Water Resources Management Plan

Chickasaw National Recreation Area

Oklahoma

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WATER RESOURCES MANAGEMENT PLAN

CHICKASAW NATIONAL RECREATION AREA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PHOTO CREDITS

Chickasaw National Recreation Area

The Water Resources Management Plan presented here will serve as a management tool to guide water resources related planning activities at Chickasaw National Recreation Area (CNRA) for the next 5 to 10 years. Included within the plan are sections that provide an overview of CNRA resources, resource management objectives, and critical water resource issues. In addition, a recommended management program is outlined that includes a set of project statements prepared following guidelines established by the National Park Service (NPS).

Having been set aside as a protected area at the request of Native American tribal units, CNRA is unique within the National Park System. The initial impetus for protection came in the late 1800's when Chickasaw and Choctaw Tribes recognized threats posed by the influx of white settlers adjacent to the freshwater and mineral springs. At the suggestion of the Chickasaw and Choctaw, 640 acres of tribal land located near the town of Sulphur Springs (currently Sulphur) in south-central Oklahoma were set aside in 1902 for protection by the federal government as the Sulphur Springs Reservation. Visitors came to the area to visit the springs, which were nationally renown for their purported healing and restorative powers. In 1906 Platt National Park was established and named in honor of Congressman Platt. During its early years as a tourist destination, Platt National Park experienced heavy visitation. In order to accommodate increases in visitor use, stone pavilions and enclosures were constructed by the Civilian Conservation Corps in the 1930s. Historic buildings, dams, wading pools, trails, and other landscape features also date to this construction period.

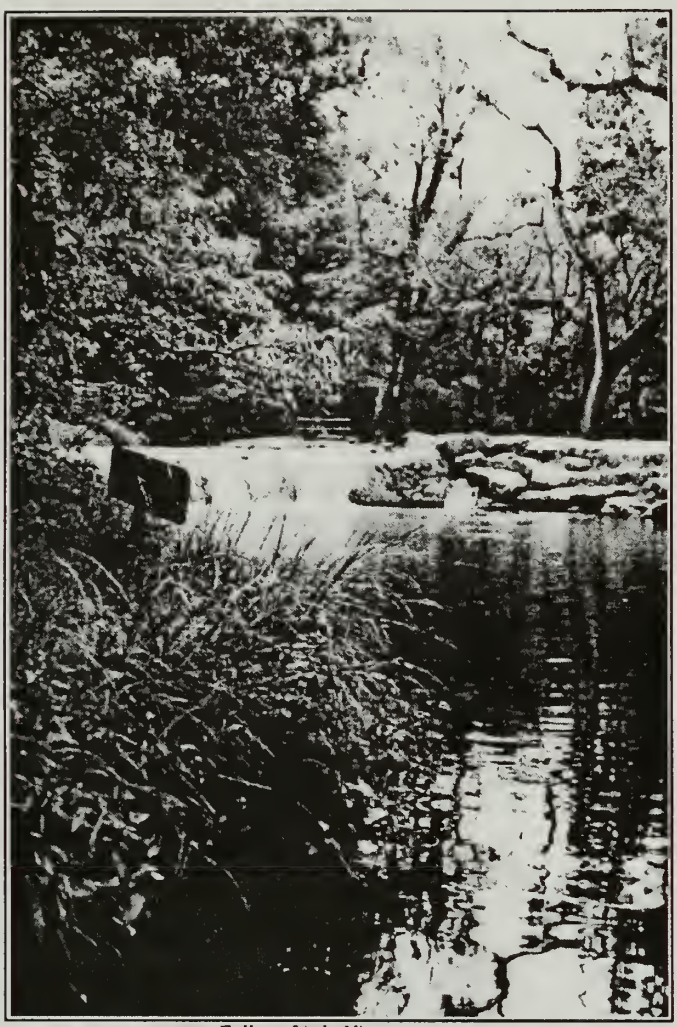
In 1976 Platt National Park was enlarged through the addition of Lake of the Arbuckles and renamed Chickasaw National

Recreation Area. In addition to honoring the Chickasaw people, the new name also reflects the change in designation from national park to national recreation area. Although visitors still came to collect water from the mineralized springs, the new attractions of Lake of the Arbuckles (added in 1976) and Veteran's Lake (added in 1983), caused a shift in visitor usage towards water-based recreation. While activities such as wading, nature watching, and hiking continue to be popular, water-based activities such as fishing, boating, and water skiing now account for the largest portion of visitation.

In terms of its physiographic setting, CNRA is located in a juncture of the Southern Osage Plains midway between Dallas, Texas and Oklahoma City, Oklahoma. Known as the Arbuckle Uplift, this area contains some of the thickest accumulations of Paleozoic rocks in the central U.S. Landforms within CNRA range from steep ridges dominated by resistant outcrops of weathered conglomerate rock to valley floors that are drained by meandering streams. Springs are among CNRA's most important asset. Archaeological evidence demonstrates that human use of spring water in the area dates back 7,000 years. Of 33 springs identified in 1933, only 19 could be located as of 1983.

Water resources at CNRA are derived from a delicately balanced, and ultimately fragile hydrologic system. Stresses to this system result from activities both within, and outside the boundaries of the Recreation Area. To address such issues, a workshop was held in December 1996 that was attended by state, federal, and local resource agency personnel, representatives of the Chickasaw Nation, Oklahoma State University researchers, and other interested individuals. The purpose was to identify critical issues affecting water resources at CNRA. Programmatic issues identified included the absence of long-term hydrological monitoring, the importance and need for baseline information about water resources at CNRA, and the need for a long-term program for land-use monitoring. Specific issues were divided into external and internal land-uses that influence CNRA water resources. External land uses noted by workshop participants included impacts from agricultural, residential, and industrial activities. Additional specific external concerns include threats posed by the transportation of hazardous wastes on nearby highways, and problems associated with illegal disposal sites. Several internal land issues were also noted including recreational impacts, the need for oil seep monitoring, exotic plant management, and especially, the importance of maintaining groundwater quality and quantity.

Development of the plan presented here has taken place within an iterative process involving significant cooperation among agencies, private organizations, and individuals. The process has included internal and external review of this document. It is hoped that the plan will continue to serve as a blueprint to assist in multi-agency coordination that will facilitate sustained efforts to protect water resources at CNRA.



Falls at Little Niagara

PURPOSE OF THE PLAN

Chickasaw National Recreation Area (CNRA) occupies 9,888 acres in south-central Oklahoma (see Figures 1 & 2). CNRA's visitors enjoy a wide variety of outdoor activities ranging from mineral water collection to swimming and fishing.

This Water Resources Management Plan (WRMP) is intended to serve as a management tool to guide water resources-related planning activities at CNRA over the next 5-10 years. The WRMP should be considered complementary to, and consistent with, other existing CNRA management documents including the *Master Plan* (NPS, 1970), *General Management Plan* (NPS, 1979), *Final Environmental Impact Statement* (NPS, 1980), *Final Amendment to General Management Plan* (NPS, 1994a), *Resource Management Plan for Chickasaw National Recreation Area* (NPS, 1994b), *Statement of Management* (NPS, 1995), and *Strategic Plan for CNRA* (NPS, 1996b). Implementation of the WRMP will assist NPS decision-making relating to the protection, preservation, use, enhancement, and management of CNRA water resources and the surrounding water-dependent environment.

This WRMP recognizes resource planning is a multi-step process and includes the following:

- **An Overview of CNRA**
  This section provides a review of significant resources, water-dependent environments, and a summary of existing hydrologic information.

- **A Review of WRMP Objectives and Issues**
  Assessments of potential threats to resource conditions and an evaluation of management action alternatives are presented in this section.

- **Development of Actions to Address Current Water Resources Issues**
  This section is primarily devoted to the preparation of project statements, used by the NPS in establishing priorities for the funding of specific management actions.

Natural and cultural resources planning for units of the NPS is a multi-step process that begins with a review of the purposes for an area's establishment, and the identification of the exceptional resource values associated with the area. A WRMP provides resource-specific information to support NPS decision-making related to the protection and management of an area's water resources and water-dependent environments. It includes a review of available information about water resources and water-dependent environments, descriptions of significant water resource management issues,

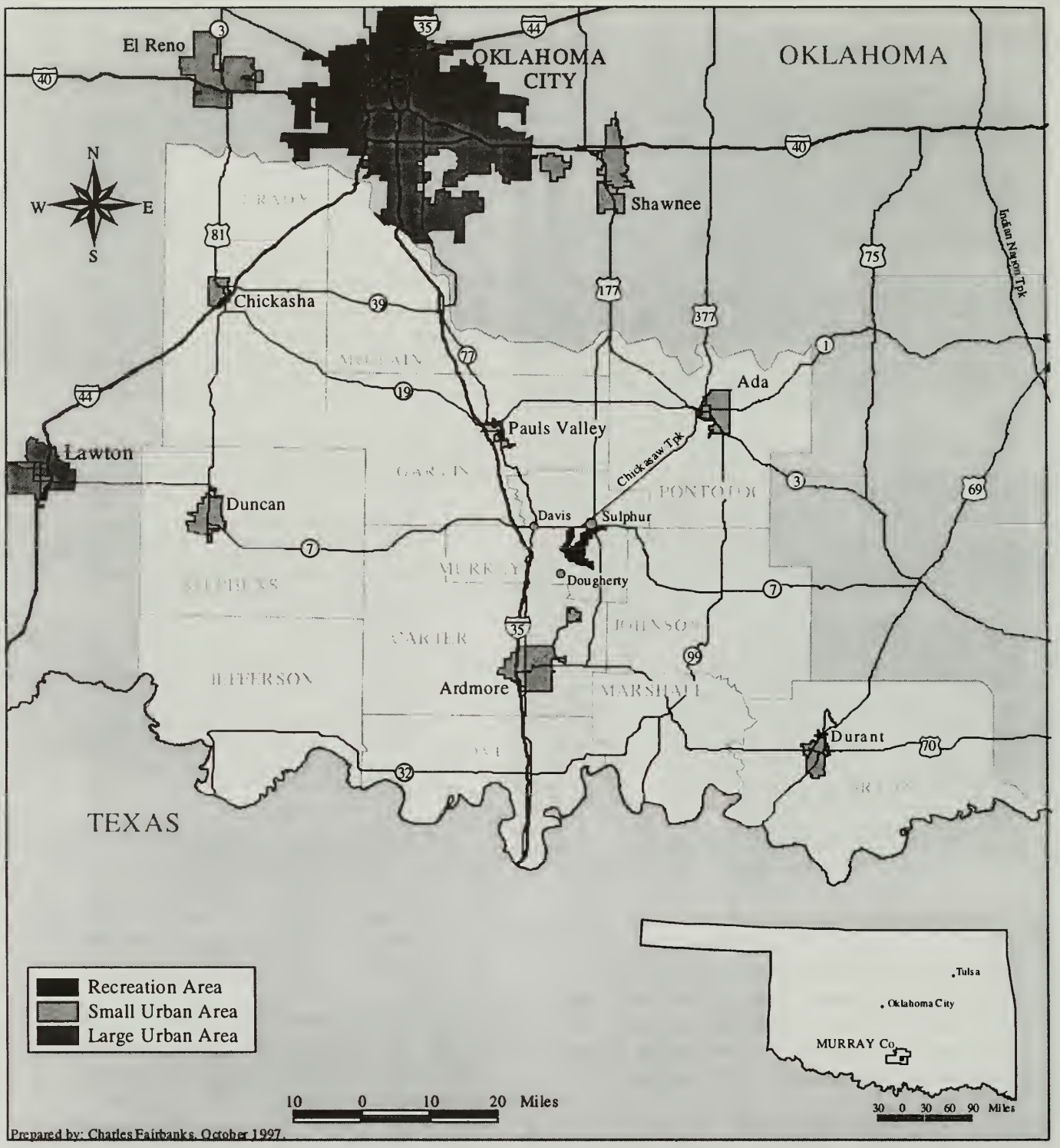


Figure 1. Regional Map

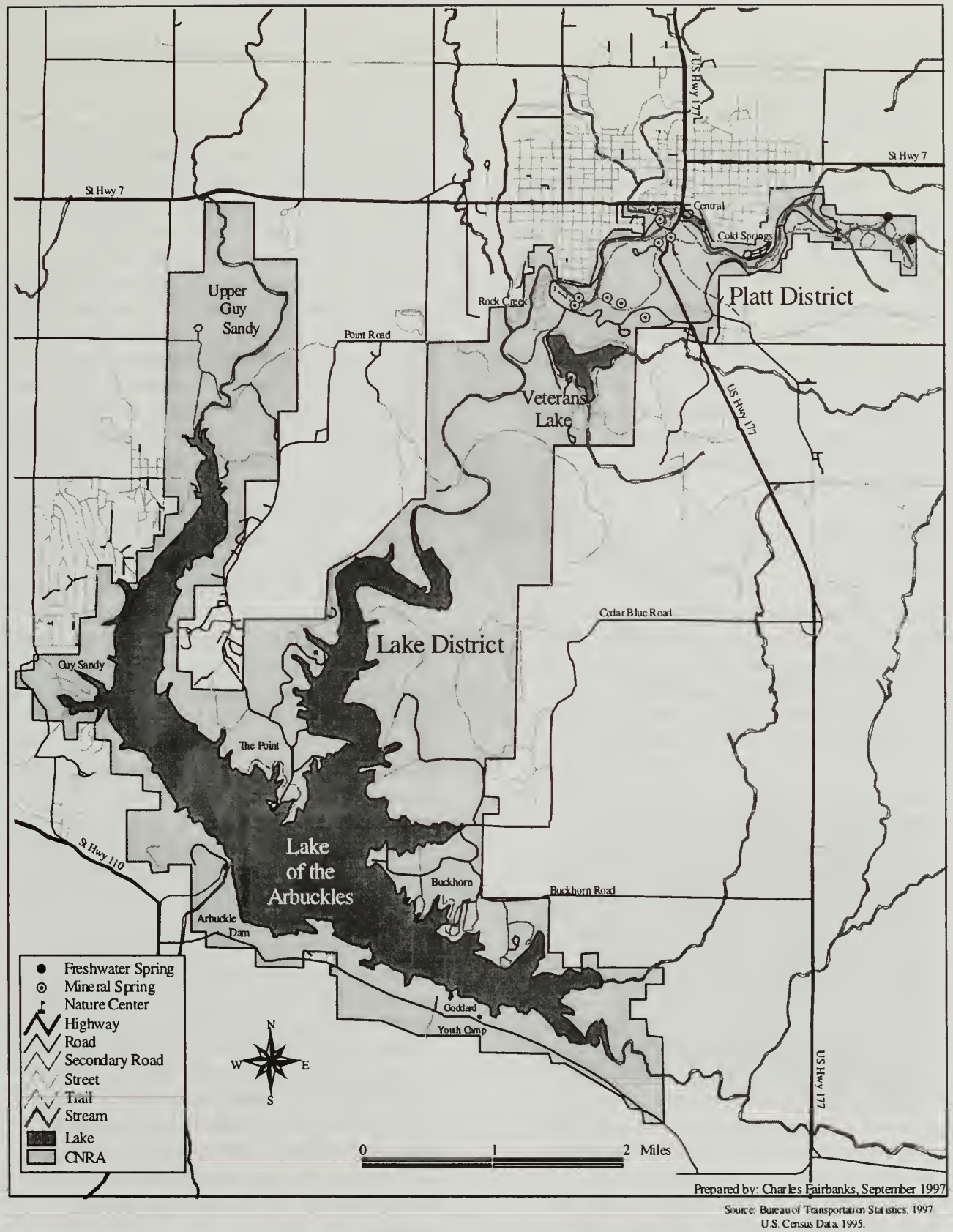


Figure 2. Chickasaw National Recreation Area

and information about constraints on water management imposed by an area's enabling legislation. Additionally, the WRMP outlines a recommended management program for water resources, including actions for inventory and monitoring, resource management, and research. Part of the recommended management program is a set of project statements prepared following guidelines established by the NPS and designed to be incorporated into the area's resource management plan. These project statements are developed to define an action plan for addressing the specific issues identified in the WRMP. The WRMP recognizes that the planning process is not stagnant and must adapt to both changes in the dynamics of the natural and cultural resources, as well as the public served by the NPS.

THE EARLY YEARS: PLATT NATIONAL PARK

Long before federal government management, the abundance of springs, streams, and lakes drew not only resident tribes such as the Wichitas and their allies the Caddos, but also non-resident tribes including the Comanche to the area that is now CNRA (Boeger, 1987). The area's lure among Native American groups was largely tied to fresh and mineralized springs located within the rolling hills. Native American groups valued spring water for its medicinal uses and viewed the springs as sacred places (Boeger, 1987; National Parks and Conservation Association, 1993). In the 1830's, the Indian Nations commonly referred to as the "Five Civilized Tribes," were relocated west of the Mississippi to an area that became known as Indian Territory. The Treaty of Dancing Rabbit Creek, signed in September of 1830, assigned the southern third of what is now Oklahoma to the Choctaw Nation. Seven years later, the Chickasaw Nation agreed to move west after purchasing an interest in the Choctaw Nation. In 1855, an agreement between the U.S. Government and the two nations divided the area, leaving land that includes the present day CNRA within the region controlled by the Chickasaw Nation.

During the 1880's, word of healing powers associated with the area's bromide and sulfur springs reached white settlers. By the turn of the century a bustling community had been built in the vicinity of the springs. Developers constructed hotels and bathhouses with hopes for the area becoming a health resort. Fearing permanent damage, or loss of the spring waters, representatives of the Chickasaw and Choctaw Nations petitioned for federal government protection of land that included the springs. An ally for their cause was Orville H. Platt, a U.S. Congressman from Connecticut, who recognized the importance of protecting spring waters in the area. Through his contact with local inhabitants, Platt learned of the curative powers of the area's spring waters and the danger of losing the pristine quality of the springs (Cunningham, 1941; Gibson, 1996). With support from Platt, 640 acres of land owned by the Native Americans was set aside by Congress on July 1, 1902 as the Sulphur Springs Reservation under the supervision of the Department of the Interior (32 Stat. 655).

Included within the enabling legislation was a mandate that enough land be set aside to embrace all the natural springs and much of Sulphur (now Travertine), Rock, and Buckhorn Creeks as deemed necessary by the Secretary of the Interior for the proper utilization and control of these waters (32 Stat. 655). A payment of $20.00 per acre was made to the Choctaw and Chickasaw Nations. Improvements to the land were to be appraised and a payment paid based on its value at the time of agreement ratification (32 Stat. 655). To provide further protection for the springs, the Congressional Appropriations Act of April 21, 1904 added another 218 acres (33 Stat. 220). The Choctaw and Chickasaw Nations received $60.00 per acre for this land. As a result of the land acquisitions, the town of Sulphur Springs was moved to its present location.

Sulphur Springs Reservation was redesignated as Platt National Park through a joint resolution of Congress on June 29, 1906, (34 Stat. 837) to honor H. Orville Hitchcock Platt.

The new National Park was unique within the National Park System for two reasons: Platt was the country's smallest national park, and it was established through a conveyance of property from two Native American Nations (Boeger, 1987). The creation of the NPS as a separate entity within the Department of the Interior in 1916 brought Platt under NPS control. The NPS's mission was directed towards the conservation of scenery and natural and historic objects and to facilitate public enjoyment in such a way so as to leave them unimpaired for the enjoyment of future generations (39 Stat. 535: 16 U.S.C. 1.).

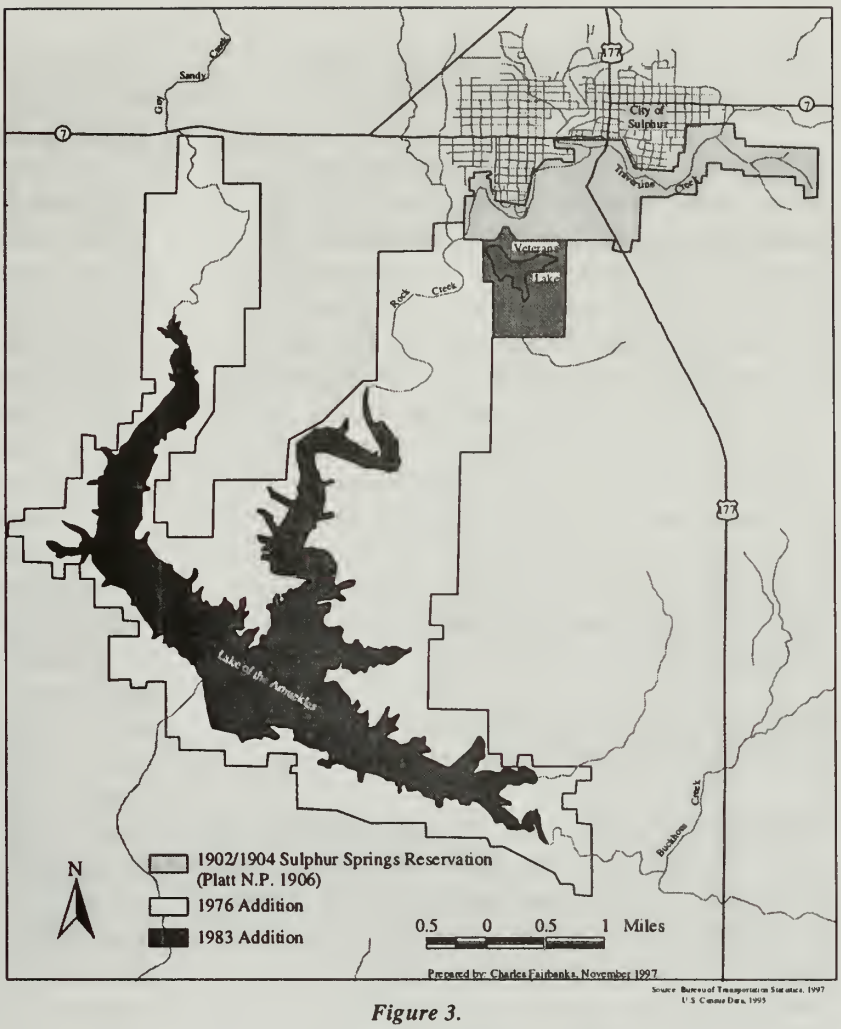


Figure 3.
Boundary Changes

During the 1930's Platt National Park was the focus of several Civilian Conservation Corps (CCC) projects. These included the planting of trees and the construction of roads, bridges, and trails (Boeger, 1987; U.S. NPS, 1996a; Sallee and Schoneweis, 1997). Since water was the main attraction, improvements were made to springs and streams including the construction of pavilions, outflow channels. Bank stabilization and the creation of dams made access to waters easier (Boeger, 1987). The dams built along Travertine Creek improved swim areas, creating many of the popular "swimming holes."

CCC workers constructing Buffalo Springs pool.

LAKE OF THE ARBUCKLES AND THE EXPANSION OF PARK BOUNDARIES

After the 1930's, visitation to Platt National Park declined. Despite the decrease in use, the mineral springs continued to be the principal attraction of the park until the completion of the nearby Lake of the Arbuckles reservoir, which was authorized through the Arbuckle Federal Reclamation Project (76 Stat. 395) on August 24, 1962. Construction of this reservoir on Rock, Guy Sandy, and Buckhorn Creeks was intended to facilitate flood control and to serve as a municipal water supply under the authority of the Bureau of Reclamation (BOR). Recreation was to be a secondary purpose of the project following municipal and industrial uses (Boeger, 1987).

REDESIGNATION AS CHICKASAW NATIONAL RECREATION AREA

Completion of the reservoir created a situation where Platt National Park and the Arbuckle Recreation Area complemented each other, with the lake providing types of water recreation unavailable in the park (Boeger, 1987). Recognizing the synergistic relationship between the park and the reservoir-based recreation area, NPS officials made a proposal in 1970 to purchase land between Lake of the Arbuckles and the park (see Figure 3). Also under consideration was a change in the area's designation from a national park to a national recreation area. Although many local residents expressed dissatisfaction with the concept of reclassification, the majority of visitors to the region were interested in recreational pursuits. Therefore, visitor desires for water-based outdoor recreational pursuits such as boating, water skiing, and fishing played an important role in Platt's redesignation as a national recreation area. During a public meeting, a member of the Chickasaw Nation suggested that the reclassified area be named Chickasaw National Recreation Area as a memorial to those who initiated the conveyance of the original tract of land (Boeger, 1987).

On March 17, 1976, CNRA was established by Public Law 94-235 (90 Stat. 235). This act was implemented,

> *...to provide for public outdoor recreation use and enjoyment of Arbuckle Reservoir and land adjacent thereto, and to provide for more efficient administration of other adjacent areas containing scenic, scientific, natural, and historic values contributing to public enjoyment of the area, and to designate the area in such a manner as will constitute a fitting memorialization of the Chickasaw Indian Nation.*

The legislation mandated the area was not to exceed ten thousand acres and would include Platt National Park (Platt District), the Lake of the Arbuckles (Arbuckle District), and land adjacent to the new districts. Additionally, the Act provided that these new lands be administered in accordance with the provisions of the Act of August 24, 1916 (39 Stat. 535: 16 U.S.C. 1, 2-4), which established the NPS. It should be noted this latter provision is not typically present in the legislation of other national recreation areas. On November 14, 1983, CNRA obtained a quit claim deed to Veterans Lake through a donation by the City of Sulphur, bringing the total size of the recreation area to 9,888 acres (see Figure 3).

The principal mission of the new CNRA was to provide sustainable opportunities for diverse outdoor experiences ranging from recreation to nature study, and to preserve both the natural and cultural resources. With its expanded size, CNRA included two lakes (Veterans Lake and Lake of the Arbuckles), six historically used springs (Black Sulphur, Pavilion, Hillside, Bromide, Antelope, and Buffalo), several little known minor springs, one artesian well (Vendome), and five creeks (Travertine, Rock, Guy Sandy, Buckhorn, and Wilson).

Resources protected within CNRA include springs (mineralized and freshwater), clear streams, lakes nestled among shady woods, and rolling hills (National Parks and Conservation

Association, 1993). It should be noted that not all of these springs were named by Native Americans; white settlers gave names to many of the springs. Pavilion, Bromide, Black Sulphur, and Hillside Springs (Beauty Spring), were developed for public use by local residents prior to federal management. Vendome Well was drilled in 1922 and acquired by the park in 1980 (Boeger, 1987). Despite having received federal protection, degradation to free flowing springs has taken place. Bromide and Medicine Springs, two mineral springs historically important for their reputed medicinal value, ceased flowing in the 1970's. Groundwater pumping and nearby artesian wells may have caused other springs to cease flowing (National Parks and Conservation Association, 1993; Boeger, 1987).

Visitors collecting Bromide Water, 1967.

LEGISLATION AND PLANNING CONSTRAINTS AND REQUIREMENTS

LEGISLATED PURPOSE

Sulphur Springs Reservation was first set aside in 1902 when legislation (32 Stat. 655) allowed the federal government to purchase 640 acres from the Chickasaw and Choctaw Indian Nations within Indian Territory. Subsequent legislation passed in 1904 (33 Stat. 220) added 217 acres to the reservation and in 1906 (34 Stat. 267) the reservation's name was changed to Platt National Park.

In 1962 Public Law 87-594 initiated the Arbuckle Federal Reclamation Project (under the BOR). This legislation authorized the construction of a reservoir for the purposes of storing, regulating, and furnishing water for municipal, domestic, and industrial use. The impoundment was also intended to assist in controlling floods; would aid in the conservation and development of fish and wildlife habitat; and would enhance recreational opportunities.

Legislation in 1976 (Public Law 94-235) combined Platt National Park and Arbuckle Recreation Area with additional lands to create CNRA. The purpose of this act was to provide for public use and enjoyment of Arbuckle Reservoir and adjacent land, and to provide for more efficient administration of other adjacent areas containing scenic, scientific, natural, and historic value.

The NPS Act of 1916 (39 Stat. 535) outlines the NPS's responsibility for public lands with the objective "...to conserve the scenery and the natural and historic objects and the wildlife therein, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Throughout the legislative history of CNRA, the principal purpose of the area has been the preservation of water resources and the provision of public use and recreation.

CONCEPTUAL PURPOSE

Using the legislation as a guide, CNRA's purpose is further defined in its *1996 Strategic Plan*. This document states that the area is preserved in order,

> *...to provide for the protection of CNRA's unique resources, springs, streams, lakes, and other natural features, and its cultural history and structures, as well as its recreational resources and built facilities; and to provide for public education, appreciation, and recreational use and enjoyment of these resources. CNRA will strive to give each visitor an enjoyable and memorable experience to provide each employee with opportunities for material and personal growth* (NPS, 1996a).

NPS MANAGEMENT POLICIES AND GUIDELINES

Management of the NPS and NPS programs is guided by the Constitution, public laws, proclamations, executive orders, rules and regulations, and directives of the Secretary of the Interior and the Assistant Secretary for Fish and Wildlife Services and Parks. Servicewide policy is articulated by the Director of the NPS and must be consistent with other laws and regulations. NPS *Management Policies* (NPS, 1988) provides broad policy guidance for planning, land protection, natural and cultural resources management, wilderness preservation and management, interpretation and education, special uses of the parks, park facilities design, and concessions management.

Recommended procedures for implementing servicewide policy are described in the Director's Orders. The guidelines most relevant to CNRA water resources include:

- DO-2, which provides guidelines for the planning process (NPS, 1982a)
- DO-12, which addresses compliance with the NEPA including preparation of EISs,

EAs, and categorical exclusions (NPS, 1982b)
- DO-75, which provides natural resource inventory and monitoring requirements (NPS, 1992);
- DO-77, which guides natural resource management activities (NPS, 1991).

In addition to the legislation establishing CNRA and the Park Service itself, the *Management Policies* address water resources (NPS 1988). Specifically, the document states the waters of a park are a primary resource on par with the wildlife, forest, geological, and historic features and that the conservation and protection of water resources are to be primary issues for management. Finally, the *Management Policies* mandate that the NPS and its agents will, consistent with applicable federal, state, and local laws and regulations, maintain the quality of all waters.

The *CNRA General Management Plan* (GMP) identifies broad-based management recommendations to address resource management issues (NPS, 1980). As an addition to the GMP, the *Resource Management Plan* (NPS, 1994b) is a tool for the management of resources and serves as a guide for decision-making in three ways:

1) by enhancing management activities which help maintain natural ecological processes,
2) through better protection of cultural resources, and
3) by serving as a set of research recommendations and priorities that are designed to obtain additional information that will aid in better park management.

FEDERAL LAWS

NPS Organic Act of 1916

The NPS Organic Act makes the NPS responsible for the preservation and conservation of natural and cultural resources in all parklands or sites under its jurisdiction. Congress reinforced this act in 1970 with legislation stipulating that all parklands are united by a common preservation purpose, regardless of title or designation. Therefore, under the provisions of the NPS Organic Act, federal law protects all water resources in the National Park System, and it is the fundamental duty of the NPS to protect those resources unless otherwise instructed by Congress.

National Environmental Protection Act (NEPA) of 1969

NEPA mandates that all major federal actions undergo an environmental analysis and be subject to public review. With regard to water resources, the act mandates a careful review of changes in water use and treatment including the construction of pipelines, visitor facilities, etc. NEPA established a general federal policy for the responsibility of each generation as a trustee of the environment for succeeding generations and requires that an environmental impact statement (EIS) be prepared as part of the review and approval process by federal government agencies for actions that significantly affect the quality of human life. The primary purpose of an EIS is to serve as an action-forming device to ensure evaluation of the impacts of proposed projects and to facilitate public review.

Federal Water Pollution Control Act (Clean Water Act)

The Federal Water Pollution Control Act, more commonly known as the Clean Water Act, was passed in 1972 and amended in 1977, 1987, and 1990. Its purpose was to restore and maintain the integrity of the nation's water by: 1) eliminating pollution within waters of the United States, 2) providing for pollution control activities in the federal government, and 3) through grants and related programs to the states. The Act also specified standards and enforcement.

Among the Clean Water Act's specific goals were swimmable and fishable waters by 1983 and no further discharge of pollutants into the nation's waterways by 1985. Two strategies for achieving these goals included a major grant program to assist in the construction of municipal sewage treatment facilities and a

program of "effluent limitations" designed to limit the amount of pollution that can be discharged.

As part of the Clean Water Act, Congress recognized the primary role of the states in managing and regulating the nation's water quality within the general framework developed by Congress. All federal agencies must comply with the requirements of state law for water quality management, regardless of other jurisdictional status or land ownership. States implement the protection of water quality under the authority granted by the Clean Water Act through Best Management Practices (BMPs) and water quality standards. BMPs are defined by the U.S. Environmental Protection Agency as methods, measures, or practices selected by an agency to meet its nonpoint pollution control needs. BMP's can be applied before, during, and after pollution producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Water quality standards are tied to the designated use or uses associated with a water body or segment, and the water quality criteria necessary to protect those uses.

Endangered Species Act of 1973

The 1973 Endangered Species Act provides for the conservation of ecosystems that preserve habitat for threatened and endangered species of fish, wildlife, and plants. This Act requires the NPS and all other federal agencies to consult with the Secretary of the Interior on all activities that potentially impact endangered plants or animals and mandates the protection of endangered species and their physical habitat.

Fish and Wildlife Coordination Act of 1934

This Act authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with federal and state agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife. This Act also directs the U.S. Fish and Wildlife Service to use impounded waters for fish-culture stations and migratory-bird resting and nesting areas and requires consultation with the Bureau of Fisheries (now the U.S. Fish and Wildlife Service) prior to the construction of any new dam in order to provide for fish migration. In addition, this Act authorizes the preparation of plans to protect wildlife resources, the completion of wildlife surveys on public lands, and the acceptance by federal agencies of funds or land for related purposes provided that the state where the land is located consents to the donation.

In addition to the provisions noted, the Fish and Wildlife Act of 1934 establishes a comprehensive national fish, shellfish, and wildlife resources policy with an emphasis on the commercial fishing industry. The Secretary of the Interior is required by Section 7(a) of the Act to take steps "...required for the development, advancement, management, conservation, and protection of fish and wildlife resources" through research, acquisition of land and water or interest therein, development of existing facilities, and other means."

Flood Control Act of 1944

The Flood Control Act authorizes the construction of dams and modifications to previously existing dams. Several provisions of the Act impact the responsibilities of the U.S. Fish and Wildlife Service under the Fish and Wildlife Coordination Act. This Act, as amended and supplemented by other flood control acts and river and harbor acts, authorizes various U.S. Army Corps of Engineers water development projects.

Section 2 of the Flood Control Act stipulates that flood control projects, including channel and drainage improvements, would be supervised by the Secretary of the Army. Watershed projects, including measures for runoff and soil erosion protection, would fall under the Secretary of Agriculture.

Section 4 authorized the Chief of Army Engineers to construct, operate, and maintain public park and other recreational facilities in reservoir areas under the Secretary of the Army's jurisdiction. Recreational uses of such

areas must be consistent with existing laws to protect state fish and game resources. Finally, this section stipulated that surplus power from reservoir projects must be provided to the Secretary of the Interior for distribution at the lowest possible rates.

Floodplain Management Executive Order 11988 of 1977

This executive order was implemented as a means of protecting life and property from loss by flooding, and to restore and preserve natural and beneficial floodplain values. The order requires the consideration of flood hazards during planning efforts for buildings and other facilities in floodplains, and requires a public review of proposed projects. It also stipulates the modification or removal of some existing facilities if they are determined to be hazardous. In addition, the Order requires all federal agencies to "...reduce the risk of flood loss... minimize the impacts of floods on human safety, health and welfare, and... restore and preserve the natural and beneficial values served by floodplains" (Goldfarb, 1988). Federal agencies are therefore required to implement floodplain planning and consider all feasible alternatives that minimize impacts prior to the construction of facilities or structures. Construction of facilities must be consistent with federal flood insurance and floodplain management programs.

West (1990) suggests that NPS managers should insure that where park resources fall within flood hazard areas, they are properly marked to increase public awareness of potential flood dangers at the site. To the extent possible, park facilities such as campgrounds and rest areas should be located outside of these areas. In response to Directive 93-4, the current guidelines for floodplain management are entitled *Floodplain Management Guidelines*.

WATER RIGHTS

Riparian

Most water systems in the eastern portion of the U.S. are based on the Riparian Doctrine, which is derived from English common law. The original Riparian Doctrine was judicially based and originally stated that owners of land (riparians) bordering a watercourse had entitlement to the use of water without diminution or impairment. As generally applied now, riparians have equal rights to the use of water from natural water bodies, as long as it does not interfere with the reasonable uses of other riparian users. A riparian water right is a property right, and generally water can only be used on the riparian land within the drainage basin of the watercourse. A riparian right is not lost because of nonuse, and can be correlated with all other users with no fixed allocation. Shortages are shared equally among riparians.

Appropriative

Water rights in most of the U.S. are based on the Doctrine of Prior Appropriation. This principle originated in the gold camps of the arid western states and later became the law for distributing water for irrigation. Scarce water supplies required the apportioning of water among competing users based on a first-come, first-serve (priority) system. According to this doctrine, the party who applies water to a state-recognized beneficial use (i.e., appropriates the water) has a right that is superior to those who commence their use later. The right is statutory and can be bought or sold. The water's point of diversion, place of use, and manner of use can also be changed without losing priority. Although the right is a fixed allocation, if the water is not used for a period of consecutive years it may be lost through action by the state (forfeiture) or intent by the right holder (abandonment). During shortages, right-holders with junior priority dates do not receive water until the uses of senior right-holders have been satisfied.

Federal Reserved

When the federal government reserves land for a purpose, it also reserves water (either implicitly or explicitly) that is unappropriated at the time of reservation, necessary to accomplish the purpose of the reservation. The President or Congress can reserve land for specific purposes. The right vests as of the date of the reservation,

regardless of when the water is actually put to use, and is superior to the rights of those who commence use after the reservation date. Federal reserved water rights may include water for consumptive uses, such as for domestic purposes or irrigation, as well as nonconsumptive uses such as instream flow.

General adjudications are the means by which the United States claims its reserved water rights as provided by the Act of June 10, 1952 (66 Stat. 560, 43 U.S.C. 666, the McCarran Act). In a general adjudication, all water users on a stream and its tributaries must claim their water rights, and after considering evidence and testimony, the court issues the decree(s) setting forth the rights within the adjudicated area, including the federal reserved water rights. Adjudications generally occur in state courts, but federal courts also have jurisdiction.

Water Rights in Oklahoma

Reasonable use of water is the limit associated with any water right in Oklahoma. Before statehood, Oklahoma adopted both the Riparian and Appropriation Doctrines to regulate the use of stream water. The Oklahoma Water Resources Board (OWRB) regulates the use of water following statutory law. Persons who believe their water rights are being impaired by the acts of others may seek a resolution in State District Court.

Stream water is not privately owned and is considered public water available for use. In 1963, the legislature enacted laws that restricted the future exercise of riparian rights to the taking of water for domestic purposes, and provided a process for validating and establishing priorities for all pre-existing riparian and appropriative non-domestic beneficial uses. The legislature enacted laws which declared that the acquisition of water for all future non-domestic uses must be accomplished by filing an application with the OWRB, receiving a permit, and putting the stream water to beneficial use. Domestic use refers to the use of water for household purposes, for farm and domestic animals up to the normal grazing capacity of the land, and for the irrigation of land not exceeding a total of three acres for the growing of gardens, orchards, and lawns.

The OWRB may hold proceedings to establish rights to the use of water from a stream after determining that such action is in the best interest of all claimants to the system's water. Oklahoma water policy stipulates that only excess and surplus water should be utilized outside of the area of origin, and citizens within areas of origin have a prior right to water originating therein.

Landholders own the groundwater beneath their lands, but their use of it is subject to regulation. For example, in 1972, a law was enacted to provide for the allocation of water located below ground. This law stipulates that the OWRB must determine the allocation based on hydrologic surveys. A survey describes the following information regarding a basin: (1) the total land area, (2) amount of groundwater, (3) the recharge rate to, and discharge rate from aquifers, (4) the transmissivity of aquifers, (5) possible pollution from natural sources, and (6) the presumed groundwater yield for a period of 20 years. Landowners and/or their lessees may be granted permits to withdraw a proportionate share of the yield equal to the percentage of land overlying the basin which is owned or leased. Permanent permits are issued only after a hydrologic survey has been completed. At this time, basin surveys that include CNRA have not been completed. Landholders are therefore entitled to take groundwater without a permit for domestic purposes.

The OWRB uses a procedure for establishing rights to use groundwater from wells that existed before July 1, 1973. Such rights are referred to as "prior rights to groundwater." The OWRB initiated the process for determining prior rights to groundwater in Murray County in 1982. The NPS submitted prior right claims to 32 springs and 3 wells (Vendome and two observation wells) within CNRA. At a 1990 hearing, however, the NPS argued that the proceeding could not establish the groundwater rights of the United States in a binding manner. In a 1991 order, the OWRB agreed with the NPS and

concluded that the order would not include the rights of the United States.

Conflicts or disputes over the use of water can be resolved by the OWRB through an administrative hearing process. Any interested party has the right to protest an application to take surface or groundwater. Protesting parties must then present evidence in support of their position at a hearing regarding the application. In the matter of a surface-water application, the OWRB determines, following a hearing, whether: (1) unappropriated water is available, (2) the applicant has a need for the water, and (3) the proposed use interferes with domestic or existing appropriative uses. When reviewing a groundwater application, the OWRB determines whether: (1) the applicant owns or leases lands overlying the groundwater basin, and (2) that the use to which the applicant intends to put the water is beneficial.

Water Rights for CNRA

Within CNRA, the United States has riparian water rights for domestic use because it is a landholder. There are no known appropriative surface-water rights for CNRA, and prior rights to groundwater have not been determined. In addition, federal reserved water rights for the area have not been adjudicated. The reserved rights, when decreed, should satisfy the purposes for which the Platt and Arbuckle Districts were established. For further information concerning federal, state, or local legislation, refer to Appendix B.

STATE LAWS

State of Oklahoma Water Quality Standards of 1985

Water quality standards apply to surface and groundwater located within CNRA. Lake of the Arbuckles serves as the principal water supply for several nearby municipalities. Since the lake itself is located within the downstream portion of CNRA drainage, water quality standards, as determined by the State of Oklahoma for public and private water supplies, apply to all stream flows which enter the lake. Two other beneficial use categories of importance to CNRA are fish and wildlife propagation and recreation.

THE HYDROLOGIC ENVIRONMENT

PHYSIOGRAPHIC SETTING

CNRA is located in south-central Oklahoma midway between Dallas, Texas and Oklahoma City, Oklahoma. Occupying approximately 9,888 acres, CNRA is situated at the juncture of the southern Osage Plains and the ancient, worn down remnants of the Arbuckle Mountains (Barker and Jameson, 1975).

At the continental physiographic scale, CNRA is located at the southern terminus of the interior plains, a region that extends from central Canada to the south-central United States, and is bounded on the west by the Rocky Mountain System and the Appalachian Highlands to the east. On a regional scale, CNRA is located in the physiographic province known as the Arbuckle Uplift (see Figure 4). As noted by Tapp (1997), this province contains some of the thickest accumulations of Paleozoic rocks in the central United States with ages ranging from 570 to 245 million years ago (MYA).

Two major geological events influenced the geology of this region. The first major event was large-scale faulting that formed enormous rift valleys much like those in eastern Africa. The rifting arm extended from the Ouachita Mountains on a southeast-northwest line to the western area known as the Anadarko Basin. Following this event, thick accumulations of sediments formed within the shallow rift valley and currently comprise a large part of the stratigraphic column of the Arbuckle Uplift region. Even thicker accumulations of sediments can be found to the northwest in the Anadarko Basin region.

A deformational process was the second major event that transformed this region. This is displayed within the Arbuckle Uplift region and can be seen in deformed rocks, numerous faults, and other tectonic features such as anticlines and synclines (Tapp, 1997). The greatest deformation in the region, however, occurred in the Ouachita Uplift province, which is located east of the Arbuckle Uplift. Rifting and deformational events also affected other areas within the region, including the Arbuckle-Wichita Trend. A more detailed description of the regional geologic history can be found in the geological section of this plan.

Landforms within CNRA vary from steep ridges dominated by weathering resistant outcrops of conglomerate rock, to valley floors that are drained by several streams. Topography generally slopes to the southwest, with the high point located at the Bromide Hill Overlook (Sallee and Schoneweis, 1997). Surface elevations in CNRA vary from almost 1200 feet above mean sea level (msl) southeast of Veterans Lake to 800 feet above msl at the Lake of the Arbuckles. The gentlest slopes within CNRA occur in northern portions of the area along streambeds. One such location is found along Travertine Creek, where the NPS has established numerous recreational sites.

CNRA's topographic variation is influenced by the diversity of rock types and their respective susceptibility to erosion. The high points of CNRA, located around Veterans Lake, are covered with erosion resistant Vanoss Conglomerate while some of the lower lying areas, where creeks cut through, are covered with less resistant carbonate formations. Some formations contain alternating layers of sandstones, shales, and limestones. The erosion-resistant sandstone rocks form topographic highs while the less resistant carbonates and clays form topographic lows, giving portions of the area a characteristic hilly topography.

Rock Creek Drainage Basin (see Figure 5) makes up the main drainage area of CNRA. This basin contains several streams including Travertine, Rock, Guy Sandy, and Buckhorn Creeks, all of which feed into Lake of the Arbuckles. Meanwhile, Wilson Creek is the main source of water for Veterans Lake. Stream flow in the area is supplied year-round by the area's numerous natural springs.

Figure 4.
Generalized Map Showing the Physiographic Provinces of Oklahoma (After Tapp, 1997).

GEOLOGY

Although only a limited number of geologic studies had been conducted within the confines of CNRA at the time of this report, the Arbuckle Mountains have been studied extensively (e.g., Al-Shaieb et al., 1977; Decker and Merritt, 1931; Ham, 1955, 1969, 1973; Johnson et al., 1984). Regional scale information obtained from studies of the Arbuckle Mountains provides insight concerning the general geology of CNRA.

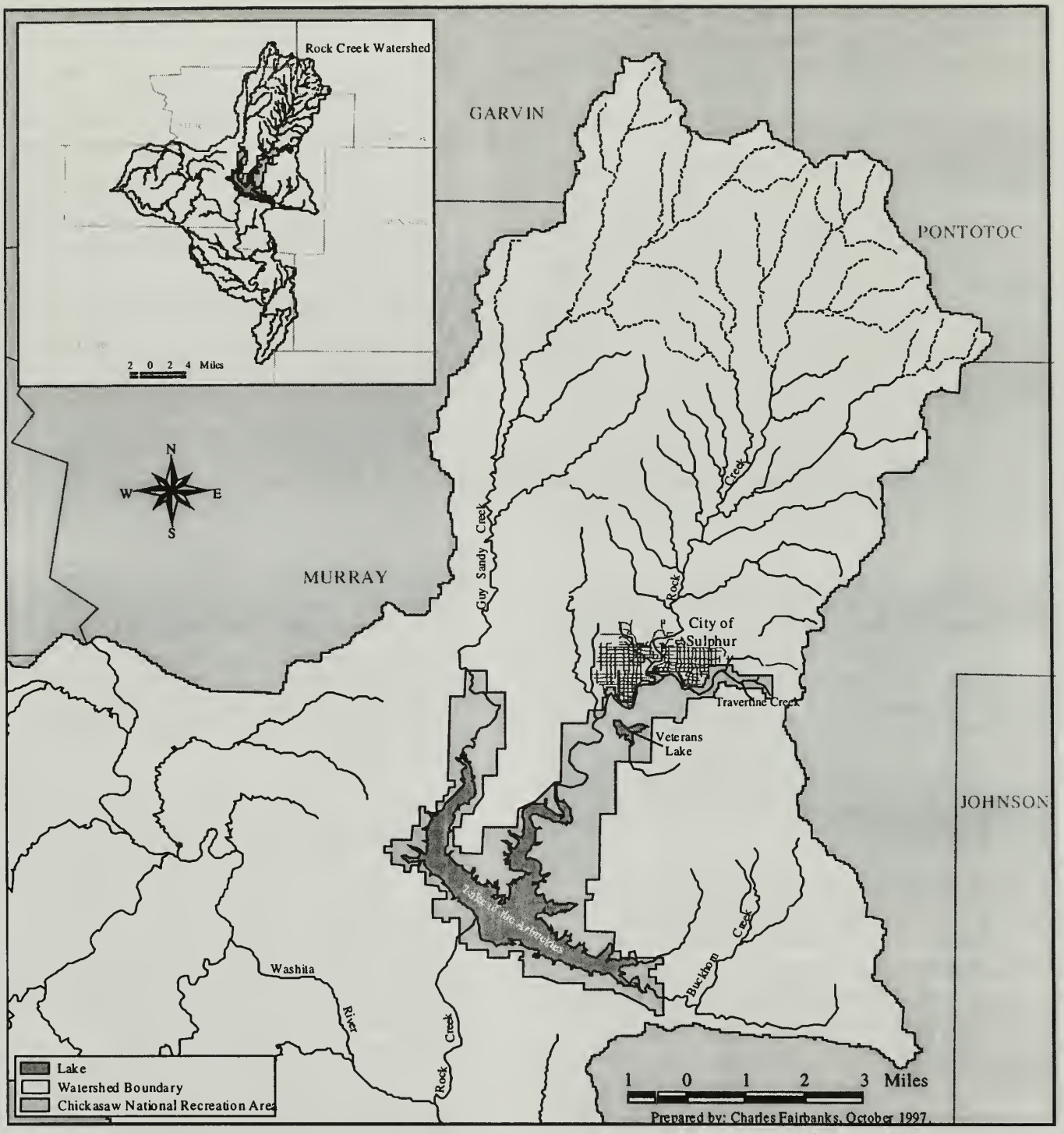
The Arbuckle Mountains are a high range of hills located between Davis and Ardmore, Oklahoma. The structure of the Arbuckles consists of three northwest-southeast trending anticlines known as the Hunton arch, and the Tishomingo and Arbuckle anticlines (U.S. Department of Interior, 1982).

Tapp (1997) provides the following geologic and tectonic chronology of events within the Arbuckles. During the Cambrian Period, (570 to 500 MYA), a large-scale faulting event (a triple junction aulacogen) formed a rift valley known as the Southern Oklahoma Aulacogen.

During the Ordovician Period, (500 to 430 MYA), the rift ceased spreading and a broad, shallow sea began to encroach over the entire region. For the next 200 million years, marine sediments accumulated on the sea floor. The calcium-rich bodies of dead sea organisms also formed thick limestone layers; in some areas, limestone and shale deposits reach thicknesses of up to two miles.

Another major geologic episode in the region occurred during the Permian Era (280 MYA to 225 MYA). During this episode, the region's crust was forced upward, presumably by the Arbuckle Orogeny (uplift event). The force of this upheaval was so great that many of the sandstone, shale, and limestone layers were broken and folded, creating large anticlines. Along with the folding process, this upward thrust formed the Arbuckle Mountains.

The Arbuckle Mountains have been severely denuded as a result of millions of years of erosion. The mountains now appear as a moderately dissected, low plateau (Harp et al., 1976). Regional geologic studies also show CNRA's geology to be dominated by a syncline



Source: Bureau of Transportation Statistics, 1997.
U.S. Census Data, 1995.

Figure 5.
Rock Creek Watershed
of the Washita River Watershed

having a west-northwest plunging graben (Hanson and Cates, 1992).

In general, the geological complexity of the area is reflected by the high frequency of faults and folds. Some of the fault variations seen in the area include dip-slip, strike-slip, and overthrust faults. There are two main faults within this region: the North Sulphur and the South Sulphur Faults. The dominant fault found near CNRA, the North Sulphur Fault, can be traced from eight miles southeast to one mile east of CNRA (Hanson and Cates, 1994). The South Sulphur Fault can be traced two and a half miles southeast of CNRA to where it parallels to the North Sulphur Fault. Despite the availability of information about them, the extent to which these and other faults influence groundwater flow in CNRA is unknown.

Although the area surrounding CNRA is geologically complex, it is situated in a region that is considered to have low seismic activity and has historically been free of high magnitude earthquakes. A plot of regional earthquake epicenters shows that no historical earthquakes have occurred within a 20-mile radius of CNRA. Earthquakes detected outside this 20-mile radius have had magnitudes less than 4.0 on the Richter scale. However, a level of uncertainty about seismic activity in the area remains, given the fact that CNRA is located only 50 miles to the west of the Nemaha uplift. This ridge is composed of a deeply buried granite traversing north-south from Nebraska to Oklahoma (U.S. Department of Interior, 1982). In this uplift is a zone of deep-seated faults, known as the Humboldt fault zone, which has been determined to be seismically active by the Kansas Geological Survey (U.S. Department of Interior, 1982).

There are three primary rock units in the subsurface of CNRA. The predominant surface rock is the Vanoss Formation, consisting of a limestone conglomerate (Cates, 1989). The Simpson Group, comprised of limestone, sandstone, and shale, lies beneath the Vanoss. The deepest and oldest major unit is the Arbuckle Group, which consists of dolomite, limestone, and sandstone.

GEOMORPHIC REGIME

Since the Arbuckle Orogeny, which occurred between 225 and 280 MYA, the landscape of CNRA has been constantly changing through gradational processes. Gradational processes mechanically shape or grade the geological structures into the landforms seen today (Ritter, 1978). The overall process of change on the earth's surface is known as geomorphism. There are five principal geomorphic agents used to shape the land: surface water, groundwater, waves and currents, glaciers, and wind (Ritter, 1978). Of these five agents, water plays the most prominent role in shaping the landscape of CNRA (Barker and Jameson, 1975).

View from Bromide Hill.

Formation of Rock Creek and Bromide Hill

Much of CNRA's landscape has evolved over the last few thousand years during the Quaternary geologic period. Rock Creek is perhaps the dominant geomorphic feature within CNRA. This Creek formed in an area that was higher than the surrounding region because of its location near the Arbuckle Uplift. Persistent runoff north and east of CNRA, along with base flow from several springs, led to the formation of Rock Creek, which cuts across the very resistant Vanoss Formation. Rock Creek has carved an extensive v-shaped valley through the resistant conglomerate that extends several miles and reaches depths of over 150 feet (Barker and Jameson, 1975). Lateral differential erosion has widened the valley in a southward direction. This process often happens when two or more materials of differing resistance are eroded by

the movement of water. The resistant Vanoss conglomerate, in this case, erodes at a slower rate than the shale and sandstone layers of the underlying Simpson Group.

Bromide Hill, which continues to be shaped by Rock Creek, is the most recognizable topographic feature within CNRA. This undercutting action of the creek weakens rock overhangs which then fall into the creek. Remnants of such rock falls can be found 100 yards east of the Rock Creek campground (Barker and Jameson, 1975). Some parts of Bromide Hill are also affected by mass wasting, which results when small portions of rock and soil roll down the face of the hill into Rock Creek. Although both undercutting and mass wasting occur at a slow rate, the combined effect of these two actions will eventually lead to the leveling of Bromide Hill.

Soils

Chemical and physical characteristics are important controls on the type of soil that forms in a given area. The principal controls on soil formation are: (1) parent material; (2) topography on which the soil forms; (3) amount and type of vegetation; (4) climatic conditions; and (5) the length of time over which changes in the soil can take place (Brady, 1990). Physiographic conditions within CNRA have led to the formation of a number of distinct soil types (Table 1), as identified by the U.S. Department of Agriculture (1984). Barker and Jameson (1975) have suggested a simple classification that recognizes two basic physiographic environments within CNRA. They have also categorized resident soils into two generalized types, lowland soils and upland soils. In many cases the valley walls serve as a transition zone between the lowland and upland soil areas.

Lowland soils within CNRA are found primarily along watercourses and are principally composed of transported alluvial material (Barker and Jameson, 1975). The parent material for these soils is primarily shale. As a result, these soils are mostly clay loams with small amounts of flood-deposited sand in their upper few inches. The lowland varieties are the deepest (7-10 feet) and darkest (heavy reddish-brown) soils located within CNRA (Barker and Jameson, 1975). The clay and silt alluvium, forming lowland soils are nutrient rich and retain water well, making them very fertile. Lowland regions of CNRA are highly diversified in terms of fauna and micro-flora. The large amounts of decaying vegetation which falls on the forest floor raises soil acidity and gives the soil a chemical makeup that is characteristic of a forest environment.

Table 1
Soil Series, Soil, and Subsoils Located within CNRA

LOWLAND SOILS
Garvin-Elandco Series
1) Garvin-Elandco soil
a) Garvin subsoil
b) Elandco subsoil
2) Elandco silt loam soil
3) Stephenville Variant-Darnell Variant complex soil
UPLAND SOILS
Kiti-Rock outcrop-Rayford Series
4) Rayford cobbly loam soil
Chigley-Travertine-Naru Series
5) Chigley-Naru complex soil
a) Chigley subsoil
b) Naru subsoil
6) Chigley gravelly sandy loam soil

Source: U.S. Dept of Agriculture, 1984

Upland areas within CNRA are covered by residual soils formed by in situ breakdown of the parent rock material (Barker and Jameson, 1975). The dominant surface formation within CNRA is the Vanoss conglomerate, which forms thin (2-8 inches) soils that are generally gray-brown in color. The large amounts of cobble and gravel found within the upland soils places them in the rough-stony category (U.S. Department of Agriculture, 1984). The Vanoss conglomerate is very resistant to weathering, and tends to form steep slopes. As a result, soil-forming processes are slow relative to erosion and water retention is generally poor. These factors combine to limit soil development and vegetative growth. Soil forming characteristics of the Vanoss conglomerate tend to create base rich or alkali soils. This is consistent with the dominant semi-arid grassland environment found within the area.

CLIMATE

Precipitation records within CNRA date back to 1917, however information concerning precipitation for years prior to 1919 is incomplete. Since 1919, the National Weather Service has consistently maintained records, although the monitoring location has been moved numerous times. As noted by Fairchild et al. (1981), station designations have been as follows: 1) Sulphur, Murray County (February 1917 to December 1950), 2) Sulphur, Platt National Park (January 1951 to October 1984), and 3) Chickasaw National Recreation Area (November 1984 to present).

CNRA is located in the moist sub-humid climate of south-central Oklahoma, with the majority of precipitation falling as rain (Fairchild et al., 1981). The climate is characterized by long warm summers with maximum mean temperatures reaching above 80 degrees Fahrenheit in July and August, and fairly short and mild winters with minimum mean temperatures of 40 degrees Fahrenheit in January and December. Wet periods occur in the spring and fall, with dry periods occurring during the winter and late summer months (see Figure 6).

As shown in Figure 7, the mean annual precipitation between the years 1919 and 1996 was 38.97 inches, with a low of 19.54 inches in 1963 and a high of 65.21 inches in 1990 (NCDC Research Customer Service Group, 1997). During this time period, annual precipitation amounts varied significantly from year to year because the region receives a majority of its precipitation from heavy rainstorm events during the spring and summer months. The large number of thunderstorms in the area result from the collision of dry cold air masses from the north with moist warm maritime air masses from the south. The records show several periods of extended wet or dry conditions. Wet periods have occurred during the years: 1926-1929, 1940-1942, 1944-1946, 1981-1985 and 1990-1995. The decade of the 1940's was the wettest; however another wet trend has taken place in the 1990's. Extended dry periods have also occurred during 1920-1922, 1950-1956, 1961-1966, and 1975-1980 (Fairchild et al., 1981).

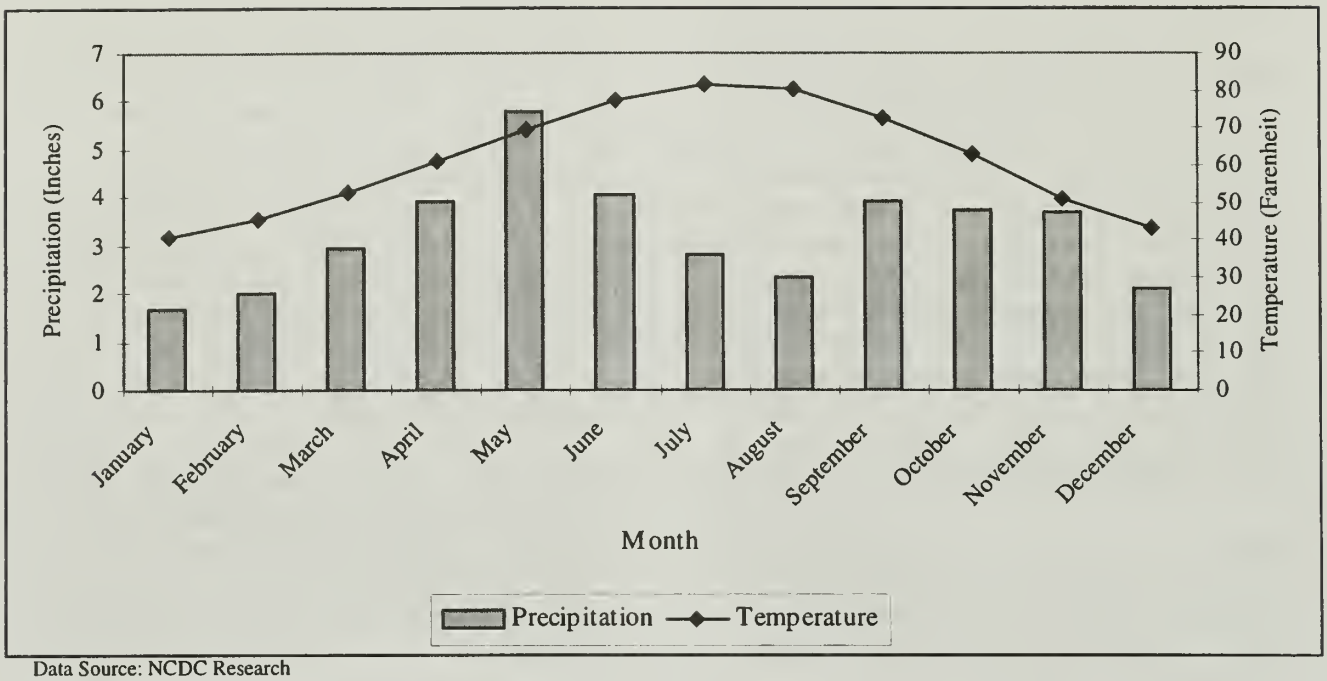
Drier periods are significant because of the aquifer's dependence on precipitation for recharge. It has been shown that during and after these dry periods, aquifer water levels experience a decline (Hanson and Cates, 1994). It is presumed the drop in the water table has caused some of the springs in CNRA to go through prolonged no-flow periods.

FLOODING HAZARDS

Heavy rains can present a flooding hazard within CNRA. As mentioned earlier, flooding occurs as a result of violent thunderstorms that can produce heavy downpours over a short period of time, saturating the soil and creating significant flood hazards.

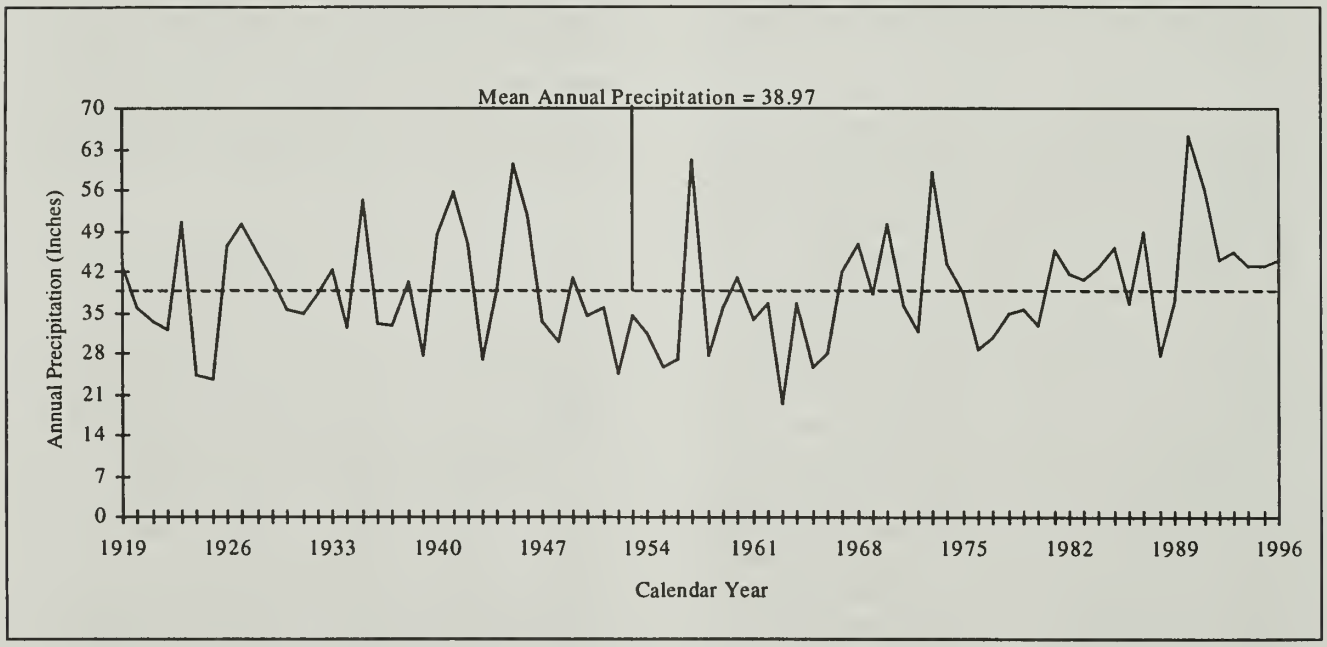
The main flooding is associated with water carried by Rock Creek (see Figure 5), which begins approximately 12 miles north of the City of Sulphur and extends in a southerly direction for 21 miles until it empties into the Washita River approximately one mile southeast of Dougherty (Soil Conservation Service, 1959). During a 20 year period from 1924 to 1943, there were 22 major floods that covered over half of the Rock Creek floodplain and 87 minor floods that filled less than half of the floodplain (Soil Conservation Service, 1959).

The first documented flash flood occurred on January 21, 1916. Although the flood was described as being severe, no precipitation record associated with this event is available (Boeger, 1987). This flood caused widespread damage to the region, especially within CNRA, by sweeping away parts of the pavilion at Bromide Spring, damaging the Washington Bridge, and flattening over a mile of fence (Boeger, 1987). Another major flood occurred on May 12, 1953, which filled 90% of the floodplain and caused over $83,000 in property damage within the region (Soil Conservation Service, 1959). Numerous sections of road within CNRA were severely damaged and several springs required repair.



Data Source: NCDC Research
Customer Service Group

Figure 6.
Mean Monthly Temperature and Precipitation



Data Source: NCDC Research
Customer Service Group

Figure 7.
Annual Precipitation

The most damaging flood recorded at CNRA occurred on October 8, 1970, when the area received its highest ever-daily precipitation total of 11.61 inches (Hanson and Cates, 1992). Despite the severity of the flood, damage to the surrounding region was minimized because the Arbuckle Dam, located downstream from CNRA, was able to withstand the inflow of floodwater from CNRA and outlying areas. Water levels rose more than 12 feet in eight hours at Lake of the Arbuckles, resulting in the first water flowing through the Morning-Glory Spillway (U.S. Department of Interior, 1995). It was estimated that during this flood, reservoir inflow exceeded 82,000 cubic-feet per second (cfs) (U.S. Department of Interior, 1995). Fortunately, property damage and loss of life were avoided. In 1982, Arbuckle Dam was evaluated by the U.S. Department of the Interior and was determined to be capable of withstanding a 250-year flood.

One of the most significant flood studies carried out within the area was performed by Harp et al. (1984). In accordance with National Park Service Floodplain Guidelines, and with Executive Order 11988, this study examined the flooding potential of Travertine and Rock Creeks as a portion of a University of Oklahoma evaluation of the geohydrologic aspects of CNRA water. It included the development of floodplain maps of the area and also provided floodplain delineation for both 100 and 500-year floods. The results noted that flooding out of the natural channel may occur at specified locations during a 100-year event, and that the Nature Center building is subject to such flooding. In order to provide a means of flood protection for the center, University of Oklahoma investigators designed a by-pass channel. It should be noted that this study did not evaluate the Probable Maximum Flood (PMF) or other flood events.

HYDROLOGY

Although quite complex, a description of the hydrology of CNRA can be divided into several categories. This section addresses both surface water and groundwater resources.

Surface Water

Lakes

There are two major reservoirs within CNRA, Veterans Lake and Lake of the Arbuckles (see Figure 2). Veterans Lake was constructed between 1933 and 1936 by the Works Project Administration (WPA) as a memorial to World War I veterans. An earthen dam located on Wilson Creek, a tributary of Rock Creek, is responsible for creating the reservoir. Constructed for recreational benefits, the lake has a surface area of approximately 67 acres and a normal storage capacity of 600 acre-feet, although the maximum storage capacity for the reservoir has been determined to be approximately 1200 acre-feet (U.S. Department of Interior, 1982).

Lake of the Arbuckles was constructed by the U.S. Bureau of Reclamation (BOR) in 1966 and is located in the southern half of CNRA. The lake receives its water from several local streams including Rock, Guy Sandy, and Buckhorn Creeks (see Figure 5). The total drainage area for the reservoir is approximately 126 square miles (Hanson and Cates, 1992). The lake is able to meet the water needs of the area due to its large capacity. The average surface area of the reservoir is 3,127 acres, with a storage capacity of 108,800 acre-feet (U.S. Department of Interior, 1982). The reservoir plays an extremely important role within the surrounding region; it serves recreational needs, facilitates flood control, and most importantly, serves as a crucial water source for local communities. The communities that rely on the reservoir include Ardmore, Davis, Dougherty, and Wynnewood. In addition, the reservoir serves the needs of a large oil refinery in Wynnewood.

Lake of the Arbuckles' overall effect on the hydrologic regime within CNRA seems to be minimal (Hanson and Cates, 1994). However, the lake's role could become more important with a proposed project to pump water from the lake as a means of addressing the City of Sulphur's municipal/industrial water needs. Similar projects have been initiated to pump water from the lake through pipelines to

Ardmore and Dougherty (U.S. Department of Interior, 1995).

The proposed pipeline was initiated to address declining water levels in the Arbuckle-Simpson aquifer and was designed to eliminate pumping at the City of Sulphur wells, replacing the pumped water with water piped from the reservoir. It is hoped that water levels in the Arbuckle-Simpson aquifer will be restored to their natural levels. However, it is important to note that the project's impact on the aquifer is unknown.

Streams

Several streams play a prominent role in CNRA's hydrology. The most significant are Rock, Guy Sandy, Buckhorn, Wilson, and Travertine Creeks. All five help to maintain Lake of the Arbuckles. These creeks are primarily supported by local springs, thus prolonged droughts sometimes result in an absence of spring and stream flow (Barker and Jameson, 1975).

The largest of the streams, Rock Creek, encompasses a drainage area of 170.4 square miles (Soil Conservation Service, 1959). However, only 1% of its drainage area is located in CNRA (Hanson and Cates, 1994). The Rock Creek Valley was formed in the highly resistant Vanoss Conglomerate as a result of a fault that allowed the creek to lengthen itself (Barker and Jameson, 1975). The stream begins approximately 10 miles north of CNRA and flows south, eventually discharging into the Washita River near the community of Dougherty. Along its course, Rock Creek is replenished by several springs and by storm runoff. During wet months, water flowing over the spillway at Veterans Lake also helps to replenish the creek (Hanson and Cates, 1994).

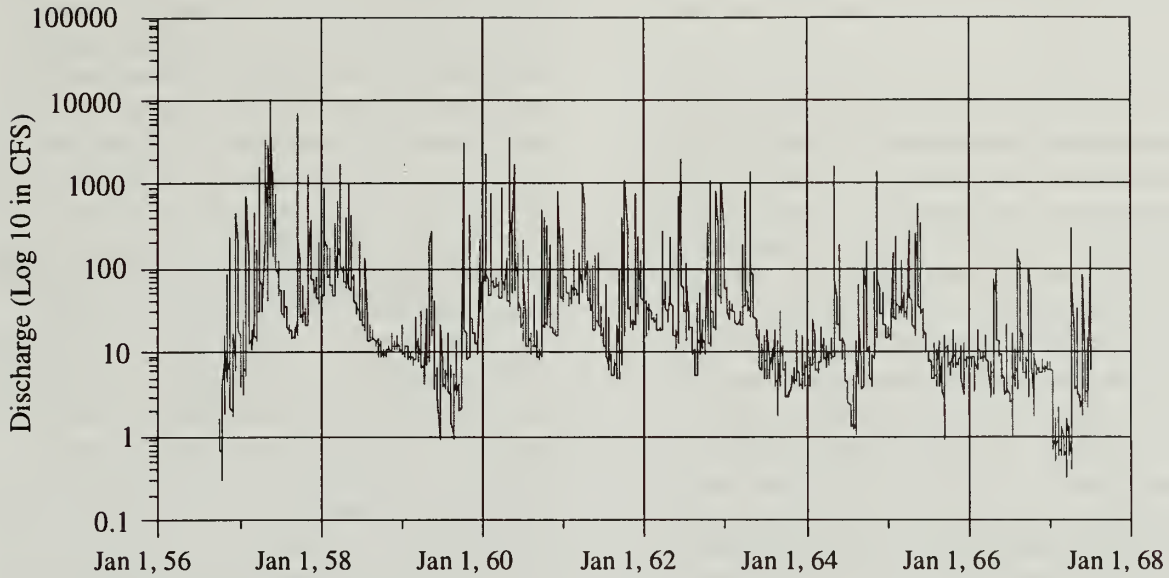
Figure 8 provides an example of the discharge measurements for a USGS gage station (# 07329900) on a section of Rock Creek located one mile north of the Washita River. This station recorded discharge measurements associated with the creek from 1957 to 1967. Measurements ceased after 1967 due to the construction of the Arbuckle Dam, which is located three miles upstream from the station. The hydrograph shows flow discharge normally ranged between 10 and 1000 cfs. However, during wet periods, discharge increased up to 10,000 cfs, while in dry periods flow dropped as low as 1 cfs. It is also important to note that a decrease in flow was found to occur during the summer months because of increased evapotranspiration and water demand. It also appears from the hydrograph that a decreasing stream flow trend took place from 1960 to 1967. The cause of this decline is unknown.

Another USGS gage station (# 07329852) is located on a section of Rock Creek approximately one mile south of the City of Sulphur, and upstream from the Lake of the Arbuckles. Discharge measurements were recorded at this station from 1989 to 1997 (see Figure 9). Although discharge ranged from 6.5 to 3500 cfs, mean flow was in a range between 20 and 70 cfs. Higher discharges were due to periods of above average precipitation, while lower discharges occurred during dry periods (Hanson and Cates, 1994).

Guy Sandy Creek has a drainage area of 44 square miles, 23% of which is located within CNRA (Hanson and Cates, 1994). This creek begins approximately 10 miles northwest of CNRA and flows directly south, finally emptying into the western portion of Lake of the Arbuckles. Most of its flow is derived from springs in the area or from storm runoff.

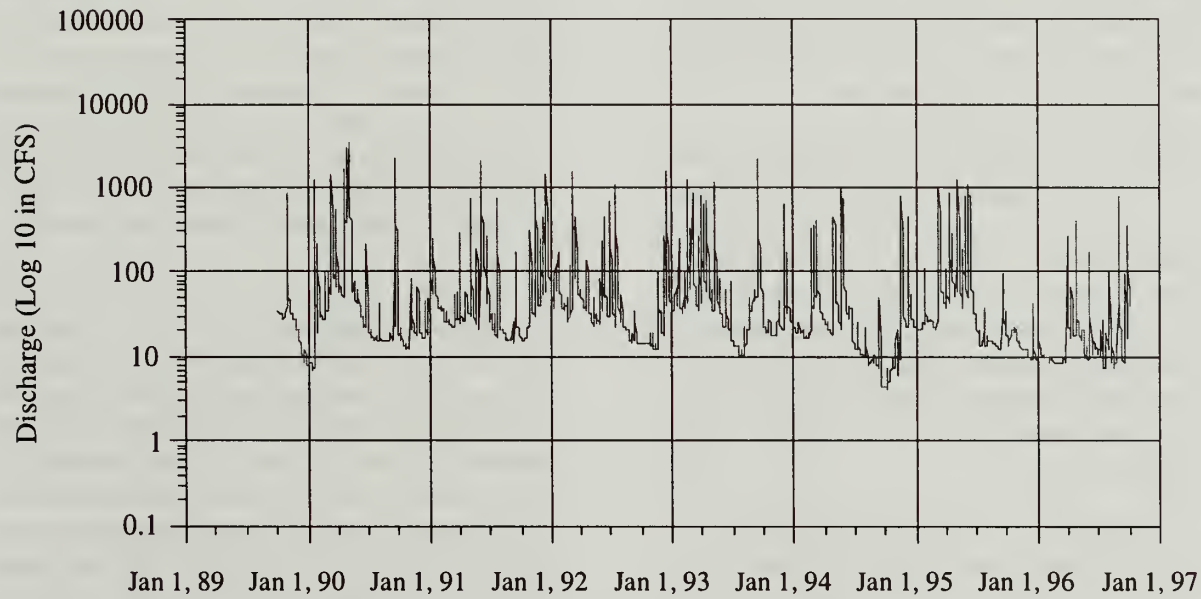
Although covering 27 square miles, only 1% of Buckhorn Creek's drainage area is located within CNRA (Hanson and Cates, 1994). The creek begins three miles southeast of CNRA at Lowrance Springs and then flows southwest until it discharges into the eastern part of Lake of the Arbuckles. The creek is primarily dependent upon the cluster of springs for its dry-weather flow.

Wilson Creek has a small drainage area of 4.2 square miles, of which 16% is located within CNRA (Hanson and Cates, 1994). Beginning approximately two miles southeast of CNRA, the stream meanders in a westerly direction for



Source: U.S. Surface-Water Data Retrieval

Figure 8.
Rock Creek Flow Data at Dougherty, OK
(USGS Station 007329900)



Source: U.S. Surface-Water Data Retrieval

Figure 9.
Rock Creek Flow Data at Sulphur, OK
(USGS Station 007329852)

several miles until it empties into Veterans Lake. The creek is the principal surface water source of Veterans Lake.

With only 3.87 square miles, Travertine Creek has the smallest drainage area of all of CNRA's streams (Hanson and Cates, 1994). The creek's name comes from the travertine mineral, which is deposited in the streambed and formed as a result of the precipitation of calcium carbonate ($CaCO_3$) from the water. Although the headwaters begin in rangeland just outside the CNRA, the creek has intermittent flow until it reaches Antelope and Buffalo Springs, where it then proceeds in a westerly direction before discharging into Rock Creek. The Travertine Creek Valley has a symmetrical shape, primarily due to periodic runoff from local precipitation events (Barker and Jameson, 1975). The creek derives a majority of its stream flow from Antelope and Buffalo Springs.

Springs

Springs within CNRA are among the region's most important assets. Archaeological evidence suggests that human use of springs dates back 7,000 years (Boeger, 1987). It is known that wild and domesticated animals also frequently relied on springs as water sources. Contemporary uses of the springs have shifted to the collection of the springs' mineralized water for drinking and purported medicinal purposes.

There have been several attempts to determine the number of springs located in and around CNRA. The first assessment was performed in 1906 by state geologist Charles Gould who documented 33 springs (Boeger, 1987). Of these, Gould noted that six were fresh water and 27 were mineralized.

A second assessment performed in 1939 by Gould and Schoff found only 19 of Platt's (CNRA's) original 33 springs (Gould and Schoff, 1939). Following the survey, it was determined that discharge from Antelope and Buffalo Springs was only 20% of what it had been in 1906 (Hanson and Cates, 1992).

Dunn (1953) carried out the next assessment of CNRA's springs. This study determined that discharge from Antelope and Buffalo Springs had declined to a negligible level and that the mineralized springs in CNRA were flowing at rates similar to those observed by Gould and Schoff in 1939. Dunn was one of the first to express concern over the trend of declining flow rates of springs within CNRA and identified two possible causes. First, he noticed the region had experienced several years of below average precipitation and that flow rates during the early 1950's appeared to fluctuate according to climatic conditions. Second, he hypothesized that withdrawals from several artesian wells within the region might explain the decline in flow from the springs.

In 1987, a spring survey was performed by Tom Taylor in an attempt to locate all of the springs that were documented by Gould (Taylor, 1988). Using information provided by Gould, Taylor was able to locate 21 of the original 33 springs, two more than Gould and Schoff had found in 1939.

As noted earlier, there are several springs within CNRA which discharge fresh water, the two most prominent of which are Antelope and Buffalo Springs. These two springs, which are located on the eastern side of CNRA, account for most surface water flow within CNRA, with an estimated discharge of 5 million gallons per day during normal years (Barker and Jameson, 1975).

The combined discharge of the two springs has been measured several times. In 1906, Gould estimated that Antelope and Buffalo springs had a cumulative discharge of 3,741 gallons per minute (gpm) or 8.35 cfs. In 1988, a more recent water quantity inventory was conducted by Hanson and Cates. Table 2 provides a summary showing how the flow from the two springs has varied over the years. Of particular note is the flow rate in 1953, which is much lower than any other year and was measured just prior to a period of no-flow from the springs. Several of these no-flow periods have taken place in the last 70 years, with the longest stretches occurring between 1934 and 1936, and

again between 1954 and 1957. Although the exact cause of these no-flow periods is not fully understood, Hanson and Cates (1994) suggest that they are associated with extended periods of below-normal rainfall, particularly when precipitation is below normal for three or more consecutive years.

Table 2
Combined Discharge from Antelope and Buffalo Springs

Year	Discharge (gpm)
1906	3,741
1953	278
1968	3,846
1988	3,431

Source: Hanson and Cates, 1992.

In 1985, a USGS stream gage station (#07329849) was installed at Antelope Spring and discharge at this location was determined to vary from 0.1 to 11 cfs between 1985 and 1989 (see Figure 10). The peak discharge occurred in the spring of 1988 at nearly 11 cfs, while the minimum discharge of less than 1 cfs occurred in early 1989.

There are also cold-water mineral springs in CNRA that discharge bromide, sulfur, and iron-bearing waters (Barker and Jameson, 1975). The mineralized water is highly prized for its perceived medicinal value, making CNRA's springs one of the region's most important natural features. Much of the flow from these mineralized springs has been manipulated for human consumption by the construction of pavilions or rock-lined pools. These pavilions were constructed from native stone and are surrounded by groves of large trees that were planted by the CCC. Mineralized water at CNRA is used primarily for drinking, and facilities at CNRA do not include bathhouses, which have been included at Hot Springs National Park in Arkansas (Barker and Jameson, 1975). However, outside of CNRA's boundaries, bathhouses can still be found, and during the 1920's and 1930's many more existed.

Located in the central portion of CNRA's Platt District are several sulfur springs. Identifiable by an odor that is distinctly reminiscent of rotten eggs, these springs include Hillside, Pavilion, and Black Sulphur. However, during the early 1970's spring waters were no longer available at Bromide Pavilion.

Two issues related to the unavailability of water at Bromide have recently been cited (Myers and Lannom, 1998). First, flow of these wells was inadequate or ceased altogether. Secondly, water quality concerns occurred over the use of mineral waters for consumption. Neither of these explanations has been confirmed as of the date of publication of this plan. In addition, water from these springs was routed to a common pavilion at the base of Bromide Hill.

Recent data suggests discharges from the mineralized springs in CNRA are much less than that of the freshwater springs. During a water inventory in 1988, it was determined that flow from three of the mineral springs (Pavilion, Hillside, and Black Sulphur) was 158 gallons per minute, about 4.6% of the total spring water being discharged within CNRA. As of 1992, no gaging stations have been installed on any of the mineralized springs in CNRA. According to Harp et al. (1976) flow was less than one gpm at both Bromide and Medicine Springs. These two springs have experienced periods of no flow, particularly during one period in 1974 (Hanson and Cates, 1992).

Ponds and Wetlands

Wetlands are transitional zones between terrestrial and aquatic environments in which the water table is usually at or near the land surface, or the land is covered by shallow water. Areas classified as wetlands must have one or more of the following attributes: 1) at least periodically, the land supports predominantly hydrophyte species; 2) the substrate is predominantly undrained hydric soil; or 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al., 1979).

CNRA does not possess a detailed inventory of ponds and wetlands within its boundaries. It should be noted though, that the U.S. Fish and Wildlife Service has developed National Wetlands Inventory (NWI) maps of this area.

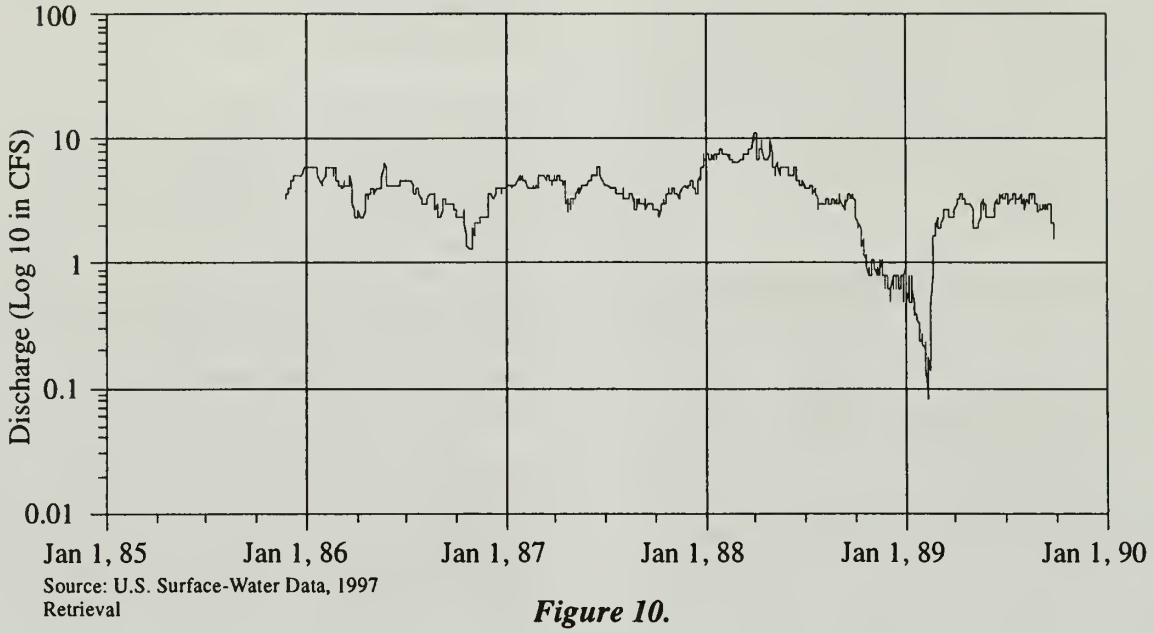


Figure 10.
Flow Data at Antelope Spring
(USGS Station 007329849)

However, these maps do not contain information on the area's wetland types and acreage; thus more extensive wetland inventories are warranted. If these inventories are conducted, the possibility exists to develop data needed for a wetlands map of CNRA. Although the ponds and wetlands in CNRA are not extensive, they require protection to ensure a long-term ecological balance. CNRA needs to:
1) determine which features should be maintained and protected as wetland habitats,
2) coordinate efforts to secure water rights protection for pond and wetland features,
3) conduct appropriate monitoring of each pond and wetland to ensure better protection, and 4) add wetland maps developed by U.S. Fish and Wildlife Service to the CNRA Geographic Information Systems (GIS) to better manage ponds and wetlands areas.

Groundwater

At this time there is insufficient information to adequately describe groundwater movement within CNRA. Given the complexity of the groundwater system underlying CNRA, there is a need for more information concerning the hydraulic parameters that control water storage and movement. This section presents background information on the region's wells, primary aquifer, water quantity, and the movement of groundwater. In addition, a section on the general condition and threats to the aquifer has been included.

Wells

Much of CNRA is covered on the surface by the Vanoss Formation. This well-cemented conglomerate acts as a confining layer to the Arbuckle-Simpson aquifer. Many wells drilled through the Vanoss become free flowing or artesian.

As the region around the current CNRA boundary became more populated in the late 1800's and early 1900's, reliable sources of water were required. To address this need, several artesian wells were drilled, the first of these in about 1889 (Hanson and Cates, 1988). Some estimates suggest that over the last 50 years approximately 40 wells were drilled in the region. A number of artesian wells discharge water from the aquifers serving CNRA; most notable are nine City of Sulphur wells, three Oklahoma Gas & Electric (OG&E) wells, and

one State Veterans well. Maximum annual pumping from these wells occurred in 1979, when approximately 536 million gallons were pumped by the OG&E wells, while 430 million gallons were withdrawn from City of Sulphur wells (Hanson and Cates, 1994).

The Arbuckle-Simpson aquifer derives its name from the rocks that comprise it, the Arbuckle and Simpson Groups. Springs in the area are created by fractures and fissures in the Vanoss Formation, which allow groundwater from the Simpson and Arbuckle Groups to reach the surface (Hanson and Cates, 1994).

The most well known artesian well in the region is Vendome Well, located adjacent to the City of Sulphur. Its flowing presence along with its distinctive sulfur smell, is noticeable at the north entrance of CNRA. Drilled in 1922, Vendome has long served as a tourist attraction for the City of Sulphur. During the 1920's through 1950's, it served as a public drinking fountain and a source of water for a nearby swimming pool. Chemical analyses of Vendome indicate the water is relatively hard with a total dissolved solid concentration of 1200 milligrams per liter (mg/l). Based on these analyses, it is believed the water is a mixture coming from both the Arbuckle and Simpson Groups (Hanson and Cates, 1994). Although the well has flowed continuously at rates between 0.8 and 1.6 cfs since it was drilled, the rate of flow has gradually decreased with time (Harp et al., 1976). Outflow from Vendome Well for the years 1985 to 1989 is shown in Figure 11.

Primary Aquifers

Although there are numerous geologic units that can be found in the region, three primary units are believed to dominate subsurface flow to springs and wells in CNRA and the surrounding region. These are the Vanoss Formation, the Simpson Group, and the Arbuckle Group (See Table 3).

The Vanoss Formation of Pennsylvanian age is the primary geologic unit that outcrops at the surface in CNRA. It can be found southeast of CNRA beginning at the boundary of the North Sulphur Fault and extending westerly throughout CNRA. Hanson and Cates (1994) reported a written communication with D.L. Hart stating that the Vanoss Formation consists of cemented limestone conglomerate, shale, and a sandstone lens. While the thickness of the formation is unknown and varies throughout CNRA, it has been suggested that sections of the Vanoss may be up to 1600 feet thick (Barthel, 1985). Numerous wells drilled through the Vanoss Formation are free flowing, or artesian in nature, implying this dense unit acts as a confining layer to underlying formations (Hanson and Cates, 1994).

Table 3
Geologic Formations

Rock Unit	Age (MYA)	Description
Vanoss Formation	Pennsylvanian (320-280)	Limestone conglomerate
Simpson Group	Ordovician (500-430)	Limestone, sandstone, and shale
Arbuckle Group	Cambrian-Ordovician (4600-500)	Dolomite, limestone, and sandstone

Source: Hanson & Cates, 1994.

The Simpson Group, of Middle to Upper Ordovician age, consists largely of limestones, sandstones, and shales. It lies beneath the Vanoss Formation and is exposed as outcrops in a 20 square mile area located south and southeast of CNRA. It is in this area where the Simpson portion of the aquifer is recharged primarily due to precipitation falling on the outcrop. This group is a highly permeable layer and makes up the upper portion of the Arbuckle-Simpson aquifer. This group is believed to be the source of water for the mineralized springs and wells in CNRA. Some of the springs that are believed to tap water from the Simpson Group include Bromide and Medicine Springs, which are located in the central portion of CNRA (Hanson and Cates, 1994). Thickness estimates of the Simpson Group vary from 600 to 1600 feet (Barthel, 1985).

Beneath the Simpson is the Arbuckle Group, which is Upper Cambrian to Middle Ordovician in age and consists of shallow marine carbonates. These include extensively faulted

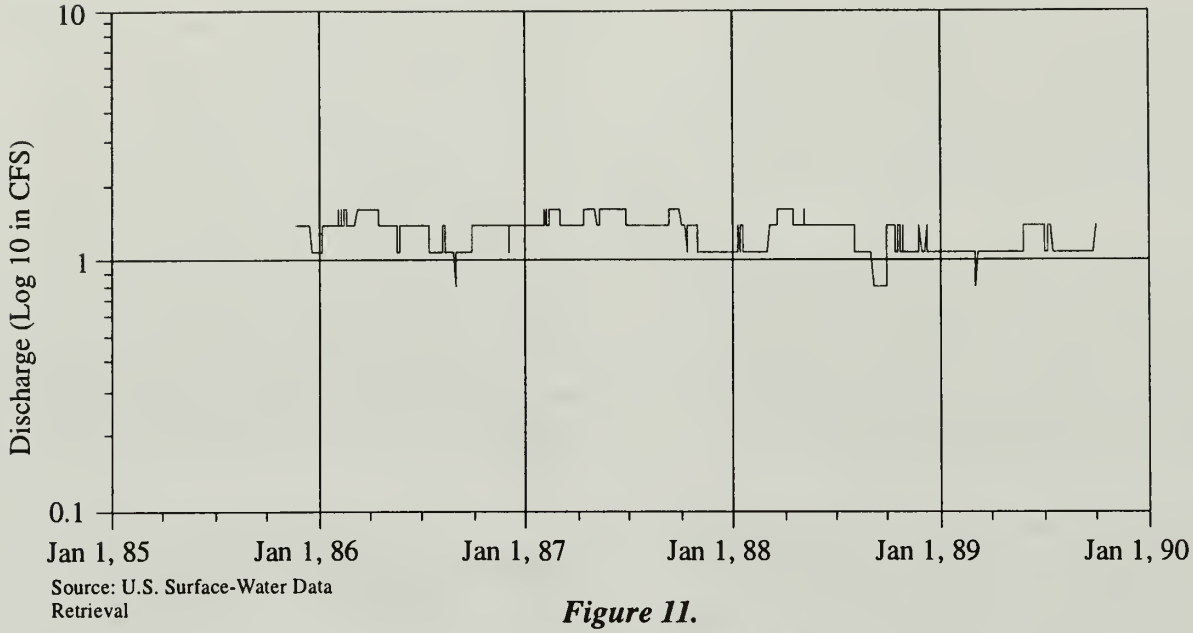


Figure 11.
Flow Data at Vendome Well
(USGS Station 007329851)

and folded sandstone. Total thickness of the Arbuckle Group also varies, but it is thought to range from 1600 to 6800 feet (Barthel, 1985). It is believed that this group supplies fresh water to springs and wells in CNRA and, in particular, is the source of Antelope and Buffalo Springs (Hanson and Cates, 1994). The unit is permeable and outcrops are located within a 150 square mile area located east, southeast, and northeast of CNRA (Harp et al., 1976). It is in this outcrop area where the Arbuckle-Simpson aquifer is believed to be recharged (Hanson and Cates, 1994).

Quantity

Fairchild et al. (1981) suggested that the product of the storage coefficient, saturated thickness, and outcrop area could be used to estimate the volume of water available to wells tapping the Arbuckle-Simpson aquifer. The storage coefficient is a dimensionless measurement that describes change in water storage within a confined aquifer. Fairchild et al. (1981) reported that regional techniques were used to estimate a value of 0.008 for the storage coefficient of the Arbuckle-Simpson aquifer.

Using the thicknesses of the Arbuckle and Simpson Groups in the outcrop areas, it was estimated the saturated thickness of the aquifer was 3500 feet. The volume of water in the aquifer available to wells within the 500 square miles of outcrop area was then estimated to be nine million acre-feet. The enormity of this volume can be illustrated by noting that storage within the aquifer is almost 100 times that of the region's largest lake, Lake of the Arbuckles, which has a storage capacity of 108,000 acre-feet (U.S. Department of Interior, 1995).

Water storage within the aquifer varies seasonally, mostly in response to prolonged wet and dry periods. Fairchild et al. (1981) reported that human withdrawal of water from the aquifer averages about 1% per year of the total volume in storage and is usually replenished by recharge. However, a declining water level in the aquifer, which is thought to have been responsible for the cessation of several springs in the area, suggests that water storage in the aquifer may, in fact, be declining.

Movement

Groundwater flow within the region is difficult to determine because of the complexity of the subsurface geology and the lack of data. Groundwater flow has been approximated using water levels for selected wells in the region (Fairchild et al., 1990). This data facilitated the creation of a generalized potentiometric surface map of the Arbuckle-Simpson aquifer (see Figure 12). Contours show the elevation to which water would be expected to rise in a well drilled into the aquifer. Note, that in artesian aquifers the potentiometric surface will be at an elevation higher then that of the ground. Even though groundwater level information is sparse, it is believed that the general direction of flow is to the northwest (Fairchild et al., 1990).

Another flow study in the region was carried out by Barthel (1985), who also developed a potentiometric map of the Arbuckle-Simpson aquifer based on regional groundwater elevations from 36 wells located within a 60-mile radius of CNRA. Barthel concluded that groundwater flow in the Arbuckle-Simpson aquifer was generally taking place in a westward direction. It is believed that subsurface geologic structures, such as faults, influence groundwater flow in varying ways. For instance, a fault can affect groundwater by acting as a barrier or conduit to movement.

General Condition

The general condition of the Arbuckle-Simpson aquifer depends on its ability to sustain its natural water level, and thus allow for continued discharge to springs and wells. In general, an aquifer's water level is the result of a balance between inflows (recharge) and outflows (discharge). Recharge to the aquifer happens as a result of precipitation on the outcrops of the Arbuckle and Simpson Groups, while outflow occurs from the discharge of water to springs and wells. Evidence of reduced water level can be seen by the reduced flow and sometimes cessation of springs and wells in the region, particularly within CNRA.

Reduced recharge of the aquifer is most likely not due to a change in precipitation, since precipitation has been steady over the past decade. However, it is known that times of drought can affect the flow of springs and wells over short periods of time. A possible cause of less recharge to the aquifer could be changing land use patterns. Land use changes over the past 50 years could be responsible for less infiltration into the aquifer. For example, one possible change in infiltration rates to the aquifer could be linked to the proliferation of eastern red cedars to the area. These cedars may affect the aquifer because they have higher evapotranspiration rates than native grasses. Future studies will need to be conducted to determine whether this is, in fact, occurring.

Outflows from the aquifer have increased throughout the century due to wells drilled within CNRA and on surrounding land. It is likely that the decline of the aquifer's water-level is tied to the increase in discharge from wells in the region (Hanson and Cates, 1992). The City of Sulphur alone pumps more than 1.6 million gallons of freshwater daily. This does not even take into account the approximately 20 artesian wells that remove an additional two million gallons per day of mineralized water from the aquifer. It is probable that withdrawal of this water affects the aquifer by reducing the artesian pressure necessary to sustain spring and well flow.

HYDROLOGIC BUDGET

The hydrologic budget accounts for inflow, outflow, and storage in a hydrologic unit, such as an unconfined drainage basin or confined aquifer. Budgets serve as conceptual models of the relationship among evaporation, precipitation, runoff, and the change in water storage of the unit (Bates and Jackson, 1987). The hydrologic budget can be expressed as:

$$P = Q + ET$$

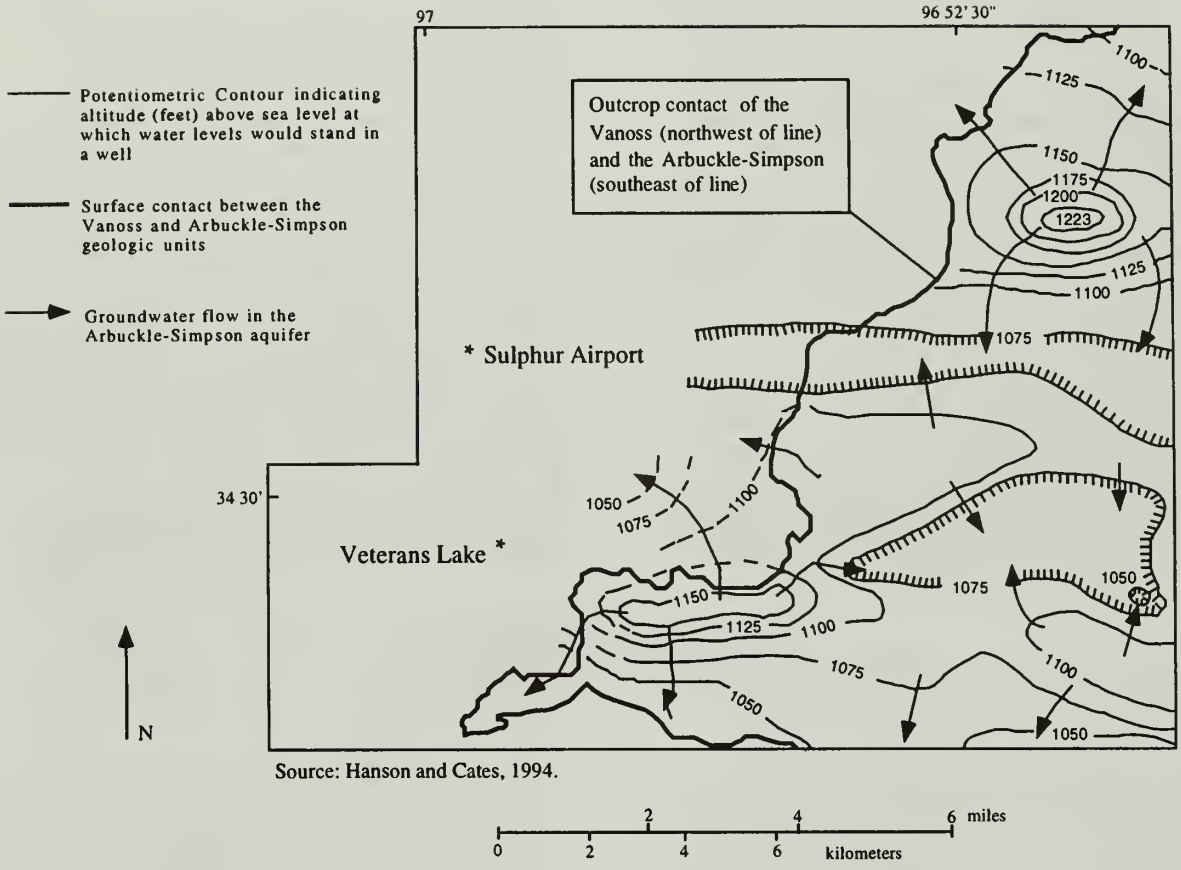


Figure 12.
Potentiometric Map for Chickasaw National Recreation Area

where P is the total annual precipitation, Q is the total annual runoff of the streams and ET is the total annual evapotranspiration. Runoff (Q) can be divided into two variables, base flow and direct runoff following precipitation. Base flow is stream water derived from groundwater sources.

Fairchild et al. (1981) used this equation to estimate the hydrologic budget of CNRA and the surrounding region. Based on a six-year average of precipitation totals from 1969-1971 and 1977-1979, annual precipitation of the region was estimated at 38.4 inches. Using flow rates of creeks in the region, the average runoff (Q) was computed to be 7.7 inches per year and base flow to the streams was assumed to be steady at an estimated 125 cfs or 4.7 inches per year.

Assuming that the aquifer experienced no change in storage and pumping withdrawals were minimal, base flow can be considered equal to the annual recharge of the aquifer. Direct runoff (3.0 inches per year) was obtained by subtracting the base flow from the total Q. Using this method, the evapotranspiration was calculated to be 30.7 inches (ET = P-Q). The majority of the precipitation (80%) is lost from the system through evapotranspiration. Of the remaining 20%, 12% goes to recharge the aquifer while the final 8% consists of direct runoff following precipitation events (see Figure 13). The estimate of evapotranspiration using Fairchild's method appears to be consistent with studies performed in analogous regions. For example, two climatically similar basins in northern Texas, located south of the study area, were found to have annual evapotranspiration rates of 30 inches per year (Williams, 1940).

In another related study (Blaney and Criddle, 1962) a formula was derived to predict evapotranspiration for a climate similar to that of South-central Oklahoma. In that study it was determined that approximately 60% of the annual evapotranspiration occurred during three summer months (June, July & August). Since the average monthly ET during these months was estimated as 5.2 inches, the annual ET = (5.2 x 3)/ 0.6 = 26 inches.

WATER QUALITY

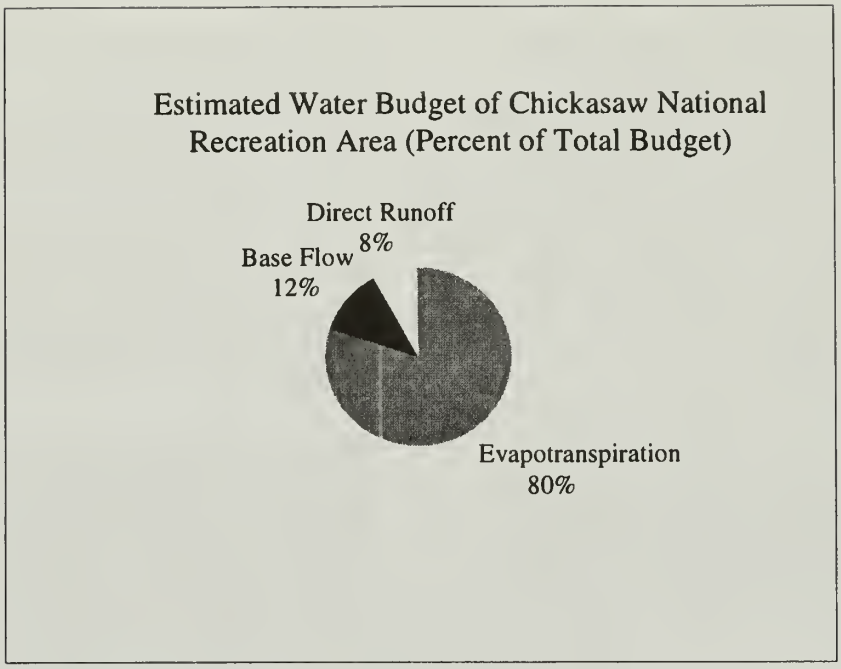
The term "water quality" refers to the chemical composition of a water sample (Hounslow, 1995). Water quality plays a major role in the historical importance of the region protected within CNRA.

Surface Water

Numerous streams can be found within CNRA and its surrounding region. Most of these originate from the discharge of springs associated with the Arbuckle-Simpson aquifer. Consequently, the quality of stream water during low-flow periods is similar to that of springs (Fairchild et al., 1981). For example, the water quality of Travertine Creek is much the same as its primary sources, Antelope and Buffalo Springs. Taylor (1994) conducted water quality tests on several regional streams, including Travertine Creek and found the water hardness of the creek was similar to Antelope and Buffalo Springs. When tested further downstream, the hardness of the water declined from 300 milligrams per liter (mg/l) at the mouth of the creek to around 275 mg/l just a mile downstream at the confluence of Travertine and Rock Creeks. This is likely to be the result of diluted creek water from regional runoff.

It has also been shown that the water quality in the streams varies seasonally (Fairchild et al., 1981). During the rainy season, mineral concentrations are lower in streams due to the increased runoff from rain which dilutes the water. The concentration of dissolved solids in streams is significantly less than in springs due to the precipitation of minerals that occurs during the transition to a new environment. Travertine, or calcium carbonate ($CaCO_3$), is commonly found in areas downstream from springs (Fairchild et al., 1981). This suggests the groundwater is saturated with calcium and when discharged from the spring, gaseous carbon dioxide is released into the air leaving the calcium carbonate mineral in streambeds. Since calcium carbonate is precipitated out of the spring water, smaller quantities of dissolved solids remain in the stream water (Fairchild et al., 1981).

Surface water quality studies have also been performed in the region to examine specific sites that may be susceptible to pollution. Much of the available data is summarized in *The Baseline Water Quality Data Inventory and Analysis for Chickasaw National Recreation Area* (NPS, 1997b). Surface water resources included in this study area were the Washita River, Lake of the Arbuckles, Veterans Lake, and many smaller reservoirs; Rock, Travertine, Buckhorn, Guy Sandy, and other small creeks; Antelope, Buffalo, and many other smaller mineralized and fresh springs. This document, which was coordinated by the NPS, presents the results of surface-water quality data for CNRA from six United States Environmental Protection Agency (EPA) national databases. These databases included: (1) Storage and Retrieval (STORET) water quality database management system; (2) River Reach File (RF3); (3) Industrial Facilities Discharge (IFD); (4) Drinking Water Supplies (DRINKS); (5) Water Gages (GAGES); and (6) Water Impoundments (DAMS). Water quality was monitored at CNRA between 1951 and 1995 using 156 monitoring stations (117 of which were located within CNRA). These yielded 30,222 observations, of which the majority (86%) were reported between 1967 and 1994. Water quality analysis was carried out on numerous groups of parameters such as copper, fecal coliform, etc. The result of CNRA water quality criteria screening found there were nine parameters that exceeded the EPA drinking water criteria (shown in Table 4) at least once. However, only parameters that exceeded the EPA criteria in numerous observations will be discussed, as they raised possible water quality concerns. Using the EPA water quality criteria analysis for the



Source: Fairchild, 1981.

Figure 13.
Hydrologic Budget

entire CNRA study area, it was surmised that fecal coliform, dissolved oxygen, copper, and chloride were the parameters that exceeded standards most often and may be associated with water quality problems (NPS, 1997b).

The most prevalent parameter raising water quality concerns was fecal coliform. Of 526 observations made between 1967 and 1977, 135 have fecal coliform levels that equaled or exceeded the allowable coliform level established by the EPA. Of those observations that exceeded the standard, 80% were associated with stations located in the northeastern portion of CNRA. This most likely occurs due to the location of several swimming areas along Travertine Creek. The highest fecal coliform levels were discovered in these areas in July 1977.

Streebin and Harp (1977) performed a study that verified several water quality problems (including fecal coliform) in CNRA's surface water. This study evaluated the dispersion of point source water pollution and the levels of oxygen and eutrophication in the lower Rock Creek drainage area. The most notable differences in the area's surface water were found to be associated with the amount of chloride and total dissolved solids (TDS). This was attributed to different land use activities occurring in the area, and the high concentrations of chloride and TDS entering Rock Creek. Nutrients and fecal coliform were also determined to vary in concentration throughout the area's surface water. These pollutants may be closely associated with land adjacent to CNRA. For example, most parts of Travertine Creek had relatively low levels of fecal coliform except for areas directly downstream from swimming areas. It was determined that the area most prone to elevated nutrient concentrations was Rock Creek, where several water quality parameters were found to exceed standards set by the EPA.

Another parameter that did not meet the acceptable water quality standard in numerous observations was dissolved oxygen. Of 1585 observations, 242 or 15% were less than or equal to the 4 mg/L which is the criterion set by the EPA. Approximately 65% of the observations exceeding the criterion were reported within the park boundary near Travertine Creek, at Buffalo Spring, and Antelope Spring from 1987 through 1994.

Table 4
USEPA Criteria for Various Parameters

Primary Drinking Water Regulations

Constituent or property	Level (MCL) mg/L
Inorganic:	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05
Fluoride1	4.0
Organic:	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-Tp Silvex	0.01
Total trihalomenthanes	0.1
Microbiological:	
Coliform bacteria	1 per 100 mL (mean)
Turbidity:	
Turbidity	1-5 tu
Radionuclides:	
Radium 226 and 118 (combined)	5 pCi/L
Gross alpha particle activity	15 pCi/L
Gross beta particle activity	4 mrem/yr

Recommended Maximum Contaminant Level (RCML)

Constituent	Level (mg/L)
Benzene	0.0
Carbon Tetrachloride	0.0
p-Dichlorobenzene	0.75
1,2-Dichloroethane	0.0
1,1-Dichloroethylene	0.007
1,1,1-Trichoroethane	0.2
Trichloroethylene	0.0
Vinyl chloride	0.0

Secondary Drinking Water Regulations

Constituent or property	Level (MCL) mg/L
Chloride	250
Color	15 color units
Copper	1
Corrosivity	Noncorrosive
Dissolved solids	500
Fluoride	2.0
Foaming agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 (threshold odor #)
pH	6.5-8.5 units
Sulfate	250
Zinc	5

Health Advisory

Constituent	Level (mg/L)
Sodium	20

Source: U.S. Environmental Protection Agency, 1986.

Copper is another element associated with water quality problems at CNRA. Copper concentrations were measured 115 times at 33 stations between 1969 and 1995. Of these observations, 65 were found to exceed the allowable level and 98% of these occurred at four stations located at Lake of the Arbuckles during 1977.

The final parameter that exceeded standards was chloride. There were a total of 197 observations recorded between 1951 through 1995 and chloride concentrations were found to have exceeded acceptable levels 53 times or for 27% of the total observations. The highest of these concentrations was reported in Rock Creek near the Oklahoma Gas and Electric Plant in May 1969.

According to *The Baseline Water Quality Data Inventory and Analysis for CNRA* (NPS, 1997b), surface waters within the study area (CNRA and surrounding region) have been significantly impacted by human activities. Among the findings, the report noted that potential anthropogenic sources of contaminants include municipal and industrial wastewater discharges, stormwater runoff, agricultural, livestock, and fish hatchery operations, oil and gas development, residential development, quarrying operations, recreational use, and atmospheric deposition.

Springs and Wells

Water quality associated with CNRA springs depends on the characteristics of the aquifer from which it emanates. The amount of dissolved solids in the water is directly dependent on the minerals present in the aquifer and the amount of time the water is in contact with the aquifer rocks.

Fairchild et al. (1981) summarized water-quality data collected from several wells and springs in the area using a report that had been prepared by D.L. Hart. Hart plotted hydro-chemical data from springs and wells on Piper and Stiff diagrams, which are graphical methods used to show the differing amounts of anions and cations in solution. He noticed striking similarities in the hydrochemistry of some of the springs and wells. He proceeded to separate the thirteen selected springs and wells into three groups based on their aquifer rock types. These three groups included springs and wells that are believed to draw water from the Simpson Group, Arbuckle Group, and Arbuckle-Simpson mixture.

Figure 14 shows the geographic location of several wells and springs examined by Hart. Spring and well data were taken from D.L. Hart (Hanson and Cates, 1994) and were subsequently plotted onto Piper and Stiff diagrams in order to determine chemical similarities or differences using the computer program Wateval (Hounslow, 1994). Table 5 is an index of all the springs and wells.

Flow from the highly mineralized group includes Bromide and Medicine Springs, located in the west end of CNRA, and two wells, 5-C1 and 5-C2, found five miles northwest of CNRA. These springs and wells are believed to have originated from the Simpson Group (Hanson and Cates, 1992). The water from this source has a TDS content of greater than 4000 mg/L and is considered to be of the sodium chloride type. The Piper diagram corresponding to this group reflects this, suggesting that almost all dissolved anions and cations are either sodium or chloride (see Figure 15). The extremely high TDS content suggests the water has high concentrations of sodium chloride. The stiff diagram of the Simpson group also shows that the water is dominated by sodium and chloride (see Figure 16). In all four wells, sodium and chloride occur in the highest frequency while bicarbonate, calcium, magnesium, and sulfate occur in smaller amounts. The amounts of bicarbonate, calcium, magnesium and sulfate seem to indicate the water does originate from a carbonate environment, in this case the Simpson group. The source of the sodium chloride is unknown given there are no sodium chloride bearing rocks in the Simpson Group. It has been suggested this saline water could be associated with a deep-circulating groundwater system that originates from deeper and more distant sources (Fairchild et al., 1981).

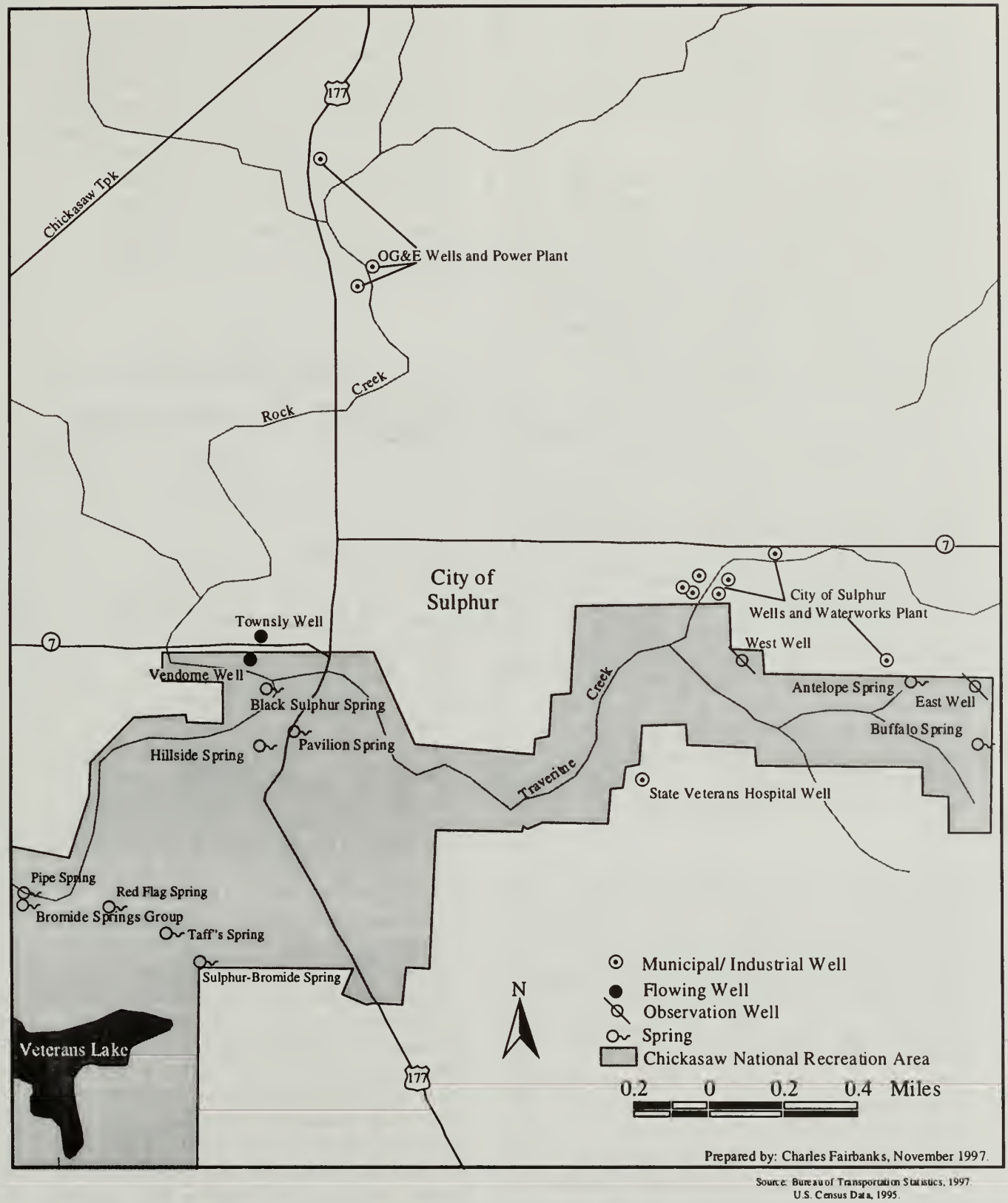


Figure 14.
Selected Well and Spring Locations at Chickasaw National Recreation Area

One final point is that by looking at the Stiff diagram corresponding to this group, it appears all four springs and wells originate from the same source rock because the shapes that they form appear to be nearly identical.

Flow believed to originate from the Arbuckle Group includes two springs and two wells. In addition to Antelope and Buffalo Springs, the City of Sulphur, and Turner Ranch Wells are located on the eastern side of CNRA. The water from these springs and wells is extremely clean, meaning that it has a low TDS when compared to other springs and wells in the area. Water from Antelope and Buffalo Springs, for example, exceeds state water quality standards for drinking but is considered safe for immediate use for industrial or municipal purposes (Fairchild et al., 1981). As demonstrated in the Piper diagram shown in Figure 17, the water is a calcium-magnesium-bicarbonate type and has a TDS content of approximately 300 mg/L. This suggests the aquifer is the Arbuckle Group, since it is composed mainly of limestone and dolomite rocks. When examining the Stiff diagram for the group, the dominance of the calcium, magnesium, and bicarbonate ions suggests carbonate dissolution (see Figure 18). In addition, the shapes of the Stiff diagrams in the group are very similar, also suggesting the springs and wells are derived from the same aquifer, which in this case is the Arbuckle Group.

Flow from the Arbuckle-Simpson mixture includes two springs and three wells. The two springs, Pavilion and Black Sulphur, are located in the central portion of CNRA. Two of the wells, OG&E #2 and #3, are located a few miles north of CNRA at the OG&E plant. The third well, Vendome, is located at the north entrance of CNRA. These springs and wells are mineralized to a certain extent. While the water is less mineralized than those of the Simpson Group wells, it has higher TDS than the Arbuckle Group wells. The TDS content of these wells ranges from 600-1200 mg/L, while the sodium and chloride content is on the order of 300 mg/L, which is intermediate to those found in the Arbuckle Group (Harp et al., 1976). This suggests the water is derived as a mixture of the Arbuckle and Simpson Group waters, probably due to faulting or other geological features in the region's subsurface. The Piper diagram (see Figure 19) reflects the intermediate levels of the TDS and sodium chloride content of the water while the Stiff diagram (see Figure 20), suggests moderate levels of sodium chloride. These diagrams also verify the presence of bicarbonate, calcium, and magnesium ions, which indicate carbonate dissolution.

Table 5
Index Of Spring and Well Numbers
The following numbers in the piper diagrams corresponds to these springs & wells:

GROUP/NUMBER	SPRING OR WELL NAME
SIMPSON GROUP	
1	BROMIDE
2	MEDICINE
3	WELL 5-C1
4	WELL 5-C2
ARBUCKLE GROUP	
5	BUFFALO
6	ANTELOPE
7	CITY OF SULPHUR
8	TURNER RANCH
ARBUCKLE-SIMPSON MIXTURE	
9	PAVILION
10	BLACK SULPHUR
11	VENDOME
12	OG&E #2
13	OG&E #3

Subsequent to the study of D.L. Hart, additional water quality data was collected in the fall of 1993 by the EPA, analyzed by Mantech Technology, and then documented as a series of unpublished letters (EPA, 1993). This analysis helped to determine the water quality of numerous springs and a few wells in the area by analyzing cations, anions, and non-natural substances. The study considered several of the springs and wells that D.L. Hart used in his study, however the report also contained several other lesser known ones in the area. Of particular interest are four springs (Sulfur-Bromide, Red Flag, Taff, and unnamed) in this report, which are not covered by Hart. All four of the springs are located generally to the north of Veterans Lake (see Figure 14).

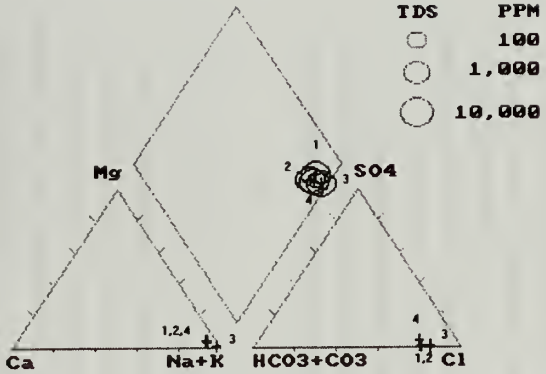


Figure 15.
Piper Diagram
of the Simpson Group

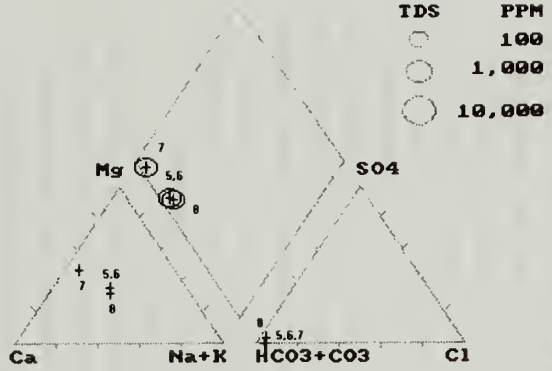


Figure 17.
Piper Diagram
of the Arbuckle Group

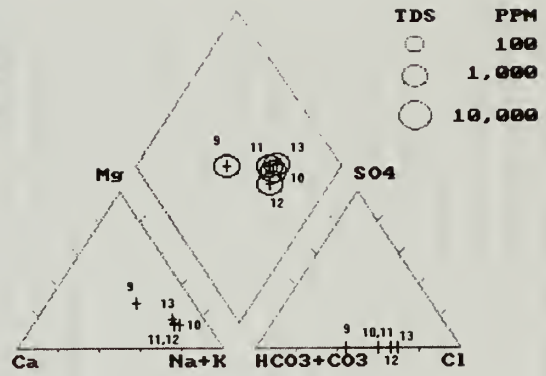


Figure 19.
Piper Diagram
of the Arbuckle-Simpson Mixture

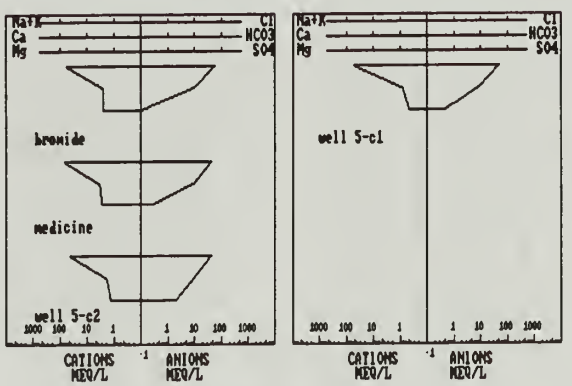


Figure 16.
Stiff Diagram
of the Simpson Group

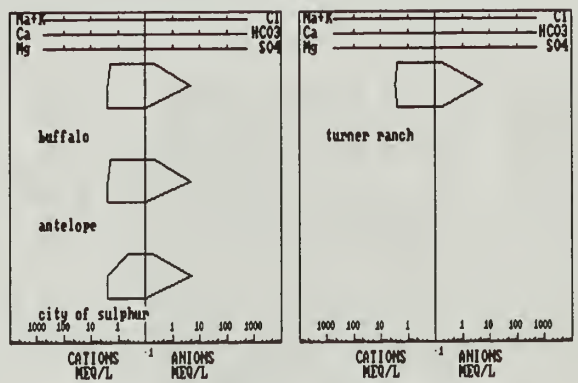


Figure 18.
Stiff Diagram
of the Arbuckle Group

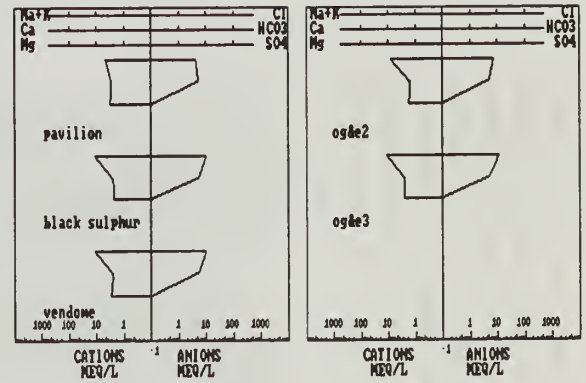


Figure 20.
Stiff Diagram
of the Arbuckle-Simpson Mixture

Source of diagrams: Hanson and Cates, 1994.

According to the analysis in the EPA's report, three of the springs: Sulfur-Bromide, Red Flag, and Taff all have similar water quality. When comparing these springs' water composition to other springs and wells in the area, it appears from the analysis that all three have a similar composition to water found in Vendome Well. For example, these three have very similar values to Vendome in conductivity, sodium, potassium, calcium, magnesium, chloride, and bicarbonate. Since Vendome Well is considered to be drawing its water from an Arbuckle-Simpson mixture, thus it is likely these three springs tap a similar source.

The fourth spring, which is officially unnamed and located in Rock Creek near the Bromide Pavilion, is known as Pipe Spring in the report, due to the fact that it flows out of a six inch pipe casing that is above normal creek level. Although the flow from the spring is quite small, it is nonetheless very interesting due to the similarity of its water to Bromide and Medicine Springs. It becomes even more interesting when you consider that Bromide and Medicine were thought to be the last highly mineralized springs to flow within CNRA and are currently no longer flowing. When comparing the spring to Bromide and Medicine Springs, water quality values were very similar in conductivity, sodium, calcium, magnesium, chloride, and potassium. Due to the spring's similarity to the Bromide and Medicine Springs, it is therefore likely that it also draws its water from the Simpson Aquifer. Also noticeable was the dominance of sodium and chloride ions in the water, which is another characteristic of Simpson derived water. One final interesting discovery in the report regarding this spring was that it had a bromide content which was significantly higher than any other spring or well currently flowing within CNRA.

BIOLOGIC RESOURCES

The Oklahoma Department of Environmental Quality (ODEQ) uses bioassessment results to measure non-point source implementation effectiveness and to identify impaired waters for biannual reports published in the Water Quality Assessment Report. A multimetric approach based on the technical guidance of EPA's Rapid Bioassessment Protocols (RBPs) and the Index of Biotic Integrity (IBI) is used to assess the community condition of Oklahoma macroinvertebrate and fish assemblages for water resource management purposes (Davis et al., 1996). ODEQ is beginning to examine ecoregional differences in biota and initiating the process of developing regional reference expectations. Also, the Oklahoma Conservation Commission (OCC) has developed and is refining protocols for rapid bioassessments using diatom communities.

At present, Oklahoma has not developed numeric biocriteria or formally incorporated bioassessment scores or ratings into their water quality standards. Biological narratives are included, however, as an aquatic life use designation component. Aquatic life use support is composed of the warm water aquatic community, habitat-limited aquatic community, cool water aquatic community, and trout fishery subcategories. Criteria for support status include evidence of habitat or community modification; point and nonpoint source effects on habitat or community; and no algal blooms, surface scum, mats, nuisance macrophyte growth, or periphyton growth (Davis et al., 1996). Water bodies with no evidence of habitat or community modification, no nonpoint or point source affects on habitat or communities, and no nuisance algal blooms, periphyton or macrophyte growths possess attributes that are indicative of full support of designated aquatic life use. However, it is also important to note that although it is not desirable to have excessive nutrients, planktonic and benthic communities are extremely important to fisheries and a median level of these nutrients must be maintained in order to ensure the well being of the fish community.

Vegetation

CNRA is considered an ecotone, where the eastern deciduous forest and prairie/grassland plant communities intermingle (i.e., western short-grass, mixed-grass prairie or mid grass type). More than 600 different plant species and twelve habitat types have been identified within the region surrounding CNRA. Most of these

are found throughout the area without definite boundaries (Hoagland and Johnson, 1997). Flora and fauna from both the forest and grassland environments can be found within the area. Four forest communities (i.e., short-lobed oak type, post-oak/winged-elm type, Texas oak/chinquapin oak type, and American elm/southern hackberry type) and three grassland communities contribute to a rich and varied flora.

Vegetation in the area has changed significantly since the 1930s. The general trend has been toward the expansion of woody plants including eastern red cedar with a corresponding decrease in natural grasses and forbs. Additionally, plants of the greenbriar family (Vitis spp.) have grown up along stream borders, blocking access to the water in some places (NPS, 1986). Parts of grassland environments found within CNRA have been covered with shrub stratum and trees. It appears that over time, some of these trees, which include red cedar, oaks, plum, and sumac will replace the original grasses (Barker and Jameson, 1975).

High rocky slopes within CNRA abound with yucca and prickly pear cactus. Undisturbed parts of the moderately moist grassland community are composed of many prairie plants such as Indian grass and switchgrass. Vegetation in the Platt District has been deliberately manipulated to produce an aesthetically pleasing environment through the planting of trees, shrubs, and grasses, and by the construction of ponds and waterfalls. In some places vegetation has also been disturbed as a result of the construction of roadways, utility lines, campgrounds, and buildings. As a result, NPS managers consider the Platt District to be a naturalistic, rather than a natural area.

Common forest species throughout CNRA include oak, hickory, elm, ash, pecan, sycamore, eastern red cedar (considered a native pest), dogwood, redbud, and ashe juniper. Other species found within CNRA include sumac, southern cottonwood, southern hackberry, and black willow, which thrive along waterways. Common grassland species include hairy grama, little bluestem, beardgrass, purple threeawn, hairy tall dropseed, yellow Indian grass, big bluestem, sideoats grama, and switchgrass. As noted previously, yucca, pricklypear cactus, and dwarf sumac are common on the higher rocky slopes. Currently there are no known federally threatened or endangered plant species within CNRA.

Tree surgery by CCC workman, 1930's

Aquatic Invertebrates

Due to CNRA's unique environment, a variety of natural water sources exist ranging from the man-made ponds to springs that flow from natural and man-made formations. Currently, little information exists on the aquatic invertebrate and plant/algae populations of these water resources. For instance, springs tend to have uniform temperatures that correspond to the mean annual air temperature of the region (Hynes, 1970). Springs also contribute to uniform conditions in areas that are subject to seasonal changes. In these spring environments, relic species have survived and many crenobionts (species confined to springs) can occur far outside their normal geographical range (Hynes, 1970). Recently, Hoagland and Johnson (1997) conducted a vegetation study,

but no attempt was made to sample the aquatic vegetation.

Fish

The relative abundance of water at CNRA sustains a rich fish fauna. Lake of the Arbuckles, Veterans Lake, and CNRA's creeks, freshwater streams, and ponds contain a wide variety of fish including shad, catfish, carp, shiner, bass, sunfish, bullhead, drum, gar, and crappie. The western mosquitofish (Gambusia affinis) can be found in mineral waters near Vendome Well and in the creek running through Flower Park (NPS, 1970; U.S. National Parks and Conservation Association, 1993). White bass, largemouth bass, smallmouth bass, spotted bass, crappie, sunfish, channel catfish, blue catfish, bullhead catfish, and flathead catfish are all popular sport fish at CNRA. It should be noted that the white bass is the only true member of the bass family (Percichthyidae) found in CNRA. Largemouth bass is considered the most sought after game fish at CNRA and has been stocked in nearly every pond and lake in the state.
Federal laws and programs have helped to increase the abundance of many of Oklahoma's popular sport fish and have improved the availability of fishing opportunities within CNRA's boundaries (see Appendix B).

Migratory Waterfowl

More than 100 bird species are found along CNRA's riverbanks and in its woodland and grassland communities (National Parks and Conservation Association, 1993). Many of these species migrate to find food, and it is the availability of insects, rather than cold weather, that affects their migration patterns. For many migratory waterfowl, CNRA is merely a resting area while in route to other places. Most of the migrants that remain temporarily in this region feed on lands west of CNRA. Bald eagles are a transitory winter migrant to the area during winter months and are often seen at the Lake of the Arbuckles, however no nesting sites have been observed within CNRA's boundaries (NPS, 1970).

Fragmentation within CNRA has broken large areas of wildlife habitat into small ones, creating a serious threat to resting areas of migratory birds. For example, the open cup-shaped nest built by most migrants leaves eggs and young vulnerable to predators such as raccoons, snakes, blue jays, and crows. Unfortunately for most migratory birds, these nest predators thrive along forest and prairie edges. Other problems include pesticides from nearby farming communities that rarely kill birds or other wildlife directly, but can reduce their ability to withstand the physiological stresses of migration. Pesticides also reduce insect populations, which in turn may reduce the ability of many bird species to raise young.

Cultural Resources

A Cultural Landscape Inventory of the Platt District completed in 1997 determined that the entire district is nationally significant as a Historic Designed Landscape. As noted in this report, the area's periods of landscape design significance extended from 1902, when the site was ceded to the government, to 1932: another period of design occurred between 1933 and 1940. Some cultural influences remain from the district's first period of design significance, but the historic designed landscape largely reflects the era from 1933 to 1940, when the Civilian Conservation Corps (CCC) implemented NPS rustic designs (NPS, 1997a).

NPS landscape plans have focused largely on the design opportunities presented by the site's many springs and its accompanying streams and waterfalls, woodlands and prairies, and valley setting. The design for CNRA is intended to foster traditional family and community activities, including picnicking and camping, while addressing solutions to conservation problems, such as haphazard parking, erosion, and forest rejuvenation within the park. CNRA's master plan includes development of the spring areas with flowing circulation and structures to attract visitors while at the same time providing

a national park experience and preserving the site's landforms and other unique features (NPS, 1997a).

Many constructed features, both earthen and structural, were added to the landscape during the 1930's which relate directly or indirectly to mineral and fresh water springs, streams, and Vendome well. For example, stream alignments were modified, revetments added to stabilize banks, rock dams added to form pools, mineral springs encased and piped for drinking convenience, and artesian waters used to form streams, pools, and falls, through Flower Park. A Cultural Landscape Inventory, Level II will be completed between 1998-99 to better delineate the importance of these and other remaining character-defining characteristics from significant historic periods.

LAND USE AND WATER QUALTIY

CNRA is located within the Rock Creek watershed. Covering approximately 9,888 acres, the area contains numerous surface water resources such as Lake of the Arbuckles (see Figure 5). Some of the creeks in the watershed include Rock, Guy Sandy, Buckhorn, and Travertine. Rangeland, pastureland, cropland, and urban areas have the greatest influence on the water quality of surface water resources such as Rock Creek (see Table 6 and 7).

Soil structure, fertility, and drainage have resulted in only marginally productive croplands within Murray County. As a result, agricultural activities have moved towards industries such as dairy farming and poultry operations. These activities, which can create elevated levels of nitrogen and phosphorus (Streebin and Harp, 1977), range in size from 40 to 80 head of cattle per farm or about 100,000 hens per poultry house. It has been estimated that rural areas contribute 71% of the nitrogen and 68% of the phosphorus contamination in the region (Streebin and Harp, 1977). Urban areas, which occupy a much smaller percentage of the total land area in the watershed, contribute much less to nitrogen and phosphorus problems within the larger area (Streebin and Harp, 1977). Several industrial sources of surface water pollution adjacent to CNRA have been identified (see Table 7). For example, in the summer of 1990, chlorine from the Sulphur Well field flowed into Travertine Creek killing fish (National Parks and Conservation Association, 1993). In addition, numerous industries are located along Rock Creek upstream from CNRA. Sulphur's waste treatment plant, an Oklahoma Gas and Electric (OG&E) Generating Plant, a cement company, and construction operations could potentially affect CNRA's water resources. Additionally, water drainage runoff from urban domestic sources (i.e., fertilizer runoff, pesticides, herbicides, and petroleum products) could impact CNRA's water resources.

Each year, approximately two million visitors enjoy recreational activities at CNRA (see Figure 21). This level of human presence can have a negative impact on the quality of surface water through increased erosion, opportunities for human body contact, and through the use of motorized watercraft.

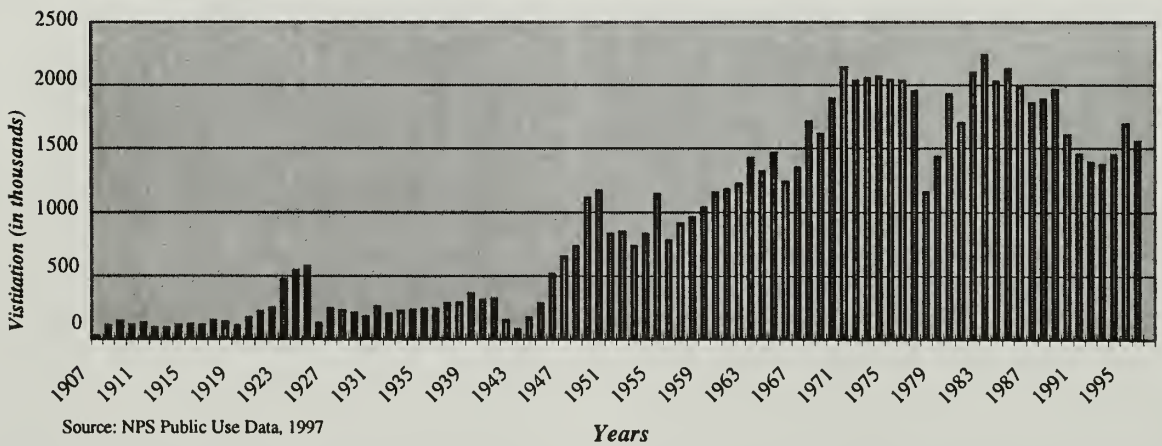


Figure 21.
Annual Visitation 1907-1997

Table 6
Land Use, Rock Creek Watershed

Use	Acres	Percent of Total
Rangeland	42,930	54.0
Pastureland	19,080	24.0
Forest, Upland	7,950	10.0
Cropland	3,975	5.0
Water	3,180	4.0
Urban Area	1,590	2.0
Forest	238	.3

Source: Streebin, and Harp, 1977.
Note: Information from Oklahoma Conservation Commission

Table 7
Non-point Nutrient Sources
Estimate of the Amounts of Total Nitrogen and Total Phosphorus Contributed by various Non-point Sources in the Watershed

Sources	Acres	Nitrogen lbs/yr/ac	Pounds per Watershed	Percent	Phosphorus lbs/yr/ac	Pounds per Watershed	Percent
1. Runoff							
Rural Area							
Cropland	3,975	6	23,850	10	.3	1,192	9
Pastureland	19,080	4	95,400	40	.2	3,816	30
Rangeland	42,930	1	42,930	18	.08	3,434	26
Forest land	7,950	1	7,950	3	.05	398	3
Urban Area	1,590	8	12,720	6	2.0	3,180	24
2. Precipitation	3,180	10	31,800	13	.05	160	1
3. Groundwater	--	--	24,350	10	--	910	7

Source: Streebin, and Harp, 1977

Municipal and recreational sources of contamination also impact water quality. Pollution from these sources occurs primarily from human wastes. The City of Sulphur is located adjacent to CNRA's watershed and has municipal sewer lines that run directly through the area. In the past, these old and inadequate lines leaked raw sewage directly into Rock Creek. During storm events, the City of Sulphur's sanitary sewer system can become overloaded by storm water, causing sewage loss to surrounding drainage ways and eventually flowing into CNRA waters. In addition to improving routine maintenance, the City of Sulphur is actively seeking grants to repair the sanitary system and prevent storm waters from entering the sanitary system. The major sanitary line, which transfers sewage from the City of Sulphur to the sewage treatment plant, was improved in 1987. This line is contained within the historic Platt District. There have also been problems with educating the public about the severity of sewage problems (Streebin and Harp, 1977).

It should be noted that many of these leaks have been repaired.

Another source of human waste in surface water is associated with recreational activities within the region. CNRA is a popular summer destination for tens of thousands of visitors who engage in a wide variety of water-related activities. Among these, swimming has an impact on the fecal coliform levels of surface water, especially within streams (Streebin and Harp, 1977).

As previously mentioned, the quality of surface water within CNRA is significantly influenced by land use within and outside the area's borders. Rock Creek passes through rangeland, livestock holding pens, industrial property, and the City of Sulphur. Some of the potential pollution sources which may exist along the stream include runoff from city streets, cattle and chicken ranching operations, industrial activities, and recreational activities.

To assist in a continuation of baseline information acquisition, CNRA staff

recently acquired water sampling equipment that will aid in the collection of parameters including specific conductance, dissolved oxygen, standard pH, temperature, depth, nitrates, alkalinity, and bacterial counts.

In an effort to monitor biological hazards, CNRA staff regularly sample and analyze streams and lakes for fecal coliform bacteria.

FACILITIES

Facilities within CNRA are designed to accommodate a variety of activities such as camping, picnicking, swimming, fishing, boating, water-skiing, and hiking. Much of CNRA's facility infrastructure within historic Platt District was built by the CCC between 1933-40. In 1950 Rock Creek campground was constructed in the Platt District. During the 1960's campgrounds were constructed in the Arbuckle District and the Travertine Nature Center; modern comfort stations were constructed in the Platt District. Recently campgrounds have been rehabilitated and comfort stations added to the Buckhorn and Point areas. CNRA has six campground facilities (see Figure 2) with a total of 450 camping sites (NPS, 1995). Three of these are located in the Platt District (Rock Creek, Central, and Cold Springs Campgrounds). Three others are located in the Lake District (Point, Buckhorn, and Guy Sandy Campgrounds). Facilities also exist for other outdoor activities such as swimming, boating, and fishing. Hiking enthusiasts can enjoy 20 miles of improved trails.

Water supply and sewage facilities exist throughout CNRA. Drinking water facilities can be found at all campgrounds and water can be obtained from the numerous springs in the area. There are 17 public rest rooms and 32 chemical toilets scattered throughout CNRA. Several sewage lines run through CNRA and carry wastes from the area's rest rooms to Sulphur's water-treatment plant.

Table 8
Facilities within CNRA

Buildings / Utilities
1 headquarters building
1 maintenance area
1 water-treatment plant
1 nature center building
4 ranger stations
17 modern public rest rooms
2 picnic pavilions
2 spring pavilions
32 chemical toilets
Campgrounds / Picnic Areas
6 campgrounds, 450 sites
13 picnic areas
Trails
20 miles of improved hiking trails
Water facilities
2 lakes: Veterans Lake and Lake of the Arbuckles
Numerous streams and springs
Roads/Boat Ramps
22 miles paved
6 miles unpaved
1 mile U.S. highway 177
5 boat ramps

Source: NPS, 1995.

RECREATION

CNRA provides opportunities to experience a wide range of outdoor activities including swimming, boating, fishing, bicycling, horse back riding, hiking, nature observation, hunting, camping, and picnicking. The area has catered to traditional family activities for generations, adding to the quality of life for visitors and local residents (NPS, 1996a).

CNRA offers three different levels of water-based recreation. Upstream from the nature center, visitors can enjoy the beauty of natural springs and streams as a visual resource. Veterans Lake offers a park-like atmosphere where use is restricted to relatively quiet activities. Finally, visitors can engage in a full range of activities at Lake of the Arbuckles including motor boating and fishing (NPS, 1996a).

Fishing is permitted in all lakes and streams (except along a portion of Travertine Creek) including Veterans Lake and Lake of the Arbuckles. Use is restricted at Veterans

Lake to no-wake boating with the objective of providing for relatively quiet recreational activities. Also, no boating is permitted on area ponds. Fishing opportunities for disabled persons are facilitated by a wheelchair accessible dock at Veterans Lake. No fishing is allowed in Travertine Creek from the Travertine Nature Center to Antelope and Buffalo Springs.

Boating, water-skiing, scuba diving, and swimming are also permitted at CNRA. Swimming is allowed in all creeks, lakes, and streams except in Travertine Creek from the Travertine Nature Center to Antelope and Buffalo Springs. Water-skiing is permitted from sunrise to sunset at Lake of the Arbuckles, but is not permitted on Veterans Lake.

CNRA offers visitors a variety of opportunities for camping and picnicking; most sites are open year-round. Many of these areas provide access to hiking trails that are popular for bird watching, wildflower observation, and nature study.

WATER RESOURCE MANAGEMENT GOALS AND OBJECTIVES

Buffalo Preserve within CNRA

Water resources are broadly defined for the purposes of this plan to include the physical and chemical attributes of surface and groundwater, the biological components of aquatic systems, habitat characteristics, and the transition zone between aquatic and terrestrial systems which occurs in the form of wetlands and riparian areas. The water resources, of course, are components of a larger system consisting of natural and cultural attributes. Climate, geology, watersheds, terrestrial communities of plants and animals, and cultural features such as visitor facilities, local communities, and historic land uses are all components of this larger system that affect the water resources of CNRA.

The policy of the NPS is to maintain, rehabilitate, and perpetuate the inherent natural integrity of water resources and water-dependent environments within units of the NPS, because of water's importance in maintaining resources (NPS, 1991). The objective is to preserve options and avoid large-scale, irreversible changes instigated by human land use practices that harm water resources and larger natural systems.

Through the years various plans have been put forth recommending management goals and objectives for protecting the quality of the waters and restoring spring flow to natural conditions. These include: the *1979 General Management Plan for CNRA*, the *1980 Final Environmental Impact Statement of the GMP*, the *1994 Resource Management Plan*, the *1995 Statement for Management*, and the *1996 Strategic Plan*. These documents identify and discuss specific water resources of CNRA and recommend management goals and objectives for protecting the quality of the waters and restoring the flow of the springs to their natural condition.

GENERAL RESOURCE MANAGEMENT GOALS AND OBJECTIVES

General resource management goals and objectives for CNRA include:

- Managing CNRA water resources in accordance with legislative mandates.
- Identifying the groundwater system(s) responsible for the flow of the numerous springs within CNRA, and determining actions necessary to restore the natural flow of the springs.

- Maintaining existing natural ecosystems, both riparian wetland and aquatic.
- Minimizing hazards to life and property associated with flooding.
- Avoiding or mitigating human activities that cause contamination of water resources.
- Identifying water quality conditions that are harmful or hazardous to CNRA visitors or wildlife.
- Managing to maintain all recreational values of CNRA.

RESOURCE MANAGEMENT

CNRA water resources management actions will be carried out to achieve the following objectives:

- CNRA resources will be preserved for current and future generations.
- Decisions concerning natural, cultural, and recreational resources are based upon sound research and planning.
- Visitor use facilities are protected, maintained, and made accessible to the public.
- CNRA waters exhibit quality and quantity characteristics consistent with those that first attracted people to the area.
- Historic structures and landscapes are preserved, protected, and well maintained.
- CNRA ecosystems maintain natural ecosystem dynamics and natural processes.

COOPERATIVE MANAGEMENT

CNRA will also seek to establish and maintain good working relationships with other public and private agencies and organizations through the following actions:

- Maximize the use of cooperative relationships with Arbuckle Master Conservancy District, Ardmore Public Works, U.S. Geological Survey, City of Sulphur, Goddard Youth Camp, Bureau of Reclamation, Chickasaw Nation, Oklahoma Department of Environmental Quality, and other entities, to achieve CNRA resource management objectives. In addition, CNRA will utilize these relationships to contribute substantively to ecosystem restoration efforts and regional water management objectives.
- Protect both the quantity and quality of waters contributed by CNRA's watershed and adjacent private and public lands.

NATURAL RESOURCES OBJECTIVES

Objectives for the management of CNRA's natural resources are:

- Implement a Natural Resource Base Inventory that addresses issues including geology, soil, habitat, fossil pollen, and the flora and fauna of terrestrial and aquatic environments.
- Continue programs for monitoring water quality and quantity, and initiate additional or new geological, hydrological, and ecological studies to facilitate area management, conservation, and education programs.
- Discourage non-native species, and prevent further introduction of exotic species. Utilize plant materials produced from local stock for the revegetation of construction zones and maintain the gene pool of species native to CNRA. Perpetuate and/or restore the native oak/hickory forest and mixed grass plant communities.
- Provide for the public hunting of native species in natural habitats and in natural concentrations on a sustained-yield basis, in cooperation with the Oklahoma Department of Wildlife Conservation. Maintain an agreement with the Oklahoma Department of Wildlife Conservation for the management of game and fish.
- Suppress all wildfire at accessible natural or artificial barriers (unless life or structures are threatened), or at other reasonable locations convenient to suppression activities, pending research to determine how fire can be used as a natural resource management tool.
- Seek ways to preserve the community groundwater resources.
- Work with federal and local government agencies and civic organizations to establish a water pipeline from Lake of the Arbuckles to Sulphur so that the city will no longer draw its water from the same aquifer that supplies Antelope and Buffalo Springs.

- Designate the aquifer testing of Vendome Well as a top priority in understanding the relationship between the aquifers and spring flow. Continue programs for monitoring water quality.
- Establish water rights for CNRA.
- Develop and implement a Bison Management Plan, to effectively manage the small bison herd and the area it occupies.

FACILITIES OBJECTIVES

Management goals are as follows:

- Maintain or preserve all structures in their original (historical) condition to the greatest extent possible, and provide a safe, sanitary, and aesthetically pleasing environment for visitors and employees.
- Ensure that all potable water produced or purchased by CNRA meets applicable standards set by the Safe Drinking Water Act, as administered by the State of Oklahoma and NPS-83.
- Ensure that wastewater is safely and effectively collected from CNRA facilities and piped to the City of Sulphur treatment plant.
- Ensure that solid waste generated by CNRA operations and visitors is routinely collected and disposed of in a safe and healthy manner and in compliance with EPA regulations and NPS policies.
- Be particularly sensitive to both cultural resources and natural resources in carrying out facility management duties.
- Provide adequate training for employees to carry out the duties of their position in a professional and competent manner.
- Support and assist other divisions, to the extent possible, in a spirit of cooperation and teamwork.

INTERPERTATION, VISITOR SERVICES, AND COLLECTION OBJECTIVES

Objectives for interpretation, visitor service, and collection programs are as follows:

- Provide high-quality interpretive programs for casual visitors.
- Promote maximum utilization of Travertine Nature Center and the adjoining environmental study area by schools and environmental education groups.
- Promote and support environmental education activities at the Goddard Youth Camp, which serves a vital role in educating youth concerning the values of resource protection.
- Maintain, rehabilitate, and replace exhibits as necessary.
- Provide recreational opportunities for swimming, boating, fishing, hunting, camping, picnicking, and trail use.
- Ensure that persons with disabilities have access to all facilities and activities.

VISITOR PROTECTION AND SAFETY OBJECTIVES

Visitor protection and safety programs at CNRA are as follows:

- Provide visitor assistance and law-enforcement patrol and search/rescue capability for roads, trails, backcountry areas, and lake surface and underwater areas.
- Communicate information on the safe recreational use of the land and water areas of CNRA.

PLANNING AND CONSTRUCTION OBJECTIVES

The following are short and long term objectives for improvements within CNRA:

- Provide for a wide variety of camping opportunities, such as tent, recreational vehicle, walk-in, and boat-in sites.
- Continue improving CNRA roads as part of the Federal Lands Highway Program.
- Provide for high-quality recreational experiences that range from group to solitary activities.
- Separate and cluster users at different places and allot sections of the lake for low-speed boating or fishing, and land areas for hiking, nature study, hunting, horseback riding, and bicycling.
- Provide a visitor center facility along adjacent highways in CNRA, or adjacent to CNRA within the town of Sulphur.
- Provide trails connecting the Lake and Platt Districts, as provided for in the

Comprehensive Trail Design and Environmental Assessment.

- Facilitate the construction of trails and other developments around Veterans Lake as provided for in the General Management Plan Addendum, Development Concept Plan, and Environmental Assessment.
- Provide modern maintenance facilities within or near CNRA.
- Provide a modern office facility for the superintendent, four division chiefs, administrative staff, and other staff employees.
- Provide staff housing at key locations where public housing is not readily available, to the degree essential for emergency protection services and surveillance and to facilitate maintenance.

CULTURAL RESOURCES OBJECTIVES

CNRA's objectives concerning cultural resource management include the following:

- Maintain historic properties in the Platt District that are presently being nominated for inclusion on the National Register of Historic Places and also for possible recognition as a National Historic District; and ensure that they are carried out in conformity with applicable policies, guidelines, and standards. This task will involve the following:

    1. Preservation maintenance (housekeeping; routine and cyclic maintenance; and stabilization).
    2. Routine grounds maintenance, such as grass-cutting and tree-trimming.
    3. Installation of environmental monitoring units, such as those for water and air quality.
    4. Archeological monitoring/testing and investigations of historic structures and cultural landscapes involving ground-disturbing activities or intrusions into the historic fabric for research or inventory purposes.
    5. Acquisition of lands for CNRA purposes.
    6. Rehabilitation and widening of existing trails, walks, paths, and sidewalks within previously disturbed areas.
    7. Repaving of existing roads or existing parking areas within previously disturbed areas.
    8. Placement, maintenance, or replacement of utility lines, transmission lines, and fences within previously disturbed areas.
    9. Rehabilitation work limited to actions for retaining and preserving, protecting and maintaining, and repairing and replacing in kind materials and features.
    10. Health and safety activities such as radon mitigation and removal of asbestos, lead paint, and buried oil tanks.
    11. Installation of fire detection and suppression systems and security alarm systems; and upgrading HVAC systems.
    12. Erection of signs, wayside exhibits, and memorial plaques.
    13. Leasing of historic properties, consistent with NPS-38.

- Take the following steps related to the historic collection:

    1. Transfer the present museum records to acceptable museum forms and format.
    2. Input all museum-collection data into the Automated National Cataloging System.
    3. Catalog the large backlog of unaccessioned museum items.
    4. Manage the research of human remains in the museum collection, and arrange for their repatriation or retention.
    5. Develop and implement a Collection Management Plan, Collection Storage Plan, and Collection Condition Survey.
    6. Revise the Scope of the Collections Statement.
    7. Integrate the museum collection into CNRA programs, including the Integrated Pest Management Program, Emergency Operation Plan, and Structural Fire Plan.
    8. Organize materials within the collection storage building and transfer the museum collection to this new facility. Provide the building with security and access control.

Natural springs serve as a focal point for visitor activity within the historically significant Platt District of CNRA. Continued flow of the springs is therefore crucial to maintaining the integrity of the area. CNRA's springs derive their flow from the Arbuckle (freshwater) and the Simpson (mineralized) formations; both extend for several miles beyond the borders of the recreation area.

Because of the extent of the underlying aquifer, CNRA resource management staff must be concerned with land uses on adjacent private property. Such threats include the pumping of groundwater for agricultural and municipal purposes, oil and gas operations (including saltwater injection wells), threats from potentially hazardous material, and wastewater disposal. Also of significant concern is pumping from numerous artesian wells that penetrate aquifers shared by CNRA springs.

As stated in its enabling legislation, CNRA was set aside for outdoor recreation and the protection of natural and historical resources. Water resources issues facing CNRA today are both complex and wide-ranging. In an effort to identify the most critical issues affecting water resources at CNRA, an Issues Scoping Workshop (ISW) was held in 1996 that involved both stakeholders and representatives from the NPS, Oklahoma State University, native american groups, and government agencies (federal, state, and local). ISW participants identified the specific issues presented in the following section (a complete list of participants and agencies represented can be found in Appendix C).

The following issue categories related to water resource management at CNRA were identified by ISW participants:

- limited baseline information about resources
- lack of geomorphic data
- limited water resources database
- lack of geologic information
- lack of information on internal and external land uses and impacts
- lack of contingency plans

The categories listed above have been refined and expanded to form the foundation for this section of the WRMP. The issues that follow can be divided into two general groups: programmatic and specific.

Programmatic issues relate to the need for improved understanding and management of CNRA's water resources, and the role that water resources play in regional resource management. Considerable information is needed to address these types of issues including long-term monitoring of water resources, an expansion of baseline data for CNRA, and a further understanding of land use issues. Clearly, these issues, which form the core of this WRMP, require long-term commitment and support. It is hoped the understanding of water resources gained through this program will provide a foundation for management decisions regarding specific issues.

Specific issues are tied to existing activities and problems. Such issues are generated by events or actions, and vary widely in scope and impact. They are both internal and external in nature, and require direct responses for alleviation or mitigation.

PROGRAMMATIC ISSUES

The following programmatic issues are considered essential as core features of a WRMP for CNRA:

Issue: Long-term Hydrologic Monitoring

Long-term and continuous monitoring of water resources is essential for the protection of any area where water plays a pivotal role within the ecosystem. This is especially true with regards to CNRA. Knowledge of the region's role within the hydrologic cycle is essential for rational decision-making in all aspects of management.

As noted earlier, several fresh and mineral springs, five principal streams, two major lakes, and numerous small ponds constitute the major surface water resources of CNRA. Veterans Lake and the Lake of the Arbuckles are CNRA's two major impoundments with surface areas of about 64 and 2,300 acres respectively. These resources are important to the two million annual visitors who fish, swim, and wade in the streams and lakes of CNRA. In addition to its recreational uses, Lake of the Arbuckles provides drinking water for thousands of area residents and major industrial customers. CNRA visitors, many of whose visitation dates back several generations, use mineralized spring water for either medicinal purposes or consumption. Therefore, monitoring the quality of these water resources is essential for public health and the protection of the natural environment. To assist in the continuation of baseline information collection, CNRA staff recently acquired water-sampling equipment to determine specific conductance, dissolved oxygen, pH, temperature, depth, nitrates, and alkalinity.

The watershed area that contributes to CNRA's five streams is relatively large with a combined drainage area of about 118 square miles. Land uses within this area include cattle ranching, farming, oil exploration and development, sand and rock mining, poultry production, fish hatchery production (catfish farm), and urban activities (the City of Sulphur with a population of about 4,600 is directly adjacent to CNRA). Possible threats to CNRA's water quality include solid waste disposal, waste water discharges from poultry facilities, sewage leaks, discharges from fish hatchery operations, and accidental spills on state highways that run through and adjacent to CNRA.

The most recently reported degradation to CNRA's water quality occurred in the summer and autumn of 1994. On at least four different occasions, the city sewer line backed-up and flowed into a storm drain that in turn, emptied into CNRA's Travertine Creek. This stream was closed to human contact until the flow was stopped and coliform counts were determined to have returned to acceptable levels. Except for episodic events, previous water quality measurements (taken by CNRA employees) have shown that water quality remains at acceptable levels. Nutrient loading has not been a problem in CNRA's lakes, although algal blooms do occur. In an effort to monitor biological hazards, CNRA staff regularly sample and analyze streams and lakes for fecal coliform bacteria.

CNRA's staff is also concerned with water quantity. Spring and stream flow monitoring is required in order to identify and address threats to groundwater flow. Although some historic spring flow estimates exist, there is presently no program for the accurate measurement of spring flow. The U.S. Geological Survey maintains recording gauges (hydrographs) on Rock Creek and at Antelope Spring. However, most of the mineral springs are located downstream of these gauges, and are of insufficient size relative to the streams to be measured by such on-line stream gages. Flow data provided by these hydrograph measurements will be used to determine present spring status, establish trends, and investigate influences from precipitation. The flow data will also be useful in evaluating potential mitigation measures.

Despite the importance of groundwater flow to CNRA, the present understanding of shallow and deep aquifers in the area is minimal at best. While there is a conceptual understanding of the groundwater system, refinements are needed to provide validity and to allow for predictability under continued stresses to the system. Current and potential well drilling within and adjacent to CNRA boundaries raises concern that the water quality and quantity in CNRA could be severely impacted, if it has not been already.

An improved understanding of fluctuations in the groundwater levels and their relationship to surface flow are important in order to adequately assess local flow characteristics. Aquifer tests will provide the information necessary to better understand these hydrological characteristics, including permeability, evapotranspiration, recharge, and water quality. This data will aid in the development of hydrologic models that describe water flow through CNRA. Equally

important, CNRA needs to better understand discharge rates, both historic and current. Analysis of data will give CNRA staff better information concerning the aquifers, which may facilitate improved management for sustained use.

While there are many free flowing artesian wells in and around CNRA's boundaries, resource managers have only limited information related to domestic or commercial withdrawal rates. For proper management of CNRA's water, a detailed water budget needs to be developed. In preparation of this task, an intensive study must be carried out that addresses water uses by category (domestic, commercial, and CNRA) along with withdrawals through artesian flow.

CNRA management facilities and operations should be evaluated to ensure they are not adversely affecting water flows or quality. Examples of facilities include roads, structures (buildings and bridges), fences, water and wastewater systems, hydrologic improvements along some streams, and fuel storage containers. CNRA operations also include the provision of recreational activities and the maintenance of buffalo pastures. Actions should be recommended to correct any problems that are identified.

Issue: Baseline Information

Presently CNRA staff need a basic inventory that describes both surface waters (i.e., lakes, ponds, streams, wetlands, creeks, and springs), and groundwater flow. Information concerning water within CNRA is extremely limited and available only for the Platt District. These data are valuable, and in some instances necessary, for management of CNRA water resources. Ideally, such data would be made available within a digital database and spatially referenced through a geographic information system (GIS).

Although two highways and several roads are located in or adjacent to CNRA, little is known about the hydraulic characteristics associated with their bridges, culverts, and road surfaces that influence runoff and water transportation. Likewise, very limited information is available concerning hydrologic influences associated with developed portions of the City of Sulphur. Spatial databases must also be updated. Topographic mapping by the U.S. Geological Survey in the early 1970's provided some coverage of the area, however, with the expansion of CNRA's boundaries in 1976 and 1983, these maps are in need of revision.

Fish are an important component of the water resources at CNRA; therefore a Fish Management Plan (FMP) is needed to ensure perpetuation of a quality recreational fishery at CNRA.

Water quality and quantity assessments should be conducted to evaluate potential for receiving the *Outstanding National Resource Waters Designation.* Obtaining such a designation would serve to increase protection for the natural resources. It should be noted that the NPS Water Resources Division and Servicewide Inventory and Monitoring Program has developed a Baseline Water Quality Inventory and Analysis for CNRA.

Issue: Long-term Land Use Monitoring

Changing land use activities both within, and adjacent to CNRA, must be monitored in order to anticipate changes that may impact water resources. Detection of change through monitoring can facilitate an early warning that may help in mitigating deleterious impacts to ecosystems.

Surrounding CNRA are private lands of former or current land uses that have the potential to adversely impact water resources. Activities on these lands include farming, cattle-raising, timber harvesting, oil and gas exploration and production, and concentrated recreational activities. A few abandoned homes and campsites are also found on lands adjacent to CNRA. Although such land uses have the potential to affect waters entering CNRA, their impact on the flow and quality of water cannot be adequately determined at this time.

SPECIFIC ISSUES

Both external and internal land use activities affect the quantity and quality of water within CNRA and represent some of the most pressing issues that CNRA will face in the near and distant future. Unfortunately, they often represent activities over which CNRA staff have little or no direct control.

Issues: External Land Uses

The State of Oklahoma has officially recognized the importance of CNRA water resources as "Sensitive Public and Private Water Supplies." Waters with this designation are not permitted to have new point source discharges of any pollutant or increased load of specified pollutants from existing point source discharges. However, despite state recognition of the importance of CNRA's water resources, there are a variety of activities taking place on lands outside of CNRA's boundaries that influence or potentially influence water resources within CNRA. Such activities must be closely monitored.

Agriculture

Murray County is a predominately agricultural area, with a large amount of acreage devoted to cattle ranching. In general, activities associated with rangeland, pastureland, cropland, and urban uses pose the most significant threat to CNRA water resources through the generation of point and nonpoint source pollution. Other land cover types such as forests and riparian areas may provide benefits to CNRA water resources because they filter much of the nonpoint source pollutants that would otherwise enter streams and lakes. Increasingly, agricultural activities in Murray County have turned to poultry and dairy production, activities that produce concentrated wastes.

Also of concern to CNRA officials are pesticides applied to adjacent lands. Chemicals from farming activities rarely kill birds or other wildlife directly, but can reduce their ability to withstand the physiological stresses of migration. In addition, pesticides reduce insect populations, which in turn may inhibit the ability of birds to raise their young (Oklahoma Department of Wildlife Conservation, 1995).

Residential, Municipal, and Industrial

Pollution from residential, municipal, and industrial sources may, at times, adversely affect CNRA's streams and the Lake of the Arbuckles. While the lake's water quality is generally excellent, algal blooms from undetermined pollution sources have occurred periodically, most recently in 1987 and 1994. Another problem surfaced in 1990 when a chlorine leak from the City of Sulphur well field entered Travertine Creek killing fish (National Parks and Conservation Association, 1993). Summer home development on the west side of the Lake of the Arbuckles may impact water quality by increasing construction-related erosion and through higher waste discharge levels that will require new treatment and septic systems.

If not managed properly, a catfish farm located near Buckhorn Creek could impact water quality at the Lake of the Arbuckles. However, it should be noted that the current owner has implemented BMPs to manage wastewater.

Urban influences on water quality are linked to the Platt District's location adjacent to the City of Sulphur. Water quality can be adversely affected by storm runoff and municipal or industrial land uses. The City of Sulphur's main sewage line and many smaller sewage lines pass through CNRA on their way to a sewage disposal plant located on Rock Creek. Monitoring is necessary to assure that raw sewage does not seep into the streams during periods of high flow and runoff.

A major concern to CNRA staff is the City of Sulphur's location within the same watershed as CNRA resources; any significant sewage spill or leak could potentially flow into CNRA. Many industrial sites are located along Rock Creek north of the recreation area; runoff could potentially flow into CNRA. Activities associated with nearby commercial land uses include cement operations, milk production, and construction.

Nutrient Loading and Biological Contamination

The water quality of Rock Creek watershed has been shown to be influenced by adjacent land uses (see Table 6). Non-point source pollution from agricultural and forest lands, urban runoff, and point sources discharging into the creek potentially affect its quality. At times, the water quality of Rock Creek is below standards established by the Oklahoma Water Resources Board for the designated beneficial uses of that stream (Streebin and Harp, 1977). As previously mentioned, the creek passes through or near rangeland, livestock holding pens, industrial property, and the City of Sulphur. Possible sources of pollution to this stream segment include: runoff from cattle and swine feeding and holding pens; fish farms; poultry farms; runoff from city streets; and inadvertent discharges from poorly maintained, or inadequate waste collection.

Nutrients such as nitrogen and phosphorus have the potential to become serious contaminants to CNRA's waters (see Table 7). A study conducted by Streebin and Harp (1977) found the largest contribution of nutrients to be rural lands, accounting for 71% of total nitrogen and 68% of total phosphorus. In this category, pastureland is the largest contributor with about 40% of nitrogen and 30% of phosphorus. The second largest contributor is rangeland, accounting for 18% of nitrogen and 26% of phosphorus. Because of its small area, cropland contributes only 10% of nitrogen and about 9% of phosphorus. Urban areas contribute about 6% of the nitrogen and 24% of phosphorus. The high phosphorus level is the result of sewer line leakage throughout the City of Sulphur. As suggested by Streebin and Harp (1977), contributions from precipitation are more significant in terms of nitrogen (13%) than phosphorus (1%). Levels of contamination are typically higher in rural areas because these areas occupy more acreage and sustain more intensive land uses compared to urban areas.

Risk of human infection by fecal coliform and fecal streptococcus must also be considered in dealing with CNRA water resources. Direct discharges of raw sewage into CNRA water resources have occurred (National Parks and Conservation Association, 1993). On at least five occasions in 1994, the City of Sulphur's sewage system allowed sewage to flow into CNRA's creeks. This discharge resulted in several problems including: fecal coliform levels that exceeded state water quality standards for direct bodily contact in Travertine Creek and parts of Rock Creek; subsequent closure of CNRA waters to public contact; and large algal blooms forming in the Lake of the Arbuckles.

Hillside Spring is another area where fecal coliform levels have been determined to cause water to be unsafe for human use. Historically, visitors used the waters of Hillside for consumption and other uses. However, since 1968, a sign has been posted at the spring to notify the public that water from the spring may be contaminated. The only investigation to examine sources of contamination at Hillside Spring was completed by Cumiford (1968) who identified slight bacterial contamination at Hillside that he attributed to avian and mammalian exposure.

Sulphur Pipeline

The Sulphur Pipeline is part of the Arbuckle Project, which was authorized by Public Law 87-594 and approved August 24, 1962. Construction of the dam, reservoir, and delivery facilities to Davis, Wynnewood, Daugherty, Ardmore, and Kerr-McGee Refinery began in 1964 and were completed by the Bureau of Reclamation (BOR) in 1968. However, the City of Sulphur elected to defer construction of the pipeline, pumping plant, and related works necessary to utilize its allocated share of water within Arbuckle Reservoir for an indefinite period of time. Instead, city officials contracted with the Arbuckle Master Conservancy District to pay the storage cost of the city's allocation within the reservoir.

Sulphur is currently meeting all city water needs from wells. The most significant source of withdrawals from the aquifer are artesian wells maintained by the City of Sulphur Waterworks (well field), Veterans Hospital, Vendome Well,

and Rural Water District #4. There are also approximately 20 artesian wells that remove an additional two million gallons per day. Although the exact influence of pumping on the mineralized springs within CNRA is unclear, water quality and spring discharge data suggest detrimental effects may be taking place as a result of groundwater withdrawals. Geologic and hydrologic studies that have examined the springs suggest that flow from springs ranges from one-fifth to one-tenth of what was observed in the early 1900s (Harp et al., 1976; Hanson and Cates, 1988; Taylor, 1991; Hanson and Cates, 1994; Taylor, 1994).

It is believed that construction of the Sulphur Pipeline and treatment plant and cessation of withdrawals by the City of Sulphur Waterworks would help decrease stress on the aquifer; such a project would provide Sulphur a water source for domestic and commercial purposes.

Hazardous Waste Spill Response

Roadway spills have the potential to adversely affect CNRA water resources. A major oil or hazardous spill in the vicinity of CNRA could have serious consequences to streams, lakes, or aquifers. In addition to environmental damage, a serious spill could disrupt the level and type of recreation that a visitor would have access to while at CNRA (e.g. boating, fishing, swimming, and wading). State Highway 7 adjoins a portion of CNRA's northern border and State Highway 177 bisects the Platt District. These highways are used for transporting a wide variety of materials including liquid petroleum.

Spill response typically requires the completion of the following 10 steps:

1) evacuate the area adjacent to the spill and avoid direct contact with the spilled material,
2) identify the material spilled as soon as possible,
3) contact the National Response Center and obtain assistance from qualified employees,
4) alert others of possible dangers,
5) look for injured persons,
6) identify existing and potential hazards,
7) with the qualified responders, prepare a plan of action,
8) obtain the proper equipment and materials,
9) with qualified personnel using the proper, equipment and materials, contain the spill,
10) clean up the spill according to the directions on the Material Safety Data Sheet(s).

Regulated Storage Tanks

The threat of contamination to CNRA and groundwater related to leakage from regulated storage tanks (RSTs) is a serious concern. Some RSTs are located adjacent to CNRA in the City of Sulphur. A complete inventory of RSTs is needed for the CNRA's watershed. By 1998, CNRA had removed all of its underground storage tanks. Tanks that are found to be out of compliance with state law must be upgraded or closed by the responsible party.

Illegal Disposal Sites

Unauthorized disposal of domestic wastes poses a severe threat to CNRA streams and lakes. Unfortunately, the absence of countywide solid waste pick-up has led to streambeds being used as dumpsites. CNRA is considering management actions such as: 1) surveying tributaries to identify illegal disposal sites; 2) analyzing water below disposal sites to identify toxic materials; 3) working with the county to establish county-wide solid waste pick-up locations; and 4) working with the county sheriff's department to stop illegal disposal. Another potential threat, the extent of which has not yet been determined, is the former City of Sulphur landfill which is within the watershed of Lake of the Arbuckles.

Issues: Internal Land Uses

Tribal Involvement and Development

The Chickasaw Nation is interested in the development of tourism opportunities within CNRA. Some possibilities for expanding facilities used for tourism include the construction of a visitor center or marina. However, CNRA and the Chickasaw Nation must obtain funding to support the development of a comprehensive plan for tourism and development. Currently, CNRA is working with the Chickasaw Nation to pursue these interests, however serious concerns must be addressed. The effect of a new marina or visitor center on water quality is unknown.

Although the City of Sulphur has improved their sewage treatment facilities, there is still the possibility of leakage from sewer lines. Older houses in Sulphur may not have gray water lines attached to their sewage system and in many cases homeowners discharge wastes directly into the environment. The Chickasaw Nation is particularly concerned about this issue. A home owned by a member of the Nation may receive assistance in upgrading their sewage system from the Chickasaw Nation Health System's Office of Environmental Health.

Impacts of Recreational and Inappropriate Uses

Activities within CNRA can tax water resources in terms of both quality and quantity, particularly during busy summer months. Impacts come from water recreation activities (i.e., swimming, boating), camping adjacent to surface waters, and pollution associated with human activities (i.e., litter, human waste disposal, petroleum spills, etc.). Possible actions that can be taken to address these problems include:

- reduction of human use or temporary closure for heavily impacted areas
- public education concerning concentrated use and litter control
- increased funding for ranger patrols and the availability of interpreters to provide information
- monitoring water quality

Oil Seep Monitoring

Although not widespread, investigations have identified oil seeps and globules along a small portion of Rock Creek. Seeps close to the shore or underwater slowly release oil globules into the creek, leaving a generally non-iridescent film that extends about 1/4 mile down stream, coating shoreline objects. During periods of heavy rain, the oil is washed down the creek and into the Rock Creek arm of the Lake of the Arbuckles. In the past there have been complaints when boats have been stained by oil.

While it appears that a portion of this seepage is natural, an unnatural source (i.e., past oil activity located within the watershed) may be a contributing factor. CNRA is pursuing technical assistance from the NPS Water Resources Division and the NPS Geologic Resources Division Branch to:

- determine whether the oil seeps in Rock Creek are natural, or are coming from the past activities on adjacent private lands
- determine if the amount of oil from the seeps should be considered a hazard to water resources and, if so, how the situation can be addressed

Vendome Well

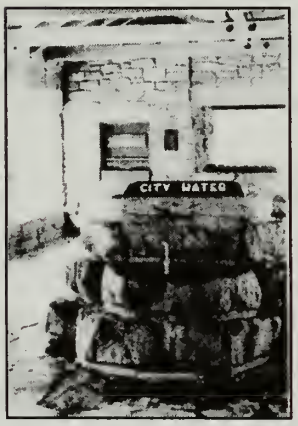
Vendome Well is located on the northern portion of the Platt District adjacent to State Highway 7. The well is of significant cultural importance to CNRA and to the City of Sulphur because it has been discharging mineralized groundwater freely since having being drilled in 1922. Its initial discharge rate of approximately 2,500 gpm has declined to about 500 gpm.

Water discharge from Vendome Well is thought to be a factor in the depletion of the Simpson-Arbuckle Aquifer. Geohydrologists believe that this aquifer supplies both Antelope and Buffalo Springs within CNRA as well as city and privately owned artesian wells in the area. The amount of groundwater (artesian flow) produced by the Vendome Well is reported to be about the same as that produced by the City of Sulphur well field for municipal supply.

Present data suggest that continued flow of the well may be adversely affecting the discharge of mineralized water from springs in CNRA. By allowing the well to flow freely, Vendome may be contributing to the reduction or elimination of discharge from mineralized springs.

In May 1998, a new well was drilled and the existing well was plugged. Replumbing from the new well to the historic foundation enclosure was also completed. Valves are now employed to regulate discharge from the new well, and flow is controlled to simulate flow rates of the past decade. This plan was implemented in order to maintain the interpretive valve and historic significance of the Vendome Well and its outflow through Flower Park.

Restoration of Mineral Water to Bromide Pavilion



Historically, Bromide and Medicine Springs were CNRA's two most important attractions. Water from these springs was highly valued for its medicinal value and local physicians often prescribed the bromide waters for their patient's aliments. During the early 1970's spring waters became no longer available at Bromide Pavilion. In addition to impacting users of spring water, the loss of flow has reduced the visual appeal of Bromide Pavilion. It may be possible for mineral water to be restored to the pavilion by installing a well into the original groundwater source or through retapping the historic springs. However, geologic and hydrologic studies must be carried out to evaluate the feasibility of such alternatives.

Ponds and Wetlands

About 20 ponds are scattered within CNRA boundaries; almost all were formed or constructed prior to NPS management. Given the fact that no inventory of these ponds is available, a management plan for ponds needs to be developed. At a minimum, the plan should include a description of each pond's location, size, volume, associated wildlife and fisheries habitat, and recreation value. Public safety issues related to water quality, the prevention of accidental injury or death from drowning, and the structural safety of each earthen dam should also be presented in this document.

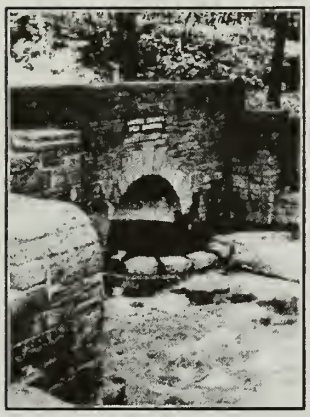
CNRA at the present time does not have an inventory of wetlands within its boundaries. Such areas are important habitats for native flora and fauna within CNRA. Although wetland areas within CNRA are not extensive, they must be properly protected to maintain an ecological balance within the area.

Although CNRA does not have an inventory of the ponds or wetlands of this area, it should be noted that the U.S. Fish and Wildlife Service has developed National Wetlands Inventory (NWI) maps of this area.

Vegetation Impacts

Another significant concern to CNRA officials is expansion of both indigenous and non-indigenous plant species. For example, the impact of the eastern red cedar on water resources in CNRA is unknown.

Hillside Spring Bacterial Contamination



Water from Hillside Spring, like many other springs in CNRA, has been collected and used for human consumption and other purposes since the years prior to NPS management. It is this continuing human consumption and collection of water from the springs that has created concern on the part of CNRA staff regarding the pubic health aspects of these waters. The area around Hillside Spring has a long history of intermittent bacterial contamination by fecal coliform and fecal strepptococci. However, at this time there is no treatment of this spring. Whether a chlorination unit or other means of treatment would be effective has not been determined. An evaluation of the spring water quality is needed.

In 1966, the NPS requested assistance from the Robert S. Kerr Water Research Center to conduct a study to determine the source of contamination at Hillside Spring. The study determined that the bacterial contamination during the dry periods came from adjacent soil. However, during wet periods, defined as when rainfall is sufficient to increase spring discharge, there were rapid increases and decreases in total coliform densities. From this observation it was determined that contamination was entering Hillside Spring's aquifer in the immediate proximity of the spring. This hypothesis was drawn because of the speed at which bacterial counts increased or decreased.

Water Rights for CNRA

Water rights for CNRA have not been defined, except for domestic use. However, it is unlikely that these rights will be defined in the near future. Actions to define water rights should be initiated by the State of Oklahoma and/or the NPS at the appropriate time. CNRA should continue monitoring outside water use and, when necessary, take action to protect the water resources of CNRA. From time to time, outside parties will propose and submit water-rights applications to divert water near CNRA. Some proposed diversions, if approved by the Oklahoma Water Resources Board and developed, may adversely affect the water rights of CNRA.

PROJECT STATEMENTS

Specific projects that are recommended by this WRMP are listed below in order of current priority and are summarized in Table 9. These priorities may change as tasks are completed, when more is learned about the area's hydrology, or when decisions are made internally or externally that affect the relative urgency of various issues.

Projects are described in greater detail within Appendix A in the standard format for NPS programming documents. It should be noted that the project budgets included in Appendix A represent estimated costs associated with equipment, supplies, and/or contract work needed. These documents are intended to serve as both planning tools used to identify problems and needed actions, and standardized programming documents used by NPS staff to compete for funding and other resources.

CHIC-I-002.000	Protection of Water Resources and Rights
CHIC-N-002.000	Water Quantity Monitoring
CHIC-N-003.000	Water Quality Monitoring
CHIC-I-004.000	Vendome Well Control
CHIC-I-003.000	Restore Mineral Water to Bromide Pavilion
CHIC-I-013.000	Hillside Spring Bacterial Contamination Assessment
CHIC-N-019.000	Inventory and Protection of Wetland Habitats
CHIC-N-015.000	Fisheries Management Plan
CHIC-N-011.000	Oil Seep Monitoring Assistance
CHIC-I-015.000	Prepare Hazardous Substance and Spill Contingency Plan
CHIC-I-016.000	Inventory External Land Uses
CHIC-I-014.000	Investigate Mechanics of Aquifer Flow System
CHIC-I-017.000	Coordination and Cooperative Management

Table 9
Summary of Project Statements
Complete Statements are presented in Appendix A

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-002.000	**Protection of Water Resources and Rights**	Water Rights for CNRA, Regulated Storage Tanks, and Illegal Disposal Sites	The protection and restoration of CNRA's water resources will require a comprehensive and unified approach to the management of ground water systems, regardless of land ownership. The need for comprehensive management has been pointed out and briefly discussed by Gould (1939) and Dunn (1953).	I. Protect the water resources of CNRA by monitoring use within and adjacent to the area's boundaries. 2. Determine management strategies best suited for land around the area's boundaries by coordinating efforts with local and state regulatory and planning programs which address land use within watersheds containing area resources. 3. Collect and prepare information to support the NPS's actions regarding adjacent land use activities associated with increased nonpoint source runoff, increased erosion, reduced groundwater flow and sedimentation, and the increased risk of contamination from discharges of fuels, sewage, chemicals, and other pollutants. 4. Obtain records of water and well rights for the Rock Creek watershed and propose voluntary plugging of private wells through cooperative funding. 5. If necessary, seek redress through the State of Oklahoma to provide protection of both surface and groundwater by protesting new withdrawals and requiring modifications of present sources and uses as necessary to restore the natural hydrologic regime and maintain a balance between natural recharge rates and withdrawal rates. 6. Propose that the State of Oklahoma establish a regulatory authority to control groundwater usage within the Arbuckle-Simpson Aquifer systems and surface water flows. Scientific evidence indicates that groundwater resources are continually being depleted and predictions suggest that spring flow will continue to attenuate to cessation within 40 years (Barthel, 1985). 7. Request that the State of Oklahoma encourage landowners to cap abandoned artesian wells within the aerial extent of the aquifers of concern. 8. Encourage the City of Sulphur to obtain its water from the proposed pipeline to the Lake of the Arbuckles and not use artesian wells unless an emergency situation exists. 9. Ask CNRA neighbors to restrict discharge from their artesian wells to the minimum necessary, if they are not already controlling discharge.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-N-002.000	**Water Quantity Monitoring**	Long-term Hydrologic Monitoring, and Baseline Information	Even though the continued flow of mineral and fresh water springs is vital to meeting the purposes of CNRA, there is no program that accurately and quantitatively measures spring flow. Some historic flow measurements do exist; however, most of the data collected provide only estimates. In order to identify potential threats to groundwater flow and to allow for the amelioration of such threats, it is imperative that CNRA establish a quantitative program of accurate spring and stream flow measurement. The USGS maintains recording gauges on Rock Creek and near Buffalo Spring. However most mineral springs are located downstream of these gauges and are of insufficient size relative to the streams to be measured by on-line stream gages. Therefore, it will be necessary to measure spring flow on an individual basis.	1. Monitor flow for all of CNRA's remaining springs. 2. Spring flow will be measured monthly. Larger springs will be measured with a park-owned pygmy flow meter or other suitable equipment. A portable flume or weir will be purchased to measure smaller springs. Park staff will require training in the operation of this equipment from Water Resource Division staff or personnel from another agency. 3. After the first year of data collection a determination will be made as to whether the park will need $5,000 of supplemental project funding. If needed, these funds will be used for installing recording gauges at springs where flow is so variable that the above techniques are not adequate. 4. A database file will be created for the flow data. If possible, this file will be consistent with, or part of, USGS records. Historic flow records will be located and entered into the data file (though some information collected will be qualitative in nature).

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-N-003.000	**Water Quality Monitoring**	Long-term Hydrologic Monitoring	CNRA has conducted water quality sampling in its creeks and springs in the past. CNRA needs to re-evaluate the need of a water-sampling program of all its water resources for bacterial and chemical contamination. The most recent degradation to the area's water quality occurred in the summer and autumn of 1994. On at least four different occasions, a city sewer line backed-up and flowed into a storm drain that later emptied into CNRA at Travertine Creek. The stream was closed to human contact until the flow was stopped and coliform counts were determined to have returned to acceptable levels. Except for episodic events, previous water quality measurements (taken by NPS employees) have demonstrated that water quality remains at acceptable levels. Nutrient loading has not been a problem in the area's major lakes, yet algal blooms do occur in some of CNRA's smaller ponds.	1. Identify areas where the water quality has not been adequately assessed. 2. Identify appropriate water quality parameters for evaluation of the water resources. 3. Incorporate a groundwater-monitoring component into the existing monitoring network. 4. Monitoring of the area's water quality should continue with an emphasis on organic contamination. Technical assistance is requested from WRD for an evaluation of water quality monitoring needs, the design of a monitoring program, and the identification of necessary equipment and supplies. 5. A less frequent baseline study monitoring program (five to ten years) should be established to determine the level of the pollutants and pesticides found within the area's waters and for an analysis of the chemical signature of each spring. This proposed monitoring program would be contracted to a qualified laboratory. 6. A groundwater-monitoring program should be established and managed to insure the safety and quality of groundwater. This proposed program will be conducted by NPS staff or contracted to a laboratory.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-004.000	**Vendome Well Control**	Vendome Well	The uncontrolled flow of the Vendome Well may be a factor in the depletion of the ground water associated with the Arbuckle-Simpson Aquifer. Past studies indicate that this aquifer supplies both Antelope and Buffalo Springs within CNRA and is also tapped by city and privately owned artesian wells in the area. The amount of ground water (artesian flow) produced by the Vendome Well is reported to be about the same as that produced by the City of Sulphur Well Field. Our present understanding of the hydrologic system indicates that each use "competes" with other uses for the available water. It should be noted that the NPS seeks to restore the discharge of some springs and conserve water by regulating the discharge of water flowing freely from the well.	1. A determination of minimum water requirements for discharge from Vendome Well and a release schedule to meet CNRA (public use) purposes should be developed. The new well and control devices should allow the well's discharge to be limited to the minimum necessary to maintain the interpretive values and historic significance of the site. 2. Before NPS staff can ask surrounding well owners to cap or control their outflow, CNRA must demonstrate significant efforts to control water loss within its own boundaries. By controlling Vendome Well's outflow, CNRA will be able to approach well owners with a proper assessment of the spring and artesian well flow and have supportive data which can aid in educating land owners about the need for proper management of their wells. Plans have been implemented to plug the old well and drill a new one within 25 feet of the historical well location. The NPS has constructed the replacement well, and plugged the old well. It is hoped that the new well will facilitate better control of water discharged from the aquifer. The new well may also provide improved knowledge of the geology in the area of the Vendome through the use of better well logging techniques during the drilling process.
PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-003.000	**Restore Mineral Water to Bromide Pavilion**	Restoration of Mineral Water to Bromide Pavilion	During the early 1970's spring waters became no longer available at Bromide Pavilion. The reason(s) for this change in water availability at Bromide Pavilion is not clear. Assembled information has provided two possibilities. First, flow of these wells was inadequate or ceased altogether. Secondly, water quality concerns occurred over the use of mineral waters for consumption (Myers and Lannom, 1998). Neither of these explanations has been confirmed as of the date of publication of this plan. This has impacted both traditional users of spring water and the appearance of the historic fountains. In order to provide for the maximum public enjoyment, flow should be restored to Bromide Pavilion. Only geologic and hydrologic studies can determine whether or not this is possible.	1. The need for action will be evaluated upon completion of other work described above. These proposed projects are intended to restore flow to Bromide and Medicine Springs.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-013.000	**Hillside Spring Bacterial Contamination Assessment**	Hillside Spring Bacterial Contamination	Water from Hillside Spring, like many other springs in CNRA, has been collected and used for public consumption and bathing since the years prior to federal protection. Hillside Spring has a long history of intermittent bacterial contamination from fecal coliform and fecal strepptococci. At this time there is no treatment of the spring. Whether a chlorination unit or other means of treatment would be effective has not been determined. An evaluation of the spring's water quality is needed. It is this continuing public use of the springs that has created concern on the part of CNRA staff regarding public health issues.	1. Determine seasonal levels of bacteria contamination. 2. Conduct a follow-up examination of the original study to verify results and to consider possible actions. 3. Determine the proper sanitation techniques necessary to make the water safe for public consumption. 4. Document the historic use of Hillside Spring. 5. Request technical support from the National Park Service for the determination of recommended actions needed to solve the Hillside Spring problem. 6. CNRA staff needs training in proper techniques for monitoring and sampling water from Hillside Spring. Additional technical assistance will therefore be requested. 7. All suggested recommendations will be evaluated to ensure that the historic fabric of the structure will remain intact. 8. The data collected will be added to a database that facilitates long-term monitoring and analysis.
PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-N-019.000	**Inventory and Protection of Wetland Habitats**	Ponds and Wetlands	CNRA does not possess a detailed inventory of wetlands within its boundaries. Although the wetlands in CNRA are not extensive, they should receive protection to maintain an ecological balance. It should be noted that the U.S. Fish & Wildlife has developed National Wetlands Inventory (NWI) maps of this area.	1. Determine features that should be maintained and protected as wetland habitat. 2. Coordinate efforts to secure water rights protection for pond and wetland features. 3. Conduct appropriate monitoring of each wetland area to ensure protection. 4. Request technical assistance to determine water rights within the area. 5. Request technical assistance to determine appropriate monitoring techniques 6. Add wetland maps developed by USFWS to the CNRA GIS to better manage wetland areas.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-N-015.000	**Fisheries Management Plan**	Development of a Fisheries Management Plan (FMP)	A FMP is needed to ensure perpetuation of a quality recreational fishery at CNRA. Enabling legislation for both CNRA and Platt NP placed an emphasis on protection of waters and their general use and enjoyment by the public. Providing a quality, sustainable recreational fishery in pleasant, tranquil settings, (e.g., CNRA streams, ponds, Lake of the Arbuckles or Veterans Lake) is consistent with the enabling legislation of CNRA.	1. A five-year FMP would be designed. The plan would identify long range goals, management objectives, and information needs. Annual research priorities, specific tasks, staffing, and budgetary requirements would be included in the recommendation. 2. The FMP would serve as a supplemental planning document to CNRA's General Management Plan (GMP), Resource Management Plan (RMP), and Water Resources Management Plan (WRMP). Specific actions developed in the FMP will be fully consistent with those listed in the GMP, RMP and WRMP. Tasks identified in the FMP will be developed into project statements for CNRA's RMP. 3. The FMP should be developed in cooperation with the appropriate state agency.
PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-N-011.000	**Oil Seep Monitoring Assistance**	Oil Seep Monitoring	Oil accumulates in small pools along the shore of Rock Creek and under rocks near seeps in the creek bottom. During periods of heavy rain the oil is washed down the creek and into the Rock Creek arm of Lake of the Arbuckles. In the past there have been occasional complaints from lake users whose boats have been stained by oil. Investigations conducted at such times have found oil globules on the water surface, as well as an oily coating on shoreline objects.	Technical assistance is requested from the Water Resources Division and the Geologic Resources Division to: 1. Determine whether the oil seeps in Rock Creek are natural, or possibly associated with past oil production activities on adjacent private lands. 2. Determine if the amount of oil from the seeps is to be considered a hazard to the area's water resources and, if so, how to mitigate the problem. 3. Determine what action can be taken to remove the threat from the brine storage tank and associated injection well.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-015.000	**Prepare Hazardous Substance and Spill Contingency Plan**	Hazardous Waste Spill Response	Possible sources of contamination from hazardous material in the area fall into three general categories: (1) those associated with commercial traffic, (2) those associated with oil fields, oil pipelines, sewage lines, and stores of hazardous material outside CNRA boundaries, (3) those associated with gasoline supplies sold to visitors near the area, and (4) fuel supplies for park vehicles within CNRA. A major oil or hazardous spill in the vicinity of CNRA could have serious consequences to the streams, lakes, and aquifers that this area was set aside to protect. A serious spill could also disrupt recreational activities in the area (e.g., boating, fishing, swimming, and wading). In addition, a large spill could cause permanent damage to springs and the surrounding environment.	1. The NPS will develop a spill contingency plan that can be followed in time of emergency. 2. Materials to be specifically addressed in an emergency action plan include petroleum products, raw sewage, and agricultural chemicals. 3. Provide a storage facility for important spill mitigation materials. 4. Facilitate coordination with the Oklahoma Department of Transportation, local highway department, Federal Highway Administration, local highway patrol, EPA, Oklahoma Department of Environmental Quality, FEMA, and other agencies that deal with hazardous materials that are identified during the planning process. 5. CNRA staff will conduct safety meetings and preparedness drills annually after the plan is in place. 6. A local Spill Contingency Plan (SCP) will be prepared providing SOPs with detailed actions that should be undertaken by CNRA staff upon the discovery of a spill. These SOPs will outline response procedures for small spills that can be addressed locally, and identify notification and response procedures for larger spills that require immediate action. In addition, the SCP would provide information relating to necessary spill response equipment and training needs for potential spill response personnel. 7. CNRA will also discuss inventory needs in order to delineate high value and particularly spill-sensitive natural resources and develop a mechanism to provide resource-specific information and advice to the Department of the Interior (DOI) Regional Response Team representative in the event of a major spill. 8. CNRA will store important spill mitigation supplies within the park boundaries.
PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-016.000	**Inventory External Land Uses**	External Land Uses: Agriculture, Residential, Municipal, and Industrial, Nutrient Loading and Biological Contamination, Sulphur Pipeline, and Impacts of Recreational and Inappropriate Uses	Nearby land uses have the potential to affect the quality and volume of waters entering CNRA. Flow from Rock Creek, Guy Sandy Creek, and Travertine Creek provide a conduit for external flows into CNRA. Unfortunately, managers do not have a complete inventory of the land uses outside CNRA's boundaries, which could potentially impact water resources. The primary external land uses adjacent to CNRA are urban (City of Sulphur) and agricultural.	1. Develop a detailed inventory from internal and external sources to identify various land uses immediately outside CNRA and define the approximate areas that influence each respective use. The primary objective of the project is to provide a more comprehensive inventory of external land uses that will allow CNRA to identify potential impacts before resource damage occurs, monitor land use trends, and effectively use regional planning to protect resources. These data will be used in conjunction with water quality and flow data.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-014.000	**Investigate Mechanics of Aquifer Flow System**	Baseline Information, and Long-term Hydrologic Monitoring	Despite the importance of groundwater flow to CNRA, an understanding of the shallow and deep aquifers is minimal at best. While there is a conceptual understanding of the groundwater system, refinements are needed to provide validity and to allow for improved predictions. Current and potential well drilling in, and adjacent to CNRA boundaries also raises concern that water quality and quantity in the area will be severely impacted.	1. Increase our understanding of the status and characteristics of the Arbuckle-Simpson Aquifer underlying CNRA. 2. Improve CNRA's ability to assess the impacts of current groundwater pumping and artesian flows and predict the impacts of new pumping and new wells drilled in the region. 3. Obtain existing (historical) groundwater monitoring data from various external sources. The groundwater data should not be restricted to the Recreation Area's boundaries but should include the entire watershed that influences CNRA water resources. 4. Prepare appropriate geologic and groundwater data (i.e., transmissivity, storativity, water quality, etc.) into a compatible database format for CNRA's hydrology program. 5. Conduct further surface geologic mapping and subsurface geologic studies to better define the geologic character and structure of the Arbuckle-Simpson Aquifer within CNRA boundaries and surrounding areas. These efforts may include test well drilling and gravity and seismic surveys. 6. Establish a rain gage network to facilitate more accurate assessments of aquifer recharge. 7. Initiate a new ground water monitoring system. The data obtained would facilitate the evaluation of the rate at which water levels are declining within the aquifers and improve CNRA staff understanding of the forces that influence spring flow levels, especially within Antelope and Buffalo Springs. 8. Age dating of water samples would provide an understanding of the travel time of groundwater flow. In addition, it would contribute further to available information related to the recharge rate and importance of rainfall in maintaining groundwater levels. In combination with water quality data, improved models of groundwater movements near the Sulphur Fault could be analyzed for "mixing" spring flow in the central portion of CNRA. 9. Compile adequate data and evaluate potential legal situations pertaining to water rights that may arise later. Shut down wells that are allowing excessive amounts of groundwater to flow to the surface.

PROJECT #	PROJECT NAME	ISSUES ADDRESSED	PROBLEM SUMMARY	SUMMARY OF PROPOSED ACTIONS
CHIC-I-017.000	**Coordination and Cooperative Management**	CNRA Issues Coordinated and Cooperatively Managed, Tribal Involvement and Development	In order to better manage water resources, CNRA staff should establish a cooperative network involving other agencies and organizations with interests in the area.	1. Maximize the use of cooperative relationships with Arbuckle Master Conservancy District, Ardmore Public Works, USGS, City of Sulphur, Goddard Youth Camp, BOR, Chickasaw Nation, ODEQ, USACE, and other entities, to achieve the purposes of CNRA. In addition, utilize these relationships to contribute substantively to ecosystem restoration efforts and regional water management objectives. 2. Protect both the quantity and quality of waters contributed by CNRA's watershed and adjacent private and public lands.

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Appendix A.

Project Statements

CHIC-I-002.000
Priority number: 1

PROJECT STATEMENT

PROTECTION OF WATER RESOURCES AND RIGHTS

Funding Status:	Funded:	0.00	Unfunded:	20.00

Servicewide Issues: N13 (Water Rights)
N12 (Water Flow)
Cultural Resource Type: N/A
RMAP Program Codes: Q00 (Water Resources Management)
Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Having been created prior to the establishment of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern about the area's future. Fluctuations in spring water flow have occurred throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. In fact, Pavilion Springs are a cluster of 5-7 outlets, rather than just one spring. Two major freshwater springs, Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek. Both of these springs are primary visitor attractions. These two springs have stopped flowing during extensive drought periods for several months at a time in 1920-22, 1950-56, 1961-66, and 1975-81.

CNRA overlies two groundwater systems (Arbuckle and Simpson aquifers) which supply spring flow within the Platt District. The presumed recharge areas for both aquifers are outside of CNRA's boundary. Existing evidence suggests that withdrawals from artesian wells in the area may be the cause of the present and continuing loss of CNRA groundwater resources. With the exception of Vendome Well, these wells are located on property not controlled by the NPS (CNRA staff are currently working to control discharge from Vendome Well). Additional developments outside CNRA boundaries would likely hasten this process.

The NPS is currently working to protect and restore CNRA's water resources, which will require a comprehensive and unified approach to the management of these groundwater systems. The need for comprehensive management has been pointed out and briefly discussed by Gould (1939) and by Dunn (1953). Since water resources are located within watersheds that extend beyond CNRA boundaries, resource management can be significantly influenced by outside activities.

For example, conversion of land from agricultural use to more intensive uses increases the potential for alteration of surface water flows and groundwater levels. Such changes can have detrimental impacts on natural and cultural resources within CNRA.

Description of Recommended Project or Activity

Effective pursuit of CNRA management objective #5 requires coordination with local and state regulatory and planning efforts. Those watersheds with significant potential for land use change should be identified and targeted for further analysis with consideration of CNRA management objectives.

The objectives of this project are to:

- Protect CNRA water resources by monitoring land use within and adjacent to CNRA's boundaries (see project statement entitled Inventory External Land Uses CHIC-I-016.000).
- Monitor applications to divert water, change existing water use, or alter land use. Prepare and submit protests and concerns, if necessary, to local, state, and federal agencies.
- Prepare and summit NPS concerns for future negotiations and actions regarding adjacent land use activities including increased nonpoint source runoff, erosion, reduced groundwater flow, sedimentation, and increased risk of contamination from discharges of fuels, sewage, chemicals, and other pollutants.

These objectives will be accomplished by the following actions:

1. Formulating a cooperative organization to manage the Arbuckle and Simpson aquifers, which will necessitate the voluntary participation of various land and well owners.
2. Developing strategies to reverse the declining trend in groundwater flow through public education about important groundwater management problems. Although federally reserved water rights for Chickasaw National Recreation Area are implicit in the purpose of the site, they have not been quantified. No adjudication under the McCarran Amendment is anticipated for this area. Therefore, there are no plans to collect the information necessary to quantify water rights. The NPS reserves the option of initiating court action to protect reserved water rights and other options that it may take outside of court action.
3. Obtaining records of water rights and well rights for the Rock Creek watershed, and proposing voluntary plugging of private wells through cooperative funding.
4. Monitoring water-rights applications, protesting applications, and attending hearings, if necessary.
5. Exploring means, and if feasible, implementing actions to establish a water-resources management district or similar body to regulate ground and surface-water usage and land use within drainage basins where CNRA is located.
6. Petitioning the State of Oklahoma to request that landowners plug their abandoned artesian wells within the extent of the aquifers of concern (see project statement Vendome Well Project CHIC-I-004.000).
7. Encouraging the City of Sulphur to obtain its water from the proposed pipeline to Lake of the Arbuckles and not use its wells unless an emergency situation exists.
8. Asking CNRA neighbors to restrict discharge from their artesian wells to the minimum necessary to meet their needs, if they are not already controlling well discharge.
9. Requesting technical assistance from the Water Resources Division to assist with water quantity and water quality issues.

These actions will be coordinated by Water Resources Division through a technical assistance request. Supplemental funding will be needed to provide coordination among local and state governments and residents.

Literature Cited

Barthel, C.J., Jr. 1985. "Hydrogeologic Investigation of Artesian Spring Flow." Norman, Oklahoma. University of Oklahoma, unpublished master's thesis, 234p.

Dunn, A. 1953. *The Water Supply Problem.* Platt National Park: National Park Service Report.

Gould, C. N., and S. L. Schoff. 1939. *Geological Report on Water Conditions at Platt National Park.* Oklahoma. National Park Service Report No. 249, or U.S. Geological Survey Open-File Report 39-14. 39 pp.

BUDGET AND FTEs:

----------FUNDED----------

Source	Activity	Type	Budget ($1000)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	WATER-RES	MON	20.00	1.0
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	20.00	1.0

Alternative Actions/Solutions and Impacts

Alternative No. 1 No action. The springs may continue to decline due to increasing demand placed on aquifers.

Compliance codes: EXCL

Explanation: 516 DM6 APP. 7.4 B (10)

CHIC-N-002.000
Priority number: 2

PROJECT STATEMENT

WATER QUANTITY MONITORING

Funding Status:	Funded: 76.40	Unfunded: 20.00
Servicewide Issues:	N12 (Water Flow)	N20 (Baseline Data)
Cultural Resource Type:	N/A	
RMAP Program Codes:	Q00 (Water Resources Mgmt)	
	Q01 (Water Resources Mgmt)	

Package Number: 10-238

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. In fact, Pavilion Springs are a cluster of 5-7 outlets, rather than just one spring. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

Despite the importance of mineral and fresh water springs to CNRA's mission, there is no program that accurately and quantitatively measures spring flow. Some historic flow measurements do exist, however, most are estimates. In order to identify potential threats to groundwater flow and to allow for the amelioration of such threats, it is imperative that CNRA establish a quantitative program of accurate spring and stream flow measurements. Although the USGS has maintained recording instrumentation on Rock Creek and near Antelope Spring, most of the mineral springs are located downstream of these gauges and spring flow is insufficient to be measured using on-line stream gages. Therefore, it will be necessary to measure spring flow at their points of discharge. Also, groundwater elevations need to be measured to better assess water quantity.

Data provided by these measurements will be used to determine present spring status, establish trends, and investigate the influences of seasonal and annual precipitation variation on stream flow. The data will also be useful in evaluating potential mitigation measures (to be undertaken by CNRA and surrounding water users).

Description of Recommended Project or Activity

The objectives of this project are to:

- Monitor flow for all of CNRA's remaining springs.
- Monitor stream flow (Wilson, Buckhorn, Rock, Travertine, and Guy Sandy Creeks).
- Monitor groundwater elevations.

These objectives will be accomplished by the following:

1. Select appropriate locations and install water stage gauges in CNRA streams. Measure stream discharge at these locations for a number of different stage heights to produce site specific stage-discharge rating curves. CNRA staff will require technical assistance to identify appropriate locations for installing gauges and measuring stream discharges from the NPS Water Resources Division or personnel from other appropriate agencies.
2. Spring flow will be measured monthly. Larger springs will be measured with a pygmy flow meter owned by CNRA. A portable flume or weir will be purchased to measure smaller springs. CNRA staff will require training in the operation of this equipment from Water Resource Division staff or personnel from another agency.
3. After the first year of data collection, a determination will be made as to whether supplemental project funding will be needed. If necessary, these funds will be used for installing recording gauges at springs where flow is so variable that the above techniques are not adequate.
4. A database will be created to monitor flow data. If possible, the format for the database will be consistent with, or joined to USGS records. Historic flow records will be located and entered into the data file. A portion of the data collected will be qualitative in nature.
5. Currently, CNRA staff have submitted a Technical Assistance Request to the NPS Water Resources Division entitled: "Water Resources Monitoring and Analysis to Protect Park Water Quality and Quantity."
6. A database will be created for groundwater elevation data. In areas that lack adequate groundwater monitoring, a proposal will be prepared that identifies priority monitoring well locations and associated installation costs. This project proposal will then be solicited for internal or cooperative funding.
7. Prepare an annual water resources report, that includes water quantity summaries for CNRA.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Type	Budget ($1000)	FTE
YEAR 1:	PKBASE-NR		MON	19.10	0.7
YEAR 2:	PKBASE-NR		MON	19.10	0.5
YEAR 3:	PKBASE-NR		MON	19.10	0.5
YEAR 4:	PKBASE-NR		MON	19.10	0.5
			Total:	76.40	2.2

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	WATER-RES	MON	20.00	0.0
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	20.00	0.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action

Impact No. 1. Water quantity data would not be collected.

Impact No. 2. Knowledge of current water quantity would not be comparable to past data.

Impact No. 3. Future trends in water quantity would no be known. Proper action could not be initiated should losses in water quantity occur.

Compliance codes: EXCL

Explanation: 516 DM6, App. 7.4 E (2)

CHIC-N-003.000
Priority number: 3

PROJECT STATEMENT

WATER QUALITY MONITORING

Funding Status:	Funded:	76.40	Unfunded:	20.00

Servicewide Issues: N11 (Water Qual-Ext) N20 (Baseline Data)
Cultural Resource Type: N/A
RMAP Program Codes:
10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

Nineteen fresh and mineral springs, five streams, two major lakes, and numerous small ponds constitute the major surface water resources of CNRA. Monitoring the quality of these resources is essential for public health and protection. Many of CNRA's two million annual visitors swim and wade in the streams and lakes of CNRA. Veterans Lake and Lake of the Arbuckles have surface areas of about 67 and 3,127 acres respectively. Lake of the Arbuckles provides drinking water for thousands of area residents and CNRA visitors. Additionally, park visitors and local residents have been using these spring waters (both mineral and fresh) for generations.

Five streams within CNRA have a combined drainage area of about 126 square miles. Land uses within their drainage area include cattle ranching, farming, oil exploration and development, poultry ranching, fish hatchery activities, and urban activities (the City of Sulphur with a population of about 4,600 is adjacent to CNRA). A 0.85 million gallon per day secondary batch reactor sewage plant is located within CNRA's boundary and treats sewage from both the City of Sulphur and CNRA. Other potential threats to CNRA's water quality include oil exploration and

development activities, discharges of contaminated water from poultry and fish hatchery operations (catfish farm), and accidental spills on state highways that run through and adjacent to CNRA (see project Prepare Hazardous Substance and Spill Contingency Plan CHIC-I-015.000).

CNRA has conducted water quality sampling in its creeks and springs in the past. CNRA needs to re-evaluate the need of a water-sampling program of all its water resources for bacterial and chemical contamination. The most recent degradation to CNRA's water quality occurred in the summer and autumn of 1994. On at least four different occasions, a city sewer line backed-up and flowed into a storm drain that later empties into Travertine Creek. The stream was closed to human contact until the flow of effluent was stopped and coliform counts were determined to have returned to acceptable levels. Except for episodic events, previous water quality measurements (taken by CNRA staff) have shown that water quality remains at acceptable levels. Nutrient loading has not been a major problem in CNRA's lakes, although algal blooms do occur. It should be noted that the NPS Water Resources Division and Servicewide Inventory and Monitoring Program has developed a Baseline Water Quality Inventory and Analysis for CNRA.

Description of Recommended Project or Activity

The objectives of this project are to:

- Identify areas where the quality of water resources is not adequately assessed.
- Identify appropriate water quality parameters, based on the potential threats, for proper evaluation of water resources.
- Incorporate a groundwater-monitoring component into the existing monitoring network.
- Identify watershed(s) affecting CNRA and associated land uses.
- Evaluate existing Oklahoma Biological Assessments to assist with identifying appropriate water quality monitoring network.
- Incorporate appropriate quality assurance/quality control (QA/QC) procedures (i.e., duplicate sampling, preparation of field blanks, chain-of-custody procedures, etc.) into water quality monitoring program.

These objectives will be accomplished by the following:

1. Selecting appropriate locations and installing water stage gauges within CNRA streams. Measure stream discharge at these locations for a number of different stage heights to produce site specific individual stage-discharge rating curves. Staff monitoring of CNRA's water quality should continue with an emphasis on organic contamination. CNRA staff will require technical assistance to identify appropriate locations for installing staff gauges and measuring stream discharges from the NPS Water Resources Division or personnel from another appropriate agency. CNRA staff will also require technical training in the proper operation of discharge meters and preparation of rating curves.
2. A baseline-monitoring program should be established to determine the level of pollutants and pesticides found within CNRA's waters and for a determination of the chemical signature of each spring. The pathways that these contaminants follow in entering CNRA need to be identified (i.e., tributaries, piping). Also, existing water quality data collected within CNRA's watershed needs to be evaluated to identify anomalies and trends. This proposed monitoring program would be contracted to a qualified laboratory.
3. A groundwater-monitoring program should be established and managed to insure the safety and quality of the groundwater.

4. An inventory of existing water quality monitoring networks (i.e., USGS, EPA, etc.) within the watershed should be carried out that facilitates cooperation among other state and federal agencies.
5. All existing and new water quality monitoring stations should be integrated within the CNRA's geographic information system (GIS).
6. A newly acquired multi-parameter sensor (minisounde unit) will be used to measure specific conductance, dissolved oxygen (with freeflow circulator), pH, temperature and depth. Water samples will also be sampled for bacteria at selected sites.
7. Utilizing existing land use maps to define areas where the potential for water quality impacts to CNRA exist. Also, an identification of indicator parameters associated with various land use practices should be carried out and expanded to more comprehensive parameters, if warranted by analytical results of the indicator parameters.
8. Preparing annual water resources report, that includes water quantity summaries for CNRA.
9. Contacting the Oklahoma Department of Environmental Quality (ODEQ) to obtain the most recent data regarding biological assessment. ODEQ uses bioassessment results to assist in identifying impaired waters (Davis et al., 1996). Biosurveys are used within a planning and management framework to prioritize water quality problems for more stringent assessments and to document "environmental recovery" (Plafkin et al., 1989).

Cited Literature

Davis, W.S., B.D. Snyder, J.B. Stribling, and C. Stoughton. 1996. *Summary of State Biological Assessment Programs for Streams and Wadeable Rivers.* Washington DC. EPA 230-R-96-07. U.S. Environmental Protection Agency. Office of Policy, Planning, and Evaluation.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes, 1989. *Rapid Bioassessment Protocols for Use in Streams and River. Benthic Macroinvertibrates and Fish.* Washington D.C. EPA/444/4-89-001. U.S. Environmental Protection Agency; Assessment and Watershed Protection Division.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Budget ($1000)	FTE
YEAR 1:	PKBASE-NR	MON	19.10	0.7
YEAR 2:	PKBASE-NR	MON	19.10	0.5
YEAR 3:	PKBASE-NR	MON	19.10	0.5
YEAR 4:	PKBASE-NR	MON	19.10	0.5
		Total:	76.40	2.2

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	WATER-RES	MON	20.00	0.0
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	20.00	0.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action

Impact No. 1. Water quality data would not be collected.

Impact No. 2. Knowledge of present water quality would not be comparable to past data.

Impact No. 3. Future trends in water quality would not be known and proper action could not be initiated should losses in water quality occur.

Compliance codes: EXCL

Explanation: 516 DM6, App. 7.4 E (2)

CHIC-I-004.000
Priority number: 4

PROJECT STATEMENT

VENDOME WELL CONTROL

Funding Status:	Funded:	145.00	Unfunded:	0.00

Servicewide Issues: N12 (Water Flow)
Cultural Resource Type: N/A
RMAP Program Codes: Q00 (Water Resources Management)
Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

Vendome Well is located in the northern portion of the Platt District, directly adjacent to State Highway 7. Mineralized groundwater has been flowing freely since the well was drilled in 1922. Because of its past use, Vendome has significant cultural and historical importance to both CNRA and the City of Sulphur. Although the dance hall and swimming pool once located adjacent to the well no longer exist, Vendome continues to serve as an important landmark within the City of Sulphur. In 1983 the well and surrounding land were acquired by the NPS.

The uncontrolled flow of the Vendome Well is thought to be a major factor in the depletion of the groundwater of the Arbuckle-Simpson Aquifer. Past studies suggest that this aquifer supplies Antelope and Buffalo Springs within CNRA, and city and privately owned artesian wells in the area (i.e., Barthel, 1985; Hanson, 1994; Harp, 1976; Taylor, 1991). The amount of groundwater (artesian flow) produced by Vendome has been reported to be about the same as that produced by

the City of Sulphur Well Field for municipal supply. Present understanding of the hydrologic system indicates that each use "competes" with other uses for the available water.

Over the last 75 years the initial discharge rate of approximately 2,500-gallon per minute (GPM) has decreased to about 500 GPM. Present data suggest that the continued flow of Vendome may be adversely affecting the discharge of mineralized water from CNRA springs (Barthel, 1985; Hanson, 1994; Harp, 1976; Taylor, 1991). For the last several years the NPS has been investigating ways to limit groundwater withdrawals in surrounding areas in an effort to restore the natural discharge of CNRA springs (see project statement Protection of Water Resources and Rights CHIC-I-002.000). However, to be consistent in terms of its position concerning artesian wells, the NPS itself must be willing and capable of controlling discharge from Vendome Well.

CNRA has constructed a new well to replace the existing well. The current plan is to plug and abandon the existing well and construct underground plumbing from the new well to the fountain where the existing well is located. If the plan is carried out, groundwater from the new well will flow through this new plumbing to the fountain. Valves will be employed to regulate discharge from the new well, and a schedule for discharge releases from the new well will be formulated to meet CNRA purposes.

Description of Recommended Project or Activity

The objectives of this project are as follows:

- Before surrounding well owners can be asked to cap or control flow from their artesian wells, CNRA must demonstrate significant effort to regulate discharge from its own artesian wells such as Vendome.
- To determine minimum water requirements for discharge from Vendome Well and create a release schedule to meet CNRA (public use) purposes. New well and control devices will allow the well's discharge to be controlled to the minimum necessary to maintain the interpretive value and historic significance of the site.

These objectives will be accomplished by plugging Vendome's well casing and drilling a new one within about 50 feet of Vendome's current well shaft. The new well will facilitate improved control of water discharged from the aquifer and provide improved knowledge of the geology in the area through the utilization of better well logging techniques during drilling.

Cited References

Barthel, C.J. 1985. "Hydrologic Investigation of Artesian Spring Flow." Sulphur, Oklahoma. Norman OK. University of Oklahoma, MS Thesis.

Hanson, R.L. and Cates S.W. 1994. *Hydrogeology of Chickasaw National Recreation Area, Murray County, Oklahoma.* USGS. Water-Resources Investigation Report 94-4102. Oklahoma City, Oklahoma.

Harp, J.F, Laguros, J.G., and Schornick, H.M. 1976. *Subsurface and Surface Water Flows at Platt National Park.* Sulphur, Oklahoma.

Taylor, T.1991. "Summary of Information Related to Flow of Springs in Chickasaw National Recreation Area." Sulphur, Oklahoma. Unpublished report.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Type	Budget ($1000)	FTE
YEAR 1:	PKBASE-NR		MON	36.25	0.5
YEAR 2:	PKBASE-NR		MON	36.25	0.5
YEAR 3:	PKBASE-NR		MON	36.25	0.5
YEAR 4:	PKBASE-NR		MON	36.25	0.5
			Total:	145.00	2.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	0.00	0.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No action

Impact No. 1. Continued deterioration of pressure in the aquifers supplying mineral and fresh water springs will most likely occur. Hydrologic analysis of the aquifer by Barthel (1985) indicates that the groundwater level within the Arbuckle-Simpson Aquifer will continue to decline. In addition, the study suggests that within the next 30 to 40 years Antelope and Buffalo will cease to flow due to the decreased water level. This declining water level will result in an unquantified reduction in the amount of artesian flow at Vendome Well and probably at all other artesian wells in the area. Therefore, this alternative does not attempt to reduce the water withdrawal from the aquifer, nor does it provide an analysis of the consequences of the other alternatives, which follow. The flow of Antelope and Buffalo Springs will not be assured. This alternative does not provide protection of Vendome Well drinking water. This action will require no additional funding.

Impact No. 2. By not controlling Vendome Well's artesian flow, it will be difficult to request that others limit the flow of their private artesian wells near CNRA.

Alternative No. 2. Repair or replace the existing well casing and related structure to better control artesian flow from Vendome Well.

Impact No. 1. Reduction of flow may reduce deterioration of pressure in the aquifers, providing the mineral and fresh water springs with some protection. The public relations impact would be minimal.

Impact No. 2. Elimination of flow from the well would provide for maximum pressure protection in the aquifer. Adverse public reaction would be likely. A significant historic site would be drastically altered since the flowing well and resulting stream have been dominant features in the area since the 1920's. Flow through Flower Park would cease, resulting in the displacement of the small fish (Gambusia sp.). There would be a significant aesthetic loss to the area.

Compliance codes: EXCL (CATEGORICAL EXCLUSION)

Explanation: 516 DM6 App. 7.4 C (4)

CHIC-I-003.000
Priority number: 5

PROJECT STATEMENT

RESTORE MINERAL WATER TO BROMIDE PAVILION

Funding Status: Funded: 0.00 Unfunded: 5.00

Servicewide Issues: C13 (Rehab/Restorat)
Cultural Resource Type:
N/A10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. During the early 1970's spring waters were no longer available at Bromide Pavilion. The reason(s) for this change in water availability at Bromide Pavilion is not clear. Assembled information has provided two possibilities. First, flow of these wells was inadequate or ceased altogether. Secondly, water quality concerns occurred over the use of mineral waters for consumption (Myers and Lannom, 1998). Neither of these explanations has been confirmed as of the date of publication of this plan. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, that serve as visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

For years Bromide and Medicine Springs were among the two most important resources to visitors of Platt National Park. The waters of these two springs were thought to have the greatest medicinal values of springs in the area and at one time the bromide water was even prescribed by local physicians. In addition to consumptive and medicinal uses of the water, the springs have an important historical role. Spring discharge, containing sulfur (common to most springs in the area), was piped to the Bromide Pavilion for public use.

Given the importance of Bromide and Medicine Springs, hydrologic and geologic investigation should be carried out to determine whether or not the spring flow can be restored.

DESCRIPTION OF RECOMMENDED PROJECT OR ACTIVITY

The objectives of this project are to restore the flow of spring water to Bromide Pavilion.

- The need for action will be evaluated upon completion of other work described above (see project statements Protection of Water Resources and Rights CHIC-I-002.000 and Vendome Well Control CHIC-I-004.000). These proposed projects may bring about flow restoration from the Bromide and Medicine Springs.

BUDGET AND FTES:

---------- FUNDED ----------

Source	Activity	Type	Budget ($1000s)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	PKBASE-OT	MIT	5.00	0.1
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total	5.00	0.1

ALTERNATIVE ACTIONS/SOLUTIONS AND IMPACTS

Alternative No. 1. No action.

Impact No. 1. Bromide Pavilion would remain as a pavilion that can be used for picnics, but much of its historic value would be lost. The fountains constructed within the pavilion by the CCC would remain dry.

Impact No. 2. Mineral water would not be available for consumption in this area of CNRA. The visual impact of water flowing from the fountains of an historic structure would remain lost.

COMPLIANCE CODE(s): EXCL

EXPLANATION: 516 DM6 App. 7.4 C(4)

CHIC-I-013.000
Priority number:6

PROJECT STATEMENT

HILLSIDE SPRINGS BACTERIAL CONTAMINATION ASSESSMENT

Funding Status:	Funded:	0.00	Unfunded:	30.00
Servicewide Issues:	N12 (Water Flow)		C72 (Protection)	
Cultural Resource Type:	COMB (Combination)			
RMAP Program Codes:	Q00 (Water Resources Mgmt)			
	Q01 (Water Resources Mgmt)			
10-238 Package Number:				

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, raising concern about the area's future.

Hillside Spring has a long history of intermittent bacterial contamination from fecal coliform and fecal strepptococci. Despite this hazard, it is believed that some visitors continue to collect water from the spring for a variety of purposes including consumption. It is this continuing public use of the spring that has created concern on the part of CNRA staff concerning safe use of the water. In the past, CNRA staff have attempted to address water quality problems at other springs such as Medicine and Bromide by installing chlorinating units or ultra-violet light sources; however, no attempt has been made to treat water from Hillside Spring.

In an effort to raise public awareness about water quality problems at Hillside Spring, a warning sign has been posted near the spring's fountain for the last several years. In 1966 CNRA staff requested assistance from the Robert S. Kerr Water Research Center to identify the source of the bacterial contamination at the spring. This investigation determined that during dry periods, bacterial contaminates originated from soils. However during wet periods, defined as situations where rainfall is sufficient to increase spring discharge, there were rapid increases and decreases in total coliform counts (Cumiford, 1968). From this observation it was suggested that contamination was entering Hillside Spring's aquifer in the immediate proximity of the spring. This hypothesis was based upon the high rate at which bacterial densities fluctuated. The assumption is further supported by the fact that the area immediately to the south and west of Hillside Spring slopes toward the spring, allowing runoff to flow naturally in the direction of the spring. It was also hypothesized that this surface runoff was the source of bacterial contamination of Hillside Spring. However, more recent tracer studies conducted to isolate the direction of

runoff from the surrounding landscape were inconclusive. Researchers believed that the cistern and tiles that surround the spring may have influenced these tracer samples.

Description of Recommended Project or Activity

The objectives of this project are to:

- Determine the current level of bacterial contamination at Hillside Spring.
- Conduct a follow up investigation to verify results of the original Kerr study and determine other courses of action that will address the contamination problem.
- Determine the proper sanitation techniques necessary to make the water safe for public consumption.
- Describe historic uses of Hillside Spring.

These objectives will be accomplished by the following:

1. Request technical support from the National Park Service for determining recommended actions needed to solve the Hillside Spring problem.
2. Request technical assistance to provide CNRA staff with training that will sustain long-term monitoring of Hillside Spring.
3. Evaluate all recommendations concerning the spring to ensure that the historic fabric of the structure remains intact.
4. Create a database to facilitate long-term monitoring of the spring.

Literature Cited

Cumiford, Harold F. 1968. "A Study of the Bacterial Contamination of Hillside Spring at Platt National Park." Ada, Oklahoma: U.S. Department of the Interior. Robert S. Kerr Water Research Center. 34 pp.

BUDGET AND FTEs:

----------FUNDED----------

Source	Activity	Type	Budget ($1000s)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000s)	FTE
YEAR 1:	MIT	MON	15.00	0.5
YEAR 2:	MIT	MON	15.00	0.5
YEAR 3:				
YEAR 4:				
		Total:	30.00	1.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action.

Impact No. 1. Hillside Spring will remain unsuitable for public consumption.

Compliance codes: EXCL

Explanation: 516 DM6, App. 7.4 B(6)

CHIC-N-019.000
Priority number: 7

PROJECT STATEMENT

INVENTORY AND PROTECTION OF POND AND WETLAND HABITATS

Funding Status:	Funded:	0.00	Unfunded:	20.00
Servicewide Issues:	N17 (Biodiversity)		N05 (Non-Nat Plants)	
Cultural Resource Type:	N/A			
RMAP Program Codes:	Q00 (Water Resources Mgmt)			
	Q01 (Water Resources Mgmt)			
10-238 Package Number:				

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future.

Presently, CNRA does not have an adequate inventory of wetlands within its boundaries. Although wetlands in CNRA are not extensive, their protection is important to ensure an ecological balance. For example, many migrating birds and other fauna use these areas for feeding and nesting. Another significant concern to CNRA officials is the impact to wetlands caused by the expansion of non-indigenous plant species, defined as those found beyond their natural range including alien and exotic species. Although CNRA does not have an inventory with acreage and wetland types defined, it should be noted that the U.S. Fish & Wildlife Service has developed National Wetlands Inventory (NWI) maps of this area.

Also of concern to NPS officials are about 20 ponds scattered within CNRA's boundaries, almost all of which were created prior to NPS management. Given the fact that no inventory of these ponds is available, a management plan for ponds needs to be developed. At a minimum, the plan should include a description of each pond's location, size, volume, associated wildlife and fisheries habitat, and recreation value. Public safety issues related to water quality, the prevention of accidental injury or death from drowning, and the structural safety of each earthen dam should also be presented in this document.

Description of Recommended Project or Activity

The objectives of this project are to:

- Determine areas that should be maintained and protected as wetland habitats.

- Coordinate efforts to secure water rights protection for pond and wetland features.
- Conduct appropriate monitoring of each wetland to ensure protection.
- Eradicate non-indigenous plant species.
- Inventory and map existing ponds in CNRA, including their location, size, volume, potential wildlife and fisheries habitat, and recreation values.
- Determine public safety and environmental issues associated with the ponds.

These objectives will be accomplished by the following:

1. Inventory the current wetland habitats within CNRA using the regional NWI maps prepared by USFWS.
2. Inventory existing ponds in CNRA, including location, size, volume, and existing and potential wildlife and fisheries habitat, and recreation values.
3. Request technical assistance to determine water rights within the area.
4. Request technical assistance to determine appropriate monitoring techniques.
5. Integrate wetland and pond maps developed by the USGS and USFWS within the CNRA GIS to facilitate improved decision-making concerning wetland areas.
6. Develop a plan for eliminating non-indigenous plant species that disrupt wetland areas.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Type	Budget ($1000s)	FTE
YEAR 1:					
YEAR 2:					
YEAR 3:					
YEAR 4:					
			Total	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000s)	FTE
YEAR 1:	MON	One-time	10.00	0.5
YEAR 2:	MON	One-time	10.00	0.5
YEAR 3:				
YEAR 4:				
		Total	20.00	1.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action

Impact No. 1. The location of all wetlands will remain unknown.

Impact No. 2. Non-indigenous plants will continue to expand into these areas.

Impact No. 3. The wetland areas will remain unprotected.

Compliance codes: EXCL

Explanation: 516 DM6, App. 7.4 E (2)

CHIC-N-015.000
Priority number: 8

PROJECT STATEMENT

FISHERIES MANAGEMENT PLAN

Funding Status:	Funded:	1.00	Unfunded:	20.00

Servicewide Issues: N00 (Fisheries)
Cultural Resource Type: N/A
RMAP Program Codes: OTH (Other)
10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

A Fisheries Management Plan (FMP) is needed to ensure perpetuation of high quality recreational fishing opportunities at CNRA. The entire recreation area is within the Rock Creek watershed, a drainage basin covering approximately 40 square miles. Major surface water resources include the 2,350-acre (at normal conservation pool elevation) Arbuckle Reservoir (Lake of the Arbuckles) and the 67-acre Veterans Lake. Guy Sandy Creek, Buckhorn Creek, Rock Creek and its tributary, Travertine Creek, feed the reservoir. CNRA staff maintain statistical information for recreational use of the lake, including the number of visitors using boats on Lake of the Arbuckles (boater visits) and the total number of boats used. In 1996, 70,140 boater visits and 19,907 boats were recorded. A large percentage of these visitors are attracted to the lake for its fishing opportunities. Many others participate in fishing as an incidental recreational activity along with boating. Principal sport fish found within the recreation area include largemouth (Micropterus salmoides), and spotted (Micropterus punctulatus) bass, crappie (Pomoxis annularis), channel catfish (Ictalurus punctatus), and sunfish (Lepomis cyanellus). CNRA enjoys a mild climate of hot summers and cool winters. Recreational fishing takes place on the larger

CNRA waters virtually every day of year, with the exception of a few extremely cold days during the winter months.
CNRA fisheries consist of both natural and altered ecological aquatic habitats, with both native and non-native species. Game and non-game species have been maintained over the years through stocking efforts of the Oklahoma Department of Wildlife Conservation. The FMP should address long range planning and implementation of integrated, interagency cooperative management efforts related to fisheries at CNRA. The scope of this plan would cover aquatic resources within the National Recreation Area as related to fish.

Description of Recommended Project or Activity

The objective of this project is to create a *Fisheries Management Plan* (FMP) that identifies long-range goals, management objectives, and information needs related to fishery management at CNRA. The plan would also include a list of annual research priorities, specific tasks, staffing, and budgetary requirements.

- The FMP would serve as a supplement-planning document to the CNRA's *General Management Plan* (GMP), *Resource Management Plan* (RMP), and *Water Resources Management Plan* (WRMP). Specific actions developed in the FMP will be fully consistent with those in the GMP, RMP, and WRMP. Tasks identified in the FMP will be developed into project statements for the CNRA's RMP.

Preliminary issues to be addressed in the FMP include, but are not limited too:

1. Determine the relationship between CNRA's enabling legislation and the FMP.
2. Determine whether or not NPS fishery management objectives are in conflict with state programs and regulations now being implemented at CNRA. These policies and guidelines address issues such as fish stocking, exotic species management, restoration of native species, habitat manipulation, public access, and public use.
3. Provide an overview of the physical and biological environment at CNRA including an overview of the climate, geology, soils, vegetation, water resources, wildlife, and other resources affected by, or influencing the abundance and distribution of fishery resources at CNRA.
4. Provide an overview of the role of fish in CNRA's ecosystem, focusing on elements relevant to the fishery resource and its management.
5. Identify the status and condition of fisheries resources in CNRA, including but not limited to the following items: a) an inventory of species; b) a summary of species composition; c) the identification of non-native or exotic fish species; d) the identification of sport fisheries; e) a summary of the reel census and angler use data; f) a summary of biological information on age-growth, age class distributions, or fisheries indices for major sport species subject to harvest regulations; and g) a description of habitat limitations or threats affecting fisheries management, including issues related to water quality and quantity.
6. Develop a history of fisheries management at CNRA, describing existing cooperative management agreements, and identifying management actions of other agencies that present potential conflicts with NPS management policies at CNRA.
7. Provide a regulatory history of recreational fishing activities at CNRA and summarize past stocking activities.
8. Summarize past projects to restore and preserve fish species.
9. Summarize information available on public use of the CNRA fishery resources, including water dependent recreation such as boating, personal watercraft usage, and canoeing.

10. Provide direction concerning: a) how to preserve CNRA native species, habitats, and ecological processes where aquatic habitats remain intact (e.g., CNRA streams); b) methods for managing reservoirs, lakes, and ponds to eradicate exotic and non-native species through stocking and habitat manipulations; c) better fishery management of both natural systems and altered ecological systems with consideration as to the synergy of the two systems within CNRA water resources.
11. Provide a comprehensive strategy for addressing fishery issues at CNRA. It is envisioned that this would be a contracted 12-15 month project.
12. Identify cooperative efforts needed between the NPS and the Oklahoma Department of Wildlife Conservation to produce an effective FMP. Fisheries management is typically a sensitive issue between the state and NPS. Therefore, it will be essential for close cooperation between state and federal agencies.

BUDGET AND FTES:

---------- FUNDED ----------

	Source	Activity	Type	Budget ($1000s)	FTE
1997:	PKEASE-NR PRO		Recurring	1.00	0.1
			Total:	1.00	0.1

---------- UNFUNDED ----------

	Activity	Type	Budget ($1000s)	FTE
Year 1:	RES	One-time	20.00	0.5
		Total:	20.00	0.5

(Optional) Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action. CNRA staff would continue to manage fishery resources without the benefit of a long range and coordinated interagency plan. Considering the complex nature of fishery resources that are subject to regulated consumptive use, fishery resources could experience degradation without a FMP.

Alternative No. 2. Implement Recommended Project. The National Park Service would be able to pursue a directed fishery resources management program that is coordinated with interagency resources. Such planning would enhance the long-term protection and management of CNRA fishery resources.

Compliance codes: EXCL (CATEGORICAL EXCLUSION)

Explanation: 516 DM6 APP. 7.4 B

CHIC-N-011.000
Priority Number: 9

PROJECT STATEMENT

OIL SEEP MONITORING ASSISTANCE

Funding Status:	Funded:	0.00	Unfunded:	20.00

Servicewide Issues: N10 (Miner/Geotherm) N16 (Near-Park Dev)
Cultural Resource Type: N/A
RMAP Program: H00 (Pest and Hazard Mgmt) H02 (Hazardous Waste Mgmt)
10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

A small area of Rock Creek has several oil seeps along the shoreline and within the creek bottom. While it appears that these seeps are natural, there is a possibility that they are a remnant of past oil exploration activity located on nearby private land. Seeps particularly close to the shore or under water release oil slowly into the creek leaving a non-iridescent film visible about 1/4 mile down stream and iridescence substance visible about 1/8 mile down stream. During periods of heavy rain the oil is washed down the creek and into the Rock Creek arm of the Lake of the Arbuckles. In the past there have been occasional complaints from lake users whose boats have been stained by oil. Investigations conducted at such times have identified oil globules on the water surface, as well as a coating on shoreline objects.

DESCRIPTION OF RECOMMENDED PROJECT OR ACTIVITY

The objectives of this project are:

- Determine whether the oil seeps in Rock Creek are natural, or possibly coming from past activities on adjacent private lands.

- Determine if the amount of oil from the seeps is a hazard to the CNRA's water resources and, if so, how to mitigate the problem.
- Determine what action can be taken to remove privately owned regulated storage tanks in the area that have been shown to be potentially hazardous.

These objectives will be accomplished by the following:

1. Request technical assistance from the Water Resources Division and the Geologic Resources Division to investigate oil seepage.
2. Sample oil and conduct a Toxicity Characteristic Leaching Procedure (TCLP) analyses to provide an initial chemical characterization of the oil substance.
3. Inventory registered regulated storage tank (RST) files at the Oklahoma Corporation Commission-Fuel Division (405-521-3107) to identify RST installations, closures, and reported leaking underground storage tanks (LUSTs) within the watershed of Rock Creek. Conduct a "radius search" of current regulated sites (RST, Superfund, etc.) in the area that may contribute to contamination problems at CNRA. Conduct a historical title search to identify any potential historical activities that may have contributed to contamination problems within the Rock Creek watershed.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Type	Budget ($1000)	FTE
YEAR 1:					
YEAR 2:					
YEAR 3:					
YEAR 4:					
			Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	ENTER-MIN	MON	10.00	0.3
	WATER-RES	MON	10.00	0.3
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	20.00	0.6

ALTERNATIVE ACTIONS/SOLUTIONS AND IMPACTS:

Alternative No. 1. No action.

Impact No. 1. The probable impacts from the oil seeps will not be known. Possible damage to CNRA's water resources could occur unabated.

Impact No. 2. The potential of a major spill of brine and/or oil from storage tanks will continue to be present.

COMPLIANCE CODE(s): EXCL

EXPLANATION: 516 DM2 App. 7.4, 3(6)

CHIC-I-015.000
Priority number:10

PROJECT STATEMENT

PREPARE HAZARDOUS SUBSTANCE AND SPILL CONTINGENCY PLAN

Funding Status:	Funded:	0.00	Unfunded:	40.00
Servicewide Issues:	N11 (Water Qual-Ext) N16 (Near-Park Dev)			
Cultural Resource Type:	N/A			
RMAP Program Codes:	H00 E00			
10-238 Package Number:				

PROBLEM STATEMENT

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A number of major transportation routes can be found within or adjacent to CNRA. Located on the northeastern portion of CNRA, the Platt District is bisected by two U.S. highways (177 and 7) that are heavily traveled by motorists and large trucks. In addition, railroad tracks run just to the north of this area. Trucks and rail cars carry fuel oil, diesel fuel, gasoline, and a variety of agricultural and industrial chemicals along these corridors. Both the type and quantity of material transported along these arteries are sufficient to cause serious water quality problems within CNRA if spills were to occur near Rock or Travertine Creeks, or adjacent to Veterans Lake or Lake of the Arbuckles.

In addition to road and rail traffic, CNRA is located directly adjacent to the City of Sulphur and numerous agricultural fields, oil fields, and storage areas for materials associated with agricultural and industrial operations. Rock Creek, the principal surface stream within the

watershed, drains this entire area. A major break in an oil pipeline or sewage line could result in contamination within the Platt District, similar to a sewage line break that occurred in the late 1970's.

Sources of contamination from hazardous material in CNRA fall into three general categories: 1) those associated with commercial traffic, 2) those associated with oil fields, oil pipelines, sewage lines, and stores of hazardous material outside CNRA boundaries, and 3) those associated with gasoline supplies sold to visitors near CNRA. A major oil or hazardous material spill in the vicinity of CNRA could have serious consequences for streams, lakes, and aquifers, and possibly disrupt the level and type of recreational opportunities available within the area (e.g. boating, fishing, swimming, and wading). Most important, a large spill could cause permanent damage to the springs and surrounding environment.

CNRA currently follows spill guidelines provided by the NPS. If a spill occurs, CNRA management will contact the EPA, Hazardous Material Management (NPS in Santa Fe), and independent contractors in nearby towns. However, due to the clear and present risk to recreational and cultural values of CNRA, it is essential that the CNRA develop its own Spill Contingency Plan (SCP) outlining Standard Operation Procedures (SOPs) that detail actions to be undertaken from the time a spill is discovered to when appropriate spill response authorities arrive on the scene. In addition, the SCP should identify spill equipment, response activities, and training requirements to address smaller spills (i.e., fuel, sewage, etc.). Without a Spill Contingency Plan, CNRA is not in compliance with the 1990 Oil Pollution Act, which establishes new requirements for oil spill response and natural resource damage assessment.

Description of Recommended Project or Activity

The development of a Spill Contingency Plan (SCP) would begin with a review of all spills that have affected CNRA in the past, and an evaluation of actions undertaken in response to those spills. In addition, all applicable regional or local Hazardous Materials Spill Contingency Plans, and response action Standard Operation Procedures (SOPs), will be acquired and reviewed.

The objectives of this project are as follows:

- CNRA staff will develop a contingency plan for dealing with spills of hazardous materials that can be followed in time of emergency.
- Materials to be addressed include petroleum products, raw sewage, and agricultural chemicals.
- CNRA will, if appropriate, provide a storage facility for spill mitigation materials.

These objectives will be accomplished by formulating a plan that CNRA personnel can execute should a hazardous spill occur. This plan will be developed in coordination with municipalities and other land management agencies in the region and with the NPS Hazardous Material Office. Specific actions to accomplish these objectives include the following:

1. The level and nature of staff involvement with hazardous material management will be determined. Strict training (with annual refreshers), safety equipment, and hazardous material containment systems (i.e., booms, DOT approved storage drums, etc.) may be required to meet CNRA hazardous material response needs. In some situations it may be

more cost effective to contract with a local emergency spill response consultant. A spill response typically requires the completion of the following 10 steps:

a. keep all personnel away from the spill and avoid direct contact with the spilled material,
b. identify the material spilled as soon as possible
c. contact the National Response Center and obtain assistance
d. seal off the area and alert others of possible dangers
e. look for injured persons, including taking time to examine oneself
f. take time to identify existing and potential hazards
g. with the qualified responders, prepare a plan of action
h. obtain the proper equipment and materials
i. with qualified personnel using the proper equipment and materials, contain the spill
j. clean up the spill according to the directions on the Material Safety Data Sheet(s).

2. Coordination with Oklahoma Department of Transportation, local highway department, Federal Highway Administration, Oklahoma Highway Patrol, EPA, Oklahoma Department of Environmental Quality, FEMA, and other entities that will be identified during the planning process.
3. CNRA will conduct safety meetings and preparedness drills annually after the plan is in place.
4. A local SCP will be prepared providing SOPs with detailed actions that should be undertaken by CNRA staff upon the discovery of a spill. These SOPs will outline response procedures for small spills that can be addressed locally, and identify notification and response procedures for larger spills that will require immediate additional assistance. In addition, the SCP will provide information relating to necessary spill response equipment and training needs for potential spill response personnel.
5. CNRA staff will review inventory needs in order to delineate high value and particularly spill-sensitive natural resources and develop a mechanism to provide resource-specific information and advice to the Department of the Interior (DOI) Regional Response Team representative in the event of a major spill.
6. CNRA will store important spill mitigation supplies within the CNRA boundaries, if appropriate.

BUDGET AND FTEs:

----------FUNDED----------

Source	Activity	Type	Budget ($1000s)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000s)	FTE
YEAR 1:	MIT	One-time	40.00	1.0
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	40.00	1.0

Alternative Actions/Solutions and Impacts

Alternative No.1. No action. CNRA will continue to operate without a plan to handle spills of hazardous material. Natural and cultural resources of CNRA, along with visitors and NPS staff, will be at risk should a major spill occur. CNRA will rely on whatever response is available from the local and regional communities to address a spill and will not be in compliance with NPS requirements for contingency planning for incidents involving hazardous materials nor will it meet provisions of the Oil Pollution Act of 1990.

Compliance codes: EXCL

Explanation: 516 DM2 App 7.4 B(5)

CHIC-I-016.000
Priority number:11

PROJECT STATEMENT

INVENTORY EXTERNAL LAND USES

Funding Status:	Funded:	0.00	Unfunded:	40.00
Servicewide Issues:	N11 (Water Qual-Ext)		N20 (Baseline Data)	
Cultural Resource Type:	C70 (Environmental Impact)		C73 (Adjacent Land Use)	
RMAP Program Codes:	C03 (GIS/Data Management)			
	Q01 (Water Resource Management)			
10-238 Package Number:				

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future.

Nearby land uses can potentially affect the quality and volume of water entering CNRA. Flow from Rock, Guy Sandy, and Travertine Creeks provide a conduit for external flows into CNRA. CNRA does not have a complete inventory of the land uses outside its boundaries that could potentially impact the area's water resources. The principal external land uses adjacent to CNRA are urban (City of Sulphur) and agricultural.

An inventory of external land uses would provide a baseline for monitoring trends, making it possible to identify new sources of impacts to water quality and flows, and allowing CNRA to become a more effective participant in regional planning. Currently, the most updated inventory of adjacent land uses is found in Streebin and Harp's (1977) Water Quality Study, and the U.S. Department of Agriculture's 1978 map "Important Farm Lands in Murray County." One of the principal external threats to the quality and/or quantity of waters within CNRA's watershed is the proposed expansion of agricultural (i.e., dairy and poultry) and municipal (drilling of new wells) activities adjacent to CNRA.

Description of Recommended Project or Activity

The objectives of this project are to:

- Develop a detailed inventory from internal and external sources to identify land uses within the CNRA watershed. The inventory would include the approximate area and influence of land uses on CNRA's water resources. The primary objectives are to: 1) provide a more

comprehensive database of external land uses that will allow CNRA to identify potential impacts before resource damage occurs, 2) monitor land use trends, and 3) to effectively use regional planning to protect CNRA water resources. Data gathered will be used in conjunction with water quality and flow data to assess the health of CNRA's water resources and to evaluate CNRA's water quality monitoring program (see project statements Water Quality Monitoring CHIC-N-002.000 and Water Quality Monitoring CHIC-N-003.000).

This project will accomplish its objectives as follows:

1. Identify land uses within CNRA's watershed (Rock Creek) utilizing external and internal sources, such as county land status maps and satellite imagery. In addition, historic external land uses will be examined to better define trends and/or correlations between land uses and associated impacts to CNRA's water resources, if any.
2. Define the immediate areas of influence for each these respective land uses. Potential influences from external land uses include:

    - Increases in nutrient and/or heavy metal concentrations from waters entering the north and western portion (Platt District) of CNRA and around Lake of the Arbuckles
    - Increases in fecal coliform levels due to the out-of-date municipal sewage system
    - Decreases in spring flow due to accelerated vegetation growth, e.g. massive and accelerated growth of eastern red cedars with their increased evapotranspiration, could possibly be affecting infiltration (and recharge) to the aquifer.

    Site specific water quality and/or quantity studies would be necessary to define the horizontal extent of influences from various land uses. Field data and/or photogrammetry will be necessary to define the areas of influence for some of the land uses (i.e., agricultural land uses). It will be important for CNRA to incorporate external monitoring sources (i.e., USGS, Arbuckle Master Conservancy District, Sulphur City Manager, Bureau of Reclamation etc.) to effectively evaluate areas of influence.

3. Capture these boundaries and input the data into CNRA's geographic information system database (GIS).
4. Include associated water quality, flows and stage data in the database for the respective land uses, if available.
5. Prepare a report summarizing the status of land uses, trends, and potential and documented impacts to CNRA.

Support needed to accomplish this project includes the hiring of a base-funded GS-9 scientist for two years (.2 FTE/year) during the initial project work. This temporary FTE would be complemented by CNRA's existing staff to provide the necessary support to accomplish project objectives. Management of CNRA is committed to the necessary efforts for this project. As stated previously, additional support from external sources (i.e., USGS, Sulphur City Manager, etc.) will be pursued to produce the most cost-effective approach to the project.

Cited Literature

Streebin, L.E. and J.F. Harp 1977. *Water Quality Management Study for the Chickasaw National Recreation Area.* Norman, Oklahoma. University of Oklahoma.

U.S. Department of Agriculture. 1978. *Important Farmlands Map, Murray County, Oklahoma (Soils and land use).* Fort Worth, Texas.

BUDGET AND FTEs:

----------FUNDED----------

	Source	Activity	Type	Budget ($1000s)	FTE
YEAR 1:					
YEAR 2:					
YEAR 3:					
YEAR 4:					
			Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000)	FTE
YEAR 1:	MON	One-time	20.00	1.0
YEAR 2:	MON	One-time	20.00	1.0
YEAR 3:				
YEAR 4:				
		Total:	40.00	2.0

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action. This alternative will limit efforts to evaluate external land uses that influence CNRA's water resources. The defined external land use boundaries will be limited to the existing, and often dated, land use maps and databases.

Compliance codes: EXCL

Explanation: 516 DM2 App. 1.6

CHIC-I-014.000
Priority number: 12

PROJECT STATEMENT

INVESTIGATE MECHANICS OF AQUIFER FLOW SYSTEM

Funding Status:	Funded:	0.00	Unfunded:	40.00

Servicewide Issues: N20 (Baseline data)
N11 (Water Qual-Ext)
Cultural Resource Type: C35 (Historic Resource Study)
RMAP Program Codes: Q00 (Water Resources Mgmt)
Q01 (Water Resources Mgmt)

10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902 and was redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one of three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future. Fluctuations in spring water flow have occurred traditionally throughout CNRA's history. However, two of the most popular mineral springs, Bromide and Medicine Springs, ceased flowing in the early 1970's. Remaining mineral springs, especially Black Sulphur and Pavilion Springs, continue to provide water to a large number of CNRA visitors. Two major freshwater springs Antelope and Buffalo, provide the water source for Travertine Creek, which flows into Rock Creek, both of which are primary visitor attractions. Since establishment of CNRA, these two springs have stopped flowing during extensive drought periods for several months at a time. During drought periods such as occurred in 1920-22, 1950-56, 1961-66, and 1975-81 CNRA visitation dropped dramatically.

Despite the importance of groundwater flow to CNRA, basic information about shallow and deep aquifers in the area is minimal at best. While there is a conceptual understanding of the groundwater system, more data is needed to predict system responses to various circumstances. Most importantly, continued artesian discharge and the potential for new well drilling adjacent to CNRA, have raised concerns about water quality and quantity within CNRA.

There are two major aquifer systems underlying CNRA, the mineralized Simpson Aquifer and the freshwater Arbuckle Aquifer. The Simpson Aquifer is comprised of sandstone, limestone, and shale and is widely exposed over large areas to the southeast of CNRA. Comprised of dolomitic limestone, the Arbuckle Aquifer is widely exposed to the southeast and northeast of

CNRA (Hanson, 1994). Based on past studies, the Arbuckle Aquifer is thought to be between 500 and 700 ft above sea level and the Simpson Aquifer is thought to be between 100 and 400 ft above sea level (Dunn, 1953). It is believed that none of the mineral wells in the area are cased or sealed to prevent mixing of fresh and mineral waters. Apparently few, if any, of the well casings that are producing mineral water extend to depths of more than 300 ft below the land surface or 700 ft above sea level (Hanson and Cates, 1994).

Understanding fluctuations in groundwater level and their relationships to surface flow are extremely important in assessing local flow characteristics. Aquifer tests will provide the information necessary to better understand these hydrologic characteristics including transmissivity, permeability, evapotranspiration, recharge, and water quality. These data aid in the development of hydrologic models that describe water flow. Equally important, CNRA staff need better information concerning production rates, both historic and current. While there are many free flowing artesian wells in and around CNRA's boundaries, CNRA staff have limited information concerning domestic or commercial withdrawal rates. Data needed to support management decisions requires an intensive study of domestic and commercial groundwater withdrawals, and CNRA spring and artesian flows. Ultimately, new information will facilitate the creation of a water budget and will provide CNRA staff with insight into fluctuations in groundwater elevations.

In addition to information concerning water quantity, a review of hydrochemical data corresponding to spring and artesian flow needs to be completed. The most currently available data, collected in 1993 by the EPA, may not be adequate.

Description of Recommended Project or Activity

The objectives of this project are to:

- Develop an increased understanding of the status and characteristics of the Simpson and Arbuckle Aquifers within CNRA.
- Improve the ability of CNRA staff to assess impacts associated with groundwater pumping and artesian flows and predict the impacts of new pumping or of new wells drilled in the region.

These objectives will be accomplished by assisting USGS and resource management personnel in establishing a groundwater-monitoring network within CNRA's watersheds. Specific actions to accomplish these objectives include the following:

1. Obtain existing (historical) groundwater monitoring data from various external sources. The groundwater data should not be restricted to CNRA's boundaries but should include the area's entire watershed.
2. Prepare appropriate geologic and groundwater data (i.e., rock type, transmissivity, storativity, water quality, etc.) within a compatible database format for CNRA's hydrology program.
3. Commission additional surface geologic mapping and subsurface geologic studies to better define the geologic character and structure of the Arbuckle and Simpson Aquifers within CNRA boundaries and surrounding areas. These efforts may include test well drilling, gravity investigations, and seismic surveys.
4. Establish a precipitation-monitoring network to allow accurate computation of the amount of recharge to the aquifers.

5. Develop a new groundwater monitoring program. The data obtained would facilitate an evaluation of the rate at which water levels in the aquifers have been declining and would improve our understanding of groundwater flow; thereby contributing to a better understanding of recharge rates and rainfall influences.
6. Initiate a program to age date and dye trace groundwater. Age dating and dye tracing would provide an understanding of the travel time of groundwater flow and contribute toward a better understanding of the recharge rates, flow direction, and precipitation influences. In combination with water quality data, models of groundwater movements near the Sulphur Fault could be created to reveal spring flow mixing.
7. Compile data and evaluate potential legal situations pertaining to water rights that may arise later (see project statement entitled Protection of Water Resources and Rights CHIC-I-002.000).
8. Close wells in situations where it is not possible to control artesian flow and develop water conservation schedules for wells that can be controlled.

Literature Cited

Dunn, A. van V., 1953. *The Water Supply Problem.* Platt National Park. National Park Service Report.

Hanson, R. L. and Cates, S. W. 1994. *Hydrogeology of Chickasaw National Recreation Area, Murray Count,. Oklahoma.* USGS Water-Resources Investigations Report 94-4102. Oklahoma City, Oklahoma. 86 pp.

BUDGET AND FTEs:

----------FUNDED----------

Source	Activity	Type	Budget ($1000's)	FTE
YEAR 1:				
YEAR 2:				
YEAR 3:				
YEAR 4:				
		Total:	0.00	0.0

----------UNFUNDED----------

	Activity	Type	Budget ($1000's)	FTE
YEAR 1:	MON	Recurring	10.00	0.3
YEAR 2:	MON	Recurring	10.00	0.3
YEAR 3:	MON	Recurring	10.00	0.3
YEAR 4:	MON	Recurring	10.00	0.3
		Total:	40.00	1.2

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action.

Compliance codes: EXCL (Categorical Exclusion)

Explanation: 516 DM6 App. 7.4 E(2)

CHIC-I-017.000
Priority number:13

PROJECT STATEMENT

COORDINATION AND COOPERATIVE MANAGEMENT

Servicewide Issues: N20 (Baseline Data)
Cultural Resource Type: N/A
RMAP Program Codes:
10-238 Package Number:

PROBLEM STATEMENT

Chickasaw National Recreation Area (CNRA) was originally established as Sulphur Springs Reservation in 1902, and redesignated as Platt National Park in 1906 to preserve unique naturally occurring mineral and freshwater springs. As such, it is one of only two units in the NPS System set aside to protect natural springs (along with Hot Springs National Park). CNRA is even more unique in that it is the only National Park Preservation ceded by Native American Indians to the United States government; a request made by those tribal units for the express purpose of protecting the natural springs. Established prior to the creation of the National Park Service in 1916, CNRA is one three NPS areas in the state of Oklahoma. Of the 33 springs that CNRA was originally established to preserve, only 19 are known to be flowing, at least seasonally. Threats to the remaining springs from development and water use in and around CNRA continue, which raise concern for the area's future.

Description of Recommended Project or Activity

To provide better management of water resources, CNRA staff would establish a cooperative network for management. CNRA receives financial and technical assistance from a wide range of federal, state, and local agencies and other organizations. Since issues that affect park resources must often be addressed by decision-makers representing a diversity of resource protection strategies, cooperative management could help to develop alliances for solving common problems. The following are examples of issues that would benefit from a cooperative approach to management:

1. The absence of county-wide solid waste pickup has led to some residents using streambeds as dumpsites. This unauthorized disposal of domestic wastes poses a severe threat to streams and lakes at CNRA. In some cases refuse and hazardous materials have entered streams and the Lake of the Arbuckles. CNRA is considering management actions such as: 1) surveying tributaries to identify illegal disposal sites, 2) analyzing water below disposal sites to identify toxic materials and sites, 3) working with the county to establish county-wide solid waste pick-up locations, and 4) working with the county sheriff's department to stop illegal disposal.

2. The location of abandoned and/or inactive regulated storage tanks (RSTs) within CNRA's watershed is currently unknown. These tanks pose a threat of contamination to both surface and groundwater resources. State and federal requirements for proper RST registration and closure are specific. RST's that do not meet the current state and federal regulations should to be upgraded or closed by the responsible party. These efforts should be coordinated with the Oklahoma Corporation Commission's Fuel Division.

3. The Chickasaw Nation is interested in the development of tourism opportunities within CNRA as a means of assisting in the economic development of the region and helping to preserve the cultural value of the region through public education. Some possibilities for expanding facilities used for tourism include the construction of a visitor center and marina on Lake of the Arbuckles. The cooperation of CNRA staff and representatives of the Chickasaw Nation will help to identify potential impacts to CNRA water resources as development plans proceed. Impacts that should be examined include the increased use of motorized watercraft on Lake of the Arbuckles and sewage treatment needs associated with construction of the proposed visitor center.

4. Although the City of Sulphur has improved their sewage treatment, there is still the possibility of leakage from sewer lines. In addition, many older houses in Sulphur do not have gray water lines attached to their sewage systems and homeowners sometimes discharge wastes improperly. The Chickasaw Nation is particularly concerned about this issue and has encouraged members of the Nation to seek assistance for upgrading gray water sewage lines from the Indian Health Service and Office of Environmental Health.

The objectives of this project are to:

- Maximize the use of cooperative relationships with agencies including the Arbuckle Master Conservancy District, Ardmore Public Works, USGS, City of Sulphur, Goddard Youth Camp, BOR, Chickasaw Nation, ODEQ, USACE, and other entities to address common issues and problems tied to water resources. In addition, CNRA staff will seek to utilize these relationships to contribute substantively to ecosystem restoration efforts and regional water management objectives.
- Protect both the quantity and quality of waters contributed by CNRA's watershed and adjacent private and public lands. The issues addressed in this project could be accomplished with existing CNRA resources.

Alternative Actions/Solutions and Impacts

Alternative No. 1. No Action. Management at CNRA will remain the same as the current approaches with limited formal or informal cooperation among agencies and organizations.

BUDGET AND FTEs:

	Source	Activity	Type	Budget ($1000)	FTE
			FUNDED		
YEAR 1:	PKBASE-NR		MON		0.1
YEAR 2:	PKBASE-NR		MON		0.1
YEAR 3:	PKBASE-NR		MON		0.1
YEAR 4:	PKBASE-NR		MON		0.1
Total:				0.00	0.4

Appendix B.

Summaries of Legislation and Executive Orders

Federal Legislation and Executive Orders

Water Quality Improvement Act 1970

Requires federally regulated activities to have state certification that they will not violate standards for water quality.

Safe Drinking Water Act of 1974 & Amendments 1985

This applies to public drinking water and requires water quality monitoring and, if necessary, treatment to assure public protection. This act sets national minimum water quality standards and requires regular testing of drinking water for developed public drinking water supplies.

Migratory Bird Treaty Act of 1918

The original 1918 statute implemented a 1916 Convention between the U.S. and Great Britain (for Canada) for the protection of migratory birds. The Act established a federal prohibition, unless permitted by regulations, to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of Convention... for the protection of migratory birds...or any part, nest, or egg of any such bird" (16 U.S.C. 703). This prohibition applies to birds included in the respective international conventions between the U.S. and Great Britain, the U.S. and Mexico, the U.S. and Japan, and the U.S. and the former Soviet Union.

Migratory Bird Conservation Act of 1929

Established a Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with Migratory Bird Conservation Funds. The Secretary of the Interior is authorized to cooperate with local authorities in wildlife conservation and to conduct investigations, to publish documents related to North American birds, and to maintain and develop refuges. The Act also provides for cooperation with states in enforcement. It established procedures for acquisition by purchase, rental or gift of areas approved by the Commission for migratory birds. The Act also includes acquisition authority for the purchase or rental of partial interest in land or waters.

Federal Aid In Sport Fish Restoration Act of 1950 as amended
Commonly known as the Wallop-Breaux Fund.

Provides federal aid to the states for management and restoration of fish having "...material value in connection with sport or recreation in the marine and/or freshwaters of the United States." Federal assistance for the development of comprehensive fish and wildlife resource management plans is also provided for under PL 91-53 (84 Stat. 1101) approved Oct. 1970.

Federal Aid In Wildlife Restoration Act of 1937

The Federal Aid in this act authorizes a grant program with State Fish and Wildlife agencies for restoration of wild birds and mammals and to acquire, develop and manage their habitats, for the education of hunters, and development and management of shooting ranges. An amendment in 1988 requires the U.S. Fish and Wildlife Service to monitor and assess migratory nongame birds, determine the effects of environmental changes and human activities, identify those likely to be candidates for endangered species listing, and identify appropriate actions.

Fish and Wildlife Improvement Act of 1978

Authorizes the Secretaries of the Interior and Commerce to establish, conduct, and assist with national training programs for state fish and wildlife law enforcement personnel. It also authorized funding for research and development of new or improved methods to support fish and wildlife law enforcement.

Fish and Wildlife Conservation Act of 1980 - "Nongame Act"

Provides grants for the development and implementation of comprehensive state nongame fish and wildlife plans and for administration of the Act. It also required the U.S. Fish and Wildlife Service to study potential mechanisms for funding these activities.

National Fish and Wildlife Foundation Establishment Act of 1984

Established the National Fish and Wildlife Foundation as a federally chartered charitable, non-profit corporation to administer the donation of real or personal property or interests in connection with U.S. Fish and Wildlife Service programs and conservation activities in the United States.

Environmental Education Act of 1990

Established the Office of Environmental Education within the Environmental Protection Agency. Among its responsibilities are the development and support of training programs and environmental education seminars, managing a federal grant program, and administering an environmental internship and fellowship program.

Water Rights Act (McCarran Amendment) of 1952

Waives the sovereign immunity of the United States where there is a suit designed to establish the rights to a river or other source of water, or the administration of such rights, and the United States appears to own or be in the process of acquiring rights to any such water. The effect is to permit state courts to adjudicate federal water rights claims under state law.

Watershed Protection and Flood Prevention (Small Watershed Program; PL-566 Program)

Provides technical and financial assistance to state agencies and units of local government in planning and carrying out works of improvement and to protect, develop, and utilize the land and water resources in small watersheds not exceeding 250,000 acres, including total resource management and planning to improve water quality and solve problems caused by flooding, erosion and sediment damage, conservation, development, utilization, and disposal of water.

Executive Order 11980 of 1977

Recognizes the national need to preserve wetlands and to protect the unique plants and animals indigenous to such areas. It requires the NPS and all other federal agencies to avoid impact or modification of wetlands where feasible.

Executive Order 11990 – Protection of Wetlands

Requires all federal agencies to "...minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands" (Goldfarb, 1988). Unless no practical alternatives exist, federal agencies must avoid activities in wetlands, which have the potential for adversely affecting the integrity of the ecosystem. NPS guidance for compliance with Executive Order 11990 can be found Floodplain Management and Wetland Protection Guidelines, published in the Federal Register (45 FR 35916, Section 9). The Wetland Regulatory Compliance: A Guidance Manual for the NPS Mid-Atlantic Region (NPS, 1989) should also be consulted for issues pertaining to wetlands.

Wetlands Reserve Program

The objective of this program is to restore and protect farmed wetlands or converted wetlands and eligible adjacent lands of landowners that have eligible land on which they agree to enter into a permanent or long-term easement with the Secretary of the Interior. The landowner receives financial assistance from Agricultural Stabilization and Conservation Service and technical assistance from the Natural Resource Conservation Service (NRCS) to plan and install necessary restoration practices on the land under the easement. NRCS then develops a Conservation Plan of Operations with the landowner.

Federal Law Enforcement Authorities Protecting Parks from Mineral Development

Resource Conservation and Recovery Act (RCRA) of 1976

Regulates the treatment, transportation, storage, and disposal of solid and hazardous wastes. Section C requires reporting of hazardous wastes, permitting for storage, transport, and disposal, and it includes provisions for oil recycling and federal hazardous water facilities inventories. Section D addresses management of solid waste, including landfills. Section G addresses citizen suits, judicial review, and enforcement authority. Section I address management, replacement, and monitoring of underground storage tanks.

Oil Pollution Act of 1990

Established new requirements and extensively amended the Federal Water Pollution Control Act to provide enhanced capabilities for oil spill response and natural resource damage assessment by the U.S. Fish and Wildlife Service.

State Legislation and Regulations

Oklahoma Water Pollution Control Laws 1963 – 1992

The state of Oklahoma developed these laws to address public health issues concerning direct physical contact with and drinking of the states water resources. General administration guidelines and sewage water regulations are also addressed in these laws. Oklahoma Pollution Remedies Law, Oklahoma Water Pollution Control Regulations, and Oklahoma Pollution Remedies Regulations These laws address water rights, pollution control, and they provide remedies for pollution of all the water and water bodies within the state of Oklahoma.

Oklahoma Pollution Control Coordinating Act of 1968

This Act address waters and water rights. It also states policy and regulation of pollution of water in the state.

Oklahoma Groundwater Act

This Act address water rights related to groundwater, and also address state laws and regulations governing groundwater use and withdrawal.

Oklahoma Underground Injection Control Rules

This legislation establishes laws that govern non-hazardous injection wells. It also addresses public health issues that arise during such practices.

Oklahoma Drinking Water Regulations

The State Department of Health is the authoritative body regulating the state's drinking standards. In this Act public water supply regulations are stated and enforced.

Oklahoma Water Quality Standards of 1977 - 1992 and Oklahoma Groundwater Quality Standards

The Oklahoma Water Resources Board advises and administers these standards, and chapter 45 lists and addresses all of the Water Quality Standards for the state of Oklahoma.

Appendix C.

Water Resources Issue Scoping Workshop, 1996

The following individuals provided valuable input into the planning process through their participation in a Water Resource Issue Scoping Workshop held at Chickasaw National Recreation Area on December 10 and 11, 1996.

PARTICIPANT	REPRESENTING
Jack C. Anderson	Arbuckle Master Conservancy District
James Anthony	Ardmore Public Works
Bob Blazs	USGS Water Resources Division
Tonia Brown	Oklahoma State University
Paul Christensen	National Park Service
Charlie Clark	Sulphur City Manager
Wayne Edgar	Goddard Youth Camp
Leon Esparza	Bureau of Reclamation
John Hilton	Chickasaw Nation
David Kennedy	Ardmore Public Works
Lou Klaver	Oklahoma Water Resources Board
Gary Laxton	CNRA (Water Treatment Plant Operator)
Elaine Lynch	Oklahoma State University
Cal Myers	CNRA (Facility Manager)
Mike Nicholl	Oklahoma State University
Ron Parker	CNRA (Resource Management Specialist)
Diana Perfect	National Park Service
Ken Ruhnke	CNRA (Landscape Architect)
David Sharrow	NPS Water Resources Division
Tom Taylor	Unaffiliated (U.S. National Park Service Retired)
Wanetta Thompson	Ardmore Public Works
Robert Turner	Ardmore Public Works
John Welch	CNRA (Superintendent)
Thomas Wikle	Oklahoma State University
Chris Wisneiewski	Oklahoma Department of Environmental Quality
Don Wollenhaupt	CNRA (Chief of Interpretation)

Appendix D.

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