Oklahoma.

² Department of Geography, OSU.

³ National Park Service, Chickasaw National Recreation Area, Sulphur, Oklahoma.



© Laura D. Wilson, www.LauraWilson.com

Figure 3. During the 1930s, the Civilian Conservation Corps constructed several improvements at what is today Chickasaw National Recreation Area. These included the pavilion, shown here, at Pavilion Spring.

mations in the vicinity of Chickasaw also show a high degree of complexity, exhibiting numerous folds, faults, and abrupt changes in rock type, much of which has not been studied.

The majority of the near-surface rocks in the recreation area belong to a geologic unit known as the Vanoss Formation. This well-cemented conglomerate is extremely dense and mostly impervious to the flow of water, except where it is fractured. Rock units that are impervious to water are known as confining layers, because they “confine” the flow of water to the underlying aquifer. Below the Vanoss Formation lie the Arbuckle (freshwater) and Simpson (mineralized) aquifers, which permit water to pass through fractures and pore spaces. Mountain building and erosional processes have left portions of the Arbuckle and Simpson aquifers exposed near the earth’s surface in a region that is higher in elevation, and generally to the east of the recreation area. Rainwater percolating into the aquifers flows toward the recreation area beneath the confining Vanoss Formation.

Just like water flowing through a pipe, water in confined aquifers is under pressure. In the Arbuckle and Simpson aquifers, water pressure is sufficiently high to raise water to the surface at breaks in the confining layer (Vanoss Formation). Artesian springs form at natural breaks in the confining layer, and wells drilled into the aquifer will flow freely without the aid of pumps (artesian wells). At any given time, the amount of water that flows from artesian wells and springs is a direct function of pressure within the aquifer. If pressure goes up, flow will increase, and vice-versa. An illustrative example of a typical artesian aquifer is shown in figure 5 (page 32),

although insufficient information exists to produce a diagram that accurately depicts conditions at Chickasaw National Recreation Area today.

As water flows through an aquifer, it dissolves minerals in the rock. The amount of dissolution is a function of rock type and the amount of time that the water remains in the aquifer. In rocks of normal to low solubility, water that moves slowly becomes mineralized, while water that moves more quickly remains fresh. Each spring at the recreation area is connected to the underlying aquifer in its own way; therefore, the chemical makeup of the mineralized waters differ from spring to spring. Chemical species found in the mineralized springs at Chickasaw include sodium, calcium, magnesium, chloride, bicarbonate, and sulfate (Hanson and Cates 1994). Chemical makeup of the spring water is also dependent on that of the rainwater that initially percolates into the aquifer in the upland areas. Therefore, land uses in these upland areas may potentially impact water quality within the aquifer, and hence the springs (see sidebar, page 32).

Water quantity issues

Although a field survey conducted in 1906 identified 33 active springs within what is now the Platt District of Chickasaw National Recreation Area, a more recent survey in 1987 identified only 21 springs, some of which were barely noticeable due to low flow (Taylor 1988). Among springs that have ceased to flow are two of the most popular, Bromide and Medicine Springs. Estimates in 1939 suggested that total spring discharge had declined approximately 80% from a 1906 estimate of 14,160 liters per

minute (3,741 g/min). Several springs had ceased to flow entirely by that time (Hanson and Cates 1994).

The observed decline in spring flow has become one of the most troubling questions facing resource managers at the recreation area. Spring flow is determined by pressure within the Arbuckle and Simpson aquifers, as discussed, which in turn is controlled by the balance between inflow (recharge) and outflow (discharge). The source for recharge is precipitation, which has remained relatively constant over the past 90 years. However, land use has changed dramatically within this same time frame, possibly influencing the fraction of precipitation that percolates through the soil to recharge the aquifers. In addition, a significant number of artesian wells have tapped the aquifer system since the area was first developed. The extent to which withdrawals from these wells may have reduced pressure within the aquifer system is currently unknown.

The water quantity issues illuminated during the 1996 workshop resulted in publication of the Water Resources Manage-

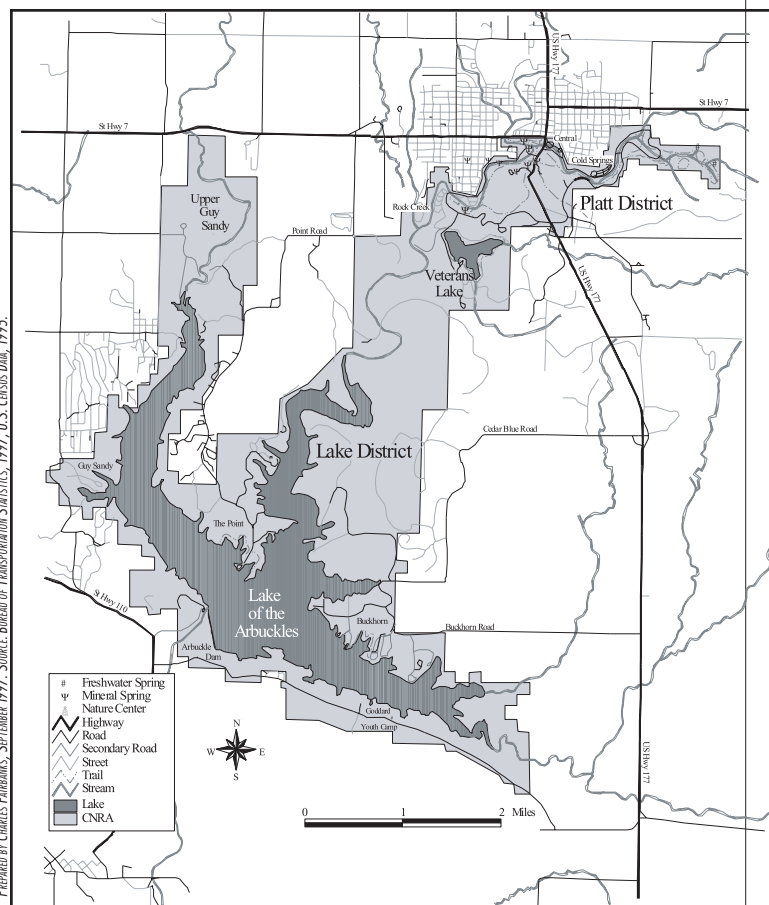


Figure 4. Detailed map of Chickasaw National Recreation Area.

“Chickasaw” continued on page 32

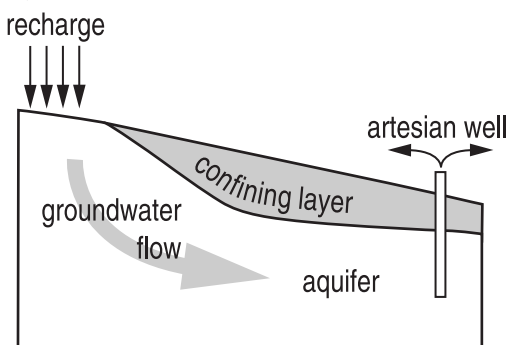


Figure 5. Generic geologic cross-section showing confined aquifer, spring, and artesian well.

ment Plan (Wikle et al. 1998) for the recreation area. Through resource management project statements, the plan details strategies for, among many others, investigating the dynamics of the aquifer flow system, restoring flow to Bromide Spring, and controlling the flow of Vendome Well, the first project to be completed.

Regulation of Vendome Well

The best known artesian well in the region is Vendome Well (see fig. 1, page 30), located on Highway 7 just south of Sulphur. Drilled outside of park boundaries in 1922 and purchased by the National Park Service in 1980, Vendome remains a popular tourist attraction and cultural landmark for Sulphur residents.

Discharge rates for Vendome have declined from approximately 9,500 liters per minute (~2,500 g/min) in 1922 to around 1,900 liters per minute (~500 g/min) in 1992 (Hanson and Cates 1994). Factors believed to be responsible for the declining flow of Vendome include a general reduction in aquifer pressure and deterioration of the well casing. Park staff suspect, too, that uncontrolled discharge from the well and leakage from the subsurface well casing may have contributed to the decline in discharge rates of mineralized springs elsewhere in the recreation area.

Because of the interest in preserving the discharge of all artesian wells and springs in the region, the National Park Service has recognized the importance of regulating the discharge of Vendome Well without compromising the cultural or historical integrity of the site. To that end, renovation of Vendome Well began in October 1997.

A new well was drilled to a depth of approximately 229 meters (750 feet) at a location approximately 9 meters (30 feet) to

the west and south of the original well (Christensen 1998). The new well produced water at a rate of around 3,800 liters per minute (~1,000 g/min); taste and smell of the water was similar to that issuing from the original fountain. After ascertaining the suitability of the new well, the original was plugged. In 1998, flow was routed from the new well into the existing fountain. Valves installed in the new well will allow flow to be controlled in accordance with management goals.

Long-term monitoring

In order to provide better information for decision-making, the water resources management plan recommends that the National Park Service implement a water quantity monitoring program that includes installation of flow gauges at each of the recreation area's springs. Although the U.S. Geological Survey maintains recording gauges to measure stream flow, the location of their equipment does not allow data collection for individual springs. Such data will be useful in determining a baseline flow for each spring, establishing trends relative to precipitation and other climatic factors, and evaluating potential mitigation measures that can be initiated by the National Park Service and surrounding water users. Information concerning withdrawal rates corresponding to artesian wells will also be needed in order to create a comprehensive water budget for the region. P_S

References

Brown, T. 1998. Chickasaw National Recreation Area: societal preference and rationale for collection and consumption of spring water.

Unpublished master's thesis. Department of Geography, Oklahoma State University.

Christensen, P. K. 1998. Vendome Well and springs at Chickasaw National Recreation Area. [www.aqd.nps.gov/wrd/vwcnra.htm]. Water Resources Division, National Park Service.

Fairchild, R. W., R. L. Hanson, and R. E. Davis. 1981. Hydrology of the Arbuckle Mountain area, south-central Oklahoma. U.S. Geological Survey. Open File Report 83-775.

Hanson, R. L., and S. W. Cates. 1994. Hydrogeology of Chickasaw National Recreation Area, Murray County, Oklahoma, Oklahoma City, Oklahoma. USGS, Water-resources Investigations Report 92.

National Park Service. 1997. Baseline water quality data inventory and analysis for Chickasaw National Recreation Area. Washington, D.C.

Taylor, T. 1988. Survey of Springs at Chickasaw National Recreation Area. Unpublished field notes.

Wikle, T., M. Nicholl, T. Brown, J. Nord, and R. Parker. 1998. Water resources management plan for Chickasaw National Recreation Area, National Park Service, 121 pp.

Michael Nicholl is Assistant Professor, School of Geology, Oklahoma State University, Stillwater, Oklahoma. He can be reached at nicholl@okway.okstate.edu. Thomas Wikle is Professor and head of the Department of Geography at Oklahoma State University; geogtaw@okstate.edu. Tonia Brown is Supervisor at DataMetrix in Tulsa; Jason Nord is a graduate student in the School of Geology at Oklahoma State. Ron Parker is Resource Management Specialist at Chickasaw National Recreation Area, Oklahoma; 405-622-3161; ron_parker@nps.gov.