3. Affected Environment

This section is a description of the environment in which the Proposed Action would take place. Each aspect of the environment that would be affected by the Proposed Action is discussed to the level of detail commensurate with the potential for environmental impact. Additional data specific to the phases of development are included when relevant and available. Those aspects of the environment that would not be affected by the Proposed Action are discussed briefly. The information in this EA is tiered to and derived primarily from the information in the *Bitter Lake NWR Comprehensive Conservation Plan* (Research Management Consultants 1998). Unless referenced to a different source, all data and information pertaining to the affected environment were obtained from the *Bitter Lake NWR Comprehensive Conservation Plan*.

3.1 Regional Setting

The Pecos River is the largest tributary of the Rio Grande. The Pecos River represents a hybrid of Rocky Mountain and Plains stream which originates in the Sangre de Cristo Mountains of north-central New Mexico. The Pecos River is confluent with the Rio Grande at what is now Amistad Reservoir near Laredo, systems, containing equally important snow melt and summer rain components of the annual hydrograph. At its origin the river drains crystalline rocks of the southern Rocky Mountains with high water quality. Below Fort Sumner, New Mexico, the river enters a naturally saline basin composed primarily of evaporitic sedimentary rocks, resulting in higher salinity loads.

The Bitter Lake NWR was established on October 8, 1937, by Executive Order 7724 “as a refuge and breeding ground for migratory birds and other wildlife.” Additional laws direct refuge activities. These include the Migratory Bird Conservation Act (16 USC 715d), which identifies the refuge “for use as an inviolate sanctuary, or for any other management purpose for migratory birds.” The Refuge Recreation Act (16 USC 460-1) identifies the refuge as being suitable “for incidental fish and wildlife-oriented development, the protection of natural resources, and the conservation of endangered or threatened species.” The Wilderness Act of 1964 (PL 88-577) directs the Service to “maintain wilderness as a naturally functioning ecosystem” on portions of the refuge.

The refuge supports plant and animal communities adapted to the diverse and unique habitat within the region. The isolated springs, seeps, and associated wetlands protected by the refuge have been recognized as providing the last known habitats in the world for several unique species. Management emphasis on the refuge is placed on protecting and enhancing habitat for endangered species and federal candidate species, maintaining and improving wintering crane and waterfowl habitat, and monitoring and maintaining natural ecosystem values.

Human activities have reduced the range and in some cases have extirpated native plants and animals. Saltcedar introduced for bank stabilization in the 1940s has significantly altered both the stream channel habitats and the native riparian plant communities. Channelization, groundwater withdrawals, and the construction and operation of dams for consumptive uses has further altered habitats and affected native aquatic communities. The environmental baseline for the refuge and the Pecos River is the current altered environment, not the environment that existed before.

3.2 Land Use

The Bitter Lake NWR is bordered by private land, Bureau of Land Management- (BLM-) administered land, and state trust lands. Surrounding land uses include residential, farming and ranching, recreational, mining, and oil and gas development. The refuge is within Chaves County, which covers 6,026 square miles and has a population of approximately 61,000. Roswell is the largest city in Chaves County, with a population of 45,293. Roswell is approximately nine miles west of the Bitter Lake NWR.

The Bitter Lake NWR encompasses 24,536 acres in three tracts. The North Tract is the Salt Creek Wilderness. The Middle Tract includes most of the developed infrastructure, including the refuge headquarters, visitor center, roads, maintenance facilities, and water impoundments. The South Tract is not open to the public and includes refuge croplands, which support and attract flocks of wintering birds. The Service does not control subsurface mineral rights on the refuge. The proposed restoration would be conducted entirely within the Middle Tract.

Most of the major natural features of the refuge have been designated by the Secretary of the Interior as the Bitter Lake Group National Natural Landmark. The National Natural Landmarks Program was established under the authority of the Historic Sites Act of 1935 (16 USC 461 et seq.) to identify and encourage the preservation of the full range of geological and ecological features that are determined to represent nationally significant examples of the nation's natural heritage. Federal agencies are required to consider the unique properties of these nationally significant areas under the National Environmental Policy Act (NEPA), and the Secretary of the Interior is required to provide an annual report to the Congress on damaged or threatened National Natural Landmarks. Special management areas on the Bitter Lake NWR include those detailed below.

Salt Creek Wilderness. The 9,621-acre Salt Creek Wilderness was established under PL 91-504 on October 23, 1970. The Wilderness Act defines wilderness as an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions. The wilderness includes a line of red clay-gypsum bluffs, gypsum sinkholes, sand dunes, and native plant communities. The tract is managed as a "naturally functioning ecosystem" for scientific research, vegetation management, wildlife management, and monitoring. The area provides opportunities for primitive

recreation, including hiking, equestrian use, hunting, and sightseeing. Within the Salt Creek Wilderness there is an underground natural gas pipeline, installed along a right-of-way in the early 1950s, which crosses the tract diagonally from northeast to southwest. Also, there is a distribution power line along much of the south Wilderness boundary and an active natural gas well lease in the southwest corner of the area.

Bitter Lake Research Natural Area. Research Natural Areas (RNAs) are lands permanently reserved for research and education. Natural processes are supposed to dominate in these tracts, which preserve some natural feature or features. Principal goals in protecting these lands are 1) to preserve a representative array of all significant natural ecosystems as sources of baseline data, against which the effects of human activities in similar environments can be measured; 2) to provide sites for studies of natural processes in undisturbed ecosystems; and 3) to provide gene pool preserves for plant and animal species, especially rare ones. The guiding management principle is to prevent unnatural encroachments. All kinds of human manipulation are discouraged, and public uses that might impair natural values are generally discouraged. Scientists who wish to use a Research Natural Area on refuge land must obtain a special use permit.

The 300-acre Bitter Lake RNA, a mile north-northwest of refuge headquarters, is dominated by the Bitter Lake playa. In winter, large numbers of waterfowl, sandhill cranes, and migratory shorebirds inhabit the lake, and species such as the snowy plover nest here. The depth of Bitter Lake ranges from 0 to four feet and receives water from Bitter Creek, Lost River, Dragonfly Spring, and Sago Spring on its west side. These aquatic systems, along with several associated sinkholes, provide unique habitat for uncommon native fish species.

Lake St. Francis Research Natural Area. The 700-acre Lake St. Francis RNA, two miles north-northwest of refuge headquarters, encompasses about 30 small, round, steep-sided sinkholes. These sinks formed by overlying strata collapsing into hollows formed by dissolution of pockets of gypsum. All sinks at one time held water, and several still do. The largest sinkhole is Lake St. Francis, which is 200 feet across and 60 feet deep. The RNA also includes Bitter Creek, a small intermittent stream, which flows southward through the west side of the RNA into Bitter Lake. Streamflow into Bitter Creek is augmented by Dragonfly Spring, Lost River, and Sago Spring. Water levels in the sinkholes declined from the mid-1940s through the 1970s, but the levels have been slowly rising in recent decades. These sinkholes support unique algae, native fish, and invertebrate communities.

Inkpot Research Natural Area. The two-acre Inkpot RNA is within the Salt Creek Wilderness on the North Tract of the refuge. The chief feature is the “Inkpot,” a vertical-walled sinkhole, 150 feet in diameter and 90 feet deep. The Inkpot is at the edge of the scenic Red Bluffs, a 50-foot Permian escarpment that runs across the north end of the refuge. The Inkpot contains the marine algae *Bataphora oerstedii* and supports a variety of native fish, including a population of endangered Pecos gambusia.

3.3 Geology and Soils

The Bitter Lake NWR is in the Lower Pecos Valley Subsection of the Great Plains Physiographic Province of southeastern New Mexico. Much of the Pecos Valley Section is underlain by Permian bedrock units composed of gypsiferous and saline evaporites, limestone and dolomite, mudstone, shales, and sandstone. Dissolution of evaporite and carbonate units is an active geomorphic process affecting landscape evolution in much of the region, and various sizes of solution-subsidence depressions are common landforms. From the headwaters of the Pecos River, the sedimentary rocks of limestones, shales, and sandstones dip off the mountains in an easterly direction to form a large continuous regional aquifer system. The permeability of the aquifers varies considerably depending on the degree of dissolution or fracturing that has taken place. These processes have been most active in the southern part of the area and have resulted in the Roswell Artesian Basin. The limestone aquifer south of Roswell is the ancient Capitan Reef, in which the Carlsbad Caverns were formed by percolating groundwater.

Soils in the area are dominated by aridisols, which are not well suited for dryland agriculture because they lack the necessary moisture to support any long-term growth, except arid-adapted vegetation. The soil horizon is low in organic matter and is light in color. Aridisols also exhibit special fertility problems due to unavailable micronutrients resulting from a high pH. Floodplain soils in the project area are Vinton-Glendale Association and Glendale loam (USDA NRCS 2005). There are no prime or unique farmlands in the proposed project area.

3.4 Climate/Air Quality

Annual rainfall in the Roswell/Bitter Lake area averages 12.25 inches, and annual snowfall averages 7.4 inches. Annual temperatures typically range from near 0°F in winter to 110°F in summer, with average lows of 41.2°F in January and average highs of 83.7°F in July. The wet season usually runs from mid-June to late August, and the average relative humidity is 48 percent. Prevailing winds are southwesterly. Late winter and spring are the seasons most closely associated with moderate to strong winds, which can bring blowing dust.

Mean annual temperatures have risen across New Mexico and the southwestern US since the early 20th century, and warming trends in the southwestern US have exceeded the global averages by nearly 50 percent since the 1970s. Long-term tree-ring records show severe droughts and mega-droughts to be part of the natural climate variability of the southwestern US. However, increased carbon dioxide and other greenhouse gas emissions in the earth's atmosphere are generally believed to be linked with worldwide climate trends, including the rapid melt of polar ice sheets, sea level rise, and the warming temperatures of the past century. Temperature and precipitation strongly influence the abundance and distribution of plant and animal life. Drought and climate change are likely to exacerbate the effects of natural and human disturbances, including

wildfire, insect outbreaks, flooding, and erosion. The Bitter Lake area has experienced smaller increases in temperature and smaller decreases in precipitation than other parts of the state. However, warmer, drier climate trends in the headwaters of the Pecos River may affect the timing and availability of flows through the project area in the future (Enquist and Gori 2008).

The Bitter Lake NWR is in the Pecos-Permian Basin Intrastate Air Quality Control Region. Air quality can be affected by both near and distant sources of air pollution, including mobile sources (e.g., cars, trucks, off-road vehicles), stationary sources (e.g., power plants and industry), and area sources (e.g., oil and gas development, agriculture, fires, and road dust). Some of the most common and abundant pollutant emissions include nitrogen oxides, ammonia, and sulfur dioxide. These air pollutants can affect air quality and natural resources, including vegetation, wildlife, soils, water quality, and visibility. High levels of ozone, for example, may affect vegetation, as well as the health of refuge visitors and staff. Nitrogen compounds from the atmosphere can affect water quality and biota, soil nutrient cycling, and plant species composition (Fenn et al. 2003). Pollutant particles in the air reduce visibility in the region and affect how far and how well we can see. Atmospheric deposition of toxic organic compounds and metals, including mercury, may have a wide range of effects on fish and wildlife (US EPA 1997).

Under the Clean Air Act (42 USC 7401-7671q, as amended in 1990), the Service has a responsibility to protect air quality and related values from the adverse effects of air pollution and to comply with federal, state, and local air pollution control laws and regulations. The Salt Creek Wilderness is designated as a Class I area. In such areas limits are placed on the maximum allowable increases of sulfur dioxide, particulate matter, and nitrogen oxides above established baseline concentrations. Visibility impairment at the Salt Creek Wilderness is monitored by the Service as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program. The rest of the Bitter Lake NWR, including the proposed project area, is considered a Class II air quality area. Class II areas are protected under the Clean Air Act but are identified for somewhat less stringent protection from air pollution damage than Class I.

Air quality at the Bitter Lake NWR is good. Chaves County is in attainment status for state and federal ambient air quality standards for criteria pollutants (particulate matter less than 10 microns, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead). The most immediate air pollution problem is blowing dust. The New Mexico Environment Department records concentrations of particulate matter at a monitoring station at the city offices in Roswell. In 2003, a violation of the federal standard for particulate matter occurred due to a dust storm, requiring the creation of the Chaves County Natural Events Action Plan to avoid nonattainment for this pollutant. The action plan is a series of measures to reduce particulate matter in the county from construction sites, cleared lands, and other potential sources of human-caused windblown dust. It does not require control of naturally occurring windblown dust (NMED 2004, 2008).

3.5 Water Resources

The Bitter Lake NWR is at the juncture of the Roswell Artesian Basin of southeastern New Mexico and the Pecos River. The Roswell Artesian Basin is a natural hydrologic basin extending six to eighteen miles west of the Pecos River and twenty miles north of Roswell, in Chaves County, to twenty miles south of Artesia, in Eddy County, a distance of approximately eighty miles. The Pecos River runs through the eastern side of the basin from north to south through the refuge. Several large tributaries drain from the west to the east. These two systems and their interactions account for the diversity of water resources within the refuge, including sinkholes, springs, wetlands, oxbow lakes, and riverine habitat. An expanded discussion of water resources is provided as Appendix D.

3.5.1 Surface Water Hydrology

The refuge has about 1,200 surface acres of water in the form of natural lakes, impoundments, sinkholes, and streams. The portion of the Pecos River being considered for the proposed river restoration is entirely within the boundaries of the refuge. For much of its length through the refuge, the river is bordered by impounded wetlands on the west side and a 300-foot-high bluff running along the east side of the river valley.

The hydrology of the Pecos River through the Bitter Lake NWR is controlled by reservoir releases from Sumner Reservoir, inflows from tributaries, and agricultural return flows south of Sumner Reservoir and north of Roswell. Before Sumner Dam was built in 1938, floods were much more intense, and base flows were higher than under post-dam conditions. Since 1937 the quantity of water released from Sumner Reservoir has been determined by the irrigation needs of the Carlsbad Irrigation District (CID) and state line water delivery requirements. Brantley Reservoir is the delivery point for Carlsbad Project water. Water is transported most efficiently to Brantley Reservoir using larger block releases. The maximum release through the gates at the reservoir at typical reservoir levels is 1,400 cubic feet per second (cfs), which typically results in a flow of approximately 1,200 cfs at the Acme Gage. The frequency of these block releases depends on downstream irrigation needs, water availability, and river conditions. Releases usually begin in March, and there can be several each year, lasting up to two weeks. Storms events can also cause peak flows above 1,200 cfs at the Acme Gage and through the refuge (FLO Engineering 1999).

As a result of a jeopardy determination in 1992 for the shiner on water operations on the Pecos River, Reclamation is working to maintain a minimum discharge to support fish populations in the river and to avoid block releases at periods in the shiner's life cycle where the release could be harmful. Current Pecos River operations are governed by the 2006 – 2016 Biological Opinion which sets a year-round target flow of 35 cfs, as measured at the Taiban Gage (Pecos River Below Taiban Creek Ft. Sumner, NM, USGS gage number 08385522) and to keep the river continuous.

Actual flows through the Bitter Lake NWR are variable. A base flow of 35 cfs at Acme Gage has been used for planning restoration actions, although this flow is not expected to

be met consistently during the irrigation season (US Fish and Wildlife Service 2003). The portion of the Pecos River being considered for the proposed river restoration is a gaining reach due to groundwater inflows and is not subject to the same concerns about intermittency as the reach above the Acme Gage.

The construction of Sumner Dam and the excavation of the channels in the Bitter Lake NWR in the 1940s also altered the channel morphology of the Pecos River. The original meanders had greater sinuosity or curving and meander length, meander amplitude, and mean radius of curvature. Current Reaches 2 and 4 are now straight excavated channels, so their morphology cannot be compared to the original meanders. Reaches 1, 3, and 5 have developed a new morphology, which is characterized by lower sinuosity, as a result of the present hydrology.

Each reach of the river has adapted to the lower flows associated with post-dam hydrology and to the straightening of the meanders. The river is a dynamic system and continues to reoccupy and cut off older oxbows. The section of the Pecos River in Reach 3 has a meandering pattern that can be used as a template for the restored areas. This section has been developing within the context of the post-dam hydrology since the southern channel was dug in the 1940s. The river also continues to carry a significant amount of sediment. The Pecos River at the Acme gage has an average sediment transport rate of approximately 640,000 tons per year (Tetra Tech, Inc. 2003).

Other Surface Water Features. The Bitter Lake NWR includes a large variety of surface water types, including arroyos, spring-fed streams, isolated oxbow lakes, large and small playa lakes, developed impoundments, artesian springs, and approximately sixty sinkholes throughout the refuge. These surface water features depend highly on local groundwater flows, which in turn depend on precipitation and water use to the north and west.

3.5.2 Groundwater Hydrology

The Bitter Lake NWR is in the discharge zone for the Roswell Groundwater Basin. The basin encompasses 10,779 square miles and includes most of Chaves County and portions of Torrance, Guadalupe, and Roosevelt Counties. Groundwater supplies are derived from several geological formations, including the Yeso and San Andres Formations, the Artesia Group, the Glorieta Sandstone, and alluvium and terrace deposits. The two major aquifers that provide the largest supplies of water are the Permian artesian aquifer and the shallow-water aquifer, located in the alluvium deposits and terraces. These two aquifers provide water for the cities of Roswell, Artesia, Dexter, Lake Arthur, and Hagerman. Irrigation wells have been developed throughout the basin, with the largest concentration located in the Pecos River Valley between Roswell and Seven Rivers.

Groundwater from the artesian zone flows from west to east into the sinkholes, springs, and seeps of the refuge and maintains the wetlands and surface water impoundments. Groundwater also preserves perennial flows in the Pecos River through the proposed

project area. Artesian flows historically maintained groundwater levels that were 80 feet above the mean topographic surface (mts, 3,500 feet) of the refuge. This level dropped to 20 feet above mts in the 1970s and since then has been on the rise toward the current level of 40 feet above mts. Trends suggest that spring flows will continue to increase, and sinkhole levels will continue to rise. The refuge uses groundwater wells to support various facilities.

3.5.3 Water Rights

The Bitter Lake NWR holds a variety of water rights. For example, there is a water right associated with the North Tract for 440 acres, with a priority date of 1916. As part of the adjudication of its federally reserved water rights by the State of New Mexico, the Service agreed not to use this water right because it wished to enhance natural hydrologic conditions within this wilderness unit. The stipulation states that the refuge shall not use this water right unless the State Engineer would allow for the change in purpose of use from agriculture to instream flow.

The refuge has received recognition from the State of New Mexico for their federally reserved water right. This right allows for the refuge to manage wetlands on the Middle Tract of the refuge and protects spring resources from impairment. Since the mid-1990s the Service has changed how the impounded wetlands of the Middle Tract are managed. Formerly, water levels in these wetlands were kept high year-round. Now lake levels are left low during the summer when evaporation is highest and are allowed to rise during the colder months. While the primary reason for this change was to mimic natural conditions and improve wetland habitat, this change may also have reduced losses due to evaporation.

The refuge also has groundwater rights associated with its Middle Tract and on its Farm Unit south of the 380 bridge. In June 1995 the United States and State of New Mexico stipulated to a consumptive right of 339.1 acre-feet of water per year from an artesian well within the Middle Unit. In December 1996, the United States and State of New Mexico stipulated to a consumptive right of 1368.9 acre-feet per year from both artesian and shallow sources within the Farm Unit.

The refuge has been very active in conserving water. The refuge has cleared saltcedar trees on the Middle Unit within the spring system and partially along the Pecos River. This project plans to clear saltcedar along the Pecos River of the Middle Unit and to manage these lands to maintain native species, including coyote willow, sacaton grass, and seep willow. The Service believes that the projected changes in plant density and use of managed native plants may consume less water than unmanaged saltcedar (US Fish and Wildlife Service 2008c), although the New Mexico Interstate Stream Commission (NMISC) is reluctant to acknowledge a net benefit to the hydrologic system from phreatophyte control.

NMISC and the Service have agreed to monitor changes in the water budget resulting from the project and to determine if there is a net depletion. The preliminary estimate of a

depletion from Phase I and Phase II, discounting any benefits from phreatophyte control, is 9.5 acre-feet a year. The Service is committed to ensuring that any net depletions to the water budget from the project will be compensated for and that there will be no adverse impact on downstream water rights or on interstate compact deliveries (Tashjian 2008).

3.5.4 Water Quality

Potential contaminant sources in the area include natural salinity, irrigated agriculture, grazing, feedlots, oil and gas production wells and pipelines, septic tanks, and historic municipal wastewater discharges to Hunter Marsh.

Upstream of the refuge, the Pecos River enters a basin dominated by evaporitic sedimentary rock. Natural salinity in the Pecos River and refuge water bodies greatly increases below this point due to geologic-based salt-loading and high evaporation rates. Water quality in the river is also affected by return flows from upstream agricultural diversion. Return flows are usually more saline than native river waters because salts are concentrated when water is removed through transpiration. The river also carries runoff from fertilizer application and other upstream contaminants. For many years during the last century, salts, selenium, and other contaminants were further concentrated in the water of refuge sinkholes due to dramatic declines in water levels. Reduced groundwater withdrawal in recent years has led to higher water levels in the sinkholes and probable decreases in salt concentrations. Change in the management of the impounded lakes may have reduced the salinity of these waters, and the removal of saltcedar may have helped remove surface salt and mineral encrustations.

There are three active oil wells and three active natural gas wells on the refuge that were included in lands acquired from the BLM in the late 1960s. The BLM continues to permit extensive natural gas development in the Pecos River floodplain just north of the boundary of the refuge Middle Tract, and leasing activity has accelerated throughout the region, including on the mesa immediately east of the refuge. The refuge does not control subsurface mineral rights, and additional development could occur. Oil spills have occurred in the past within the holding berm of the oil tanks, and there is an area that has crusted oil in spots and is void of vegetation. In 1997, a gathering system was installed to transport produced water and oil from leases on the refuge onto private property to the south. Fluids are now pumped to a central battery located off-refuge, which greatly reduces the chance of any future spills and associated habitat damage. An old abandoned delivery line and three produced water storage tanks were also removed.

The BLM now administers a habitat protection zone (HPZ) within the 500-year source water capture zone for the refuge. All oil and gas activities within the primary area of the HPZ must incorporate groundwater protection features, including steel tanks instead of earthen pits and a stringent casing protocol (US BLM 2002).

Sediment and water samples were collected from Oxbow 4 in March of 2008. The samples were analyzed for PCBs, pesticides, and metals in order to assess any potential water quality impact of the reconnection of Oxbow 4 to the Pecos River main stem

channel. All samples were clear of PCBs and pesticides. The water sample had trace amounts of arsenic (0.090 micrograms per liter of water [µg/l]) and barium (0.021 µg/L). The sediment samples had concentrations of arsenic (~10mg/kg), barium (~100 mg/kg), and chromium (~9 mg/kg). These concentrations are at or below average New Mexico background concentrations for these elements (AALI 2008, Tashjian 2008).

3.6 Biological Resources

3.6.1 Vegetation

Vegetation on the refuge consists primarily of mixed Chihuahuan shrub/grassland with areas of riparian vegetation. The South Tract is a working farm and as a result is dominated by cultivated plants. The shrub vegetation is dominated by four wing saltbush (*Atriplex canescens*) and is associated with a scattering of mesquite (*Prosopis* spp.), creosote (*Larrea tridentata*), iodine bush (*Allenrolfea occidentalis*), and Russian thistle (*Salsosa* spp.). The grassy understory is dominated by alkali sacaton (*Sporobolus airoides*), salt grass (*Distichlis spicata*), and gyp grama (*Bouteloua breviseta*). Areas adjacent to the water courses contain riparian vegetation composed primarily of coyote willow (*Salix exigua*), seepwillow (*Baccharis salicifolia*), common reed (*Phragmites australis*), and exotic saltcedar (*Tamarix ramossisima*). Cottonwoods (*Populus* spp.) occur only in scattered patches influenced by freshwater springs (Research Management Consultants 1998). Vegetation in and along the narrow riparian zone provides cover and nutrient input for fish and wildlife and is a barrier to prevent sediments, debris, and pollution from entering the river.

Common reed, Russian thistle, kochia (*Bassia scoparia*), and saltcedar are the major invasive plant species on the refuge. Saltcedar poses particular problems because of its high water use, deep root system, increased soil salinity, reduced biodiversity in riparian zones, impacts on special species habitat, increased fire risk, and effects on channel morphology, sedimentation, erosion, and flooding (USDA 2005). The refuge does not have a formal plan for invasive species control but treats invasive species as needed using available resources. As part of the refuge's Annual Performance Planning data provided to the Service, the refuge staff documents acres treated and sets annual treatment goals. Invasive species control efforts will continue throughout the refuge as funding and personnel becomes available. The refuge prepared a draft environmental assessment in 2007 for the use of saltcedar leaf beetles (*Diorhabda elongata*) on selected areas of the refuge as a biological control for saltcedar, but there has been no further action or decision to date (Sanchez 2008).

3.6.2 Wetland Habitats

Refuge wetlands support a variety of plant and animal species and are vital to migratory birds. The isolated gypsum springs, seeps, and associated wetlands protected by the refuge have been recognized as providing the last known habitats in the world for several

unique species. Wetlands range from relatively freshwater flowing streams and oxbow lakes to brackish impoundments and natural sinkholes to hypersaline playa lakes. Each of these wetland types has an intricate community of aquatic invertebrates, associated vegetation, and native fish.

As described previously, impounded wetlands are now managed to mimic natural conditions and thus improve wetland habitat. Water manipulation is crucial to managing optimum diversity and abundance of fish and wildlife on the refuge. Previously the Service attempted to maintain all pond and lake levels at their maximum capacity, which resulted in highly saline waters. Salt water holds significantly less dissolved oxygen, which is crucial to the survival of many fish and aquatic insects. Since 1994, water levels have been manipulated to flush out accumulated salts. Typically, impoundments are filled to capacity during the fall and winter to provide roosting and feeding areas for migratory waterfowl. Wetlands are slowly flooded to continually inundate vegetation grown during the summer, which makes a steady supply of food available for migratory birds as they arrive. These same wetlands are slowly lowered during the spring, summer, and early fall, exposing mud flats that provide feeding areas for migratory shorebirds and other waterbirds that require these shallow areas to forage in. The salt flats exposed during spring and summer also provide an important nesting area for snowy plovers, avocets, and least terns that otherwise would concentrate their nests along lake edges where they are much more susceptible to predators. Some lakes are kept low during winter to provide shallow roosting areas for sandhill cranes and snow geese.

The isolated limestone and gypsum springs, seeps, and wetlands of the refuge create unique habitat for diverse assemblages of endemic fish, plants, mollusks, and crustaceans. Some of the sinkholes contain the only known inland populations of marine green algae (*Bataphora oerstedii*). The sinkholes also support Pecos gambusia and protected aquatic invertebrates. There is potential for discovery of new endemic species in these special environments, and the role of these features in the ecosystem protected by the refuge requires further study.

3.6.3 Wildlife

To date, more than 360 bird species have been documented on the refuge, including 44 nesting species. Twenty thousand snow geese, Ross's geese, and Canada geese and more than 18,000 lesser sandhill cranes typically overwinter in the refuge. Marsh bird, waterbird, and shorebird populations reach over 3,000 individuals each spring and fall. In addition, 59 mammal species, 40 reptile species, 12 amphibian species, and 24 fish species have been identified on the refuge and surrounding area. The refuge also supports one of the most diverse populations of dragonflies and damselflies (Odonates) in North America. Over 90 Odonate species occur here, including the continent's largest and smallest dragonfly species. Species lists are provided in the *Bitter Lake NWR Comprehensive Conservation Plan* (Research Management Consultants 1998).

3.6.4 Special Status Species

Special status species are those listed as threatened or endangered under provisions of the Federal Endangered Species Act of 1973, as amended (ESA), those proposed or considered as candidates for such listing, and those considered rare or species of concern by federal or state agencies. Special status species also include those animals listed as state threatened or endangered under provisions of New Mexico Statutes, Chapter 17, Article 2: 17-2-37 through 17-2-46 and plants listed as state endangered under provisions of New Mexico Statutes, Chapter 75, Article 6: 17-6-1. Chaves County includes over 75 special status species, including New Mexico species of concern, many of which are found on the refuge (NHNM 2007, NMDGF 2008).

The Bitter Lake NWR provides a critical role in maintaining a sanctuary for at least 27 state or federal threatened, endangered, or candidate species (See Table 3-1). There are two special status plant species: the Pecos sunflower and the Wright's marsh thistle. The Pecos sunflower is a wetland plant that grows on wet alkaline soils at spring seeps, wet meadows, and pond margins. One of the largest Pecos sunflower wetlands occurs on the refuge, which has been identified in the *Final Pecos Sunflower Recovery Plan* as an important core conservation area for the species. The Service is developing a refuge management plan to address water and wetlands management for Pecos sunflower, while meeting the other refuge requirements for waterfowl and aquatic wildlife habitats. The schedule of filling and draining the water impoundments can greatly influence the population of the Pecos sunflower (US Fish and Wildlife Service 2005a). Critical habitat has been established for this plant on 672 acres within the refuge (US Fish and Wildlife Service 2008a, 2008b).

Table 3-1
State or Federal Threatened, Endangered, or Candidate Species of the Bitter Lake NWR

Species Type	Common Name	Scientific Name	Occurrence	Federal Status	New Mexico Status
Plants					
	Pecos sunflower	*Helianthus paradoxus*	Resident	T	E
	Wright's Marsh Thistle	*Cirsium wrightii*	Resident	SoC	SoC
Aquatic Invertebrates					
	Pecos assiminea snail	*Assiminea pecos*	Resident	E	E
	Noel's amphipod	*Gammarus desperatus*	Resident	E	E
	Say's pond snail (wrinkled marsh snail)	*Stagnicola caperatus*	Resident	--	E
	Roswell pyrg (springsnail)	*Pyrgulopsis roswellensis*	Resident	E	E
	Koster's springsnail	*Juturnia kosteri*	Resident	E	E

Table 3-1
State or Federal Threatened, Endangered, or Candidate Species of the Bitter Lake NWR *(continued)*

Species Type	Common Name	Scientific Name	Occurrence	Service Status	New Mexico Status
Reptiles					
	Western river cooter	*Pseudemys gorzugi*	Possible Resident	--	T
	Western (arid land) ribbon snake	*Thamnophis proximus*	Resident	--	T
Mammals	Swift fox	*Vulpes velox velox*	Hypothetical	C	--
	Least shrew	*Cryptotis parva*	Resident	--	T
	Black-footed ferret	*Mustela nigripes*	Hypothetical (may be extirpated)	E	--
	Pecos River muskrat	*Ondatra zabethicus ripensis*	Resident	SoC	S
Birds					
	Bald eagle	*Haliaeetus leucocephalus*	Migrant	-	T
	Interior least tern	*Sterna antillarum athalassos*	Breeding	E	E
	American peregrine falcon	*Falco peregrinus anatum*	Migrant	R	T
	Baird's sparrow	*Ammodramus bairdi*	Migrant	--	T
	Mountain plover	*Charadrius montanus*	Migrant	C	--
	Southwestern willow flycatcher	*Empidonax traillii extimus*	Migrant	E	E
	Lesser prairie chicken	*Tympanuchus pallidicinctus*	Resident	C	--
	Bells vireo	*Vireo belli*	Migrant	--	T
	Brown pelican	*Pelicanus occidentalis*	Migrant	E	E
	Neotropical cormorant	*Phalacrocorax olivaceus*	Migrant	--	T
Fish					
	Pecos bluntnose shiner	*Notropis simus pecosensis*	Resident	T	T
	Arkansas River shiner	*Notropis girardi*	Resident	E	E
	Pecos gambusia	*Gambusia nobilis*	Resident	E	E
	Pecos pupfish	*Cyprinodon pecosensis*	Resident	--	T
	Mexican tetra	*Astyanax mexicanus*	Resident	--	T
	Bigscale Logperch	*Percina macrolepia*	Resident	--	T
	Greenthroat darter	*Etheostoma lepidum*	Resident	--	T

C=Candidate; E=Endangered; R=Recovered; S=Sensitive (informal state designation); SoC=Species of Concern; T=Threatened

Sources: NHNM 2007; NMDG&F 2008; Research Management Consultants 1998; Service 2001

The Wright's marsh thistle is a federal and state species of concern. The thistle lives near desert springs and marshes. Its habitat is rare and threatened by aquifer depletion and infestation of nonnative plants. Outside of the refuge there are no known remaining populations in Chaves County. The plant also still grows in the lower elevations of the Sacramento Mountains, southwestern Socorro County, and isolated locations in Arizona and West Texas.

The Service has designated as endangered species the Roswell springsnail, Koster's springsnail, Pecos assiminea, all aquatic snails, and Noel's amphipod, a freshwater shrimp. These invertebrates are found exclusively in the springs, seeps, and sinkholes of the Pecos River basin in New Mexico and Texas. These animals depend on the health, quality, and quantity of groundwater in their environment, and their main threats are the introduction of nonnative species, surface and groundwater contamination, oil and gas extraction, local and regional groundwater depletion, severe drought, and habitat loss. No critical habitat was designated within the refuge because these lands are already managed for the conservation of wildlife, and special management considerations or protections are not required (US Fish and Wildlife Service 2005b). As part of a recent legal settlement with environmental groups, the Service is considering critical habitat designations within the refuge (Bryan 2009).

Special status reptiles include the western river cooter (a turtle) and the western ribbon snake. The turtle has been documented mostly in the south of Brantley Dam, but there is one record of it at the Bitter Lake NWR. It is primarily a stream species, preferring waters with slow to moderate current, firm bottoms, and abundant aquatic vegetation. Most records are from streams with relatively clear water and rocky or sandy bottoms. The Western or arid land ribbon snake is found in open sandy areas along the margins of water bodies.

Special status mammals include the swift fox, least shrew, black-footed ferret and the Pecos River muskrat. Swift foxes have been found to inhabit grasslands habitat in New Mexico and have been recorded historically at the Bitter Lake NWR. There are also historical accounts of the presence of black-footed ferret, also a grassland species, in Chaves County, but it is now believed to have been extirpated from New Mexico. The least shrew is a small burrowing species favoring herbaceous vegetation on moist soils, especially inland salt grass, and is known to be present at the Bitter Lake NWR. The Pecos River muskrat is a resident species that inhabits dome-shaped lodges constructed of vegetation near shallow, fresh-water sources with clumps of marshy vegetation.

As described previously, migratory and nesting birds were the primary reason that the refuge was chartered. A small population of interior least terns has nested at the Bitter Lake NWR consistently for over 50 years. Terns typically nest in colonies on broad unvegetated sandbars and flats and feed exclusively on small fish. Until 2004, the refuge was the only location in New Mexico where least terns have nested in recent history. In May of 2006, 20 adults were observed, with an estimated six nesting pairs on the shore of Brantley Lake, 60 miles south of the Bitter Lake NWR (Bureau of Reclamation 2006b). Terns have returned in subsequent years, and nesting and brood-rearing habitat is now

maintained by the CID off the western shore of Brantley Lake (Bureau of Reclamation 2006b). The refuge appears to be the only other regular nesting location on the southwestern periphery of the interior least tern's historic range. Special status migrant or wintering bird species that have been recorded but not actively managed include the bald eagle, American peregrine falcon, Baird's sparrow, mountain plover, southwestern willow flycatcher, Bell's vireo, brown pelican, and the neotropical cormorant.

Fish species include the Arkansas River shiner, Pecos gambusia, Pecos pupfish, Mexican tetra, greenthroat darter, and the Pecos bluntnose shiner. The Arkansas River shiner is an introduced species to the Pecos River and feeds on invertebrates and detritus and spawns in summer. The Pecos gambusia is not known in the mainstem of the Pecos River in New Mexico but inhabits the backwaters, pools in small tributaries, and springs of off-channel sites. The Pecos pupfish inhabits shallow groundwater springs associated with sinks and marsh habitat. The Mexican tetra is found in the river and is associated with pool and backwater habitats in clear-flowing water over gravel bottoms. The Bigscale Logperch occurs in gravel and sand runs and pools of the Pecos river and also in impoundments. The greenthroat darter inhabits swift-flowing streams and springs, especially vegetated riffle areas with gravel and rubble substrates.

Of the above fish species, the Pecos bluntnose shiner requires a more detailed description and analysis to determine possible effects resulting from proposed restoration at the Bitter Lake NWR. Since its listing as threatened in 1987, the Pecos bluntnose shiner has been the subject of conservation efforts within its current range by several agencies. Information on this species is primarily taken from the *Biological Opinion for the Bureau of Reclamation's Proposed Carlsbad Project Water Operations and Water Supply Conservation EIS, 2006-2016* (US Fish and Wildlife Service 2006) and, which should be consulted for a more detailed description of the species and its requirements.

Pecos Bluntnose Shiner. Historically, bluntnose shiner, *Notropis simus,* were found in main channel habitats of the Rio Grande, Rio Chama, and Pecos River, New Mexico, and Texas. The Rio Grande subspecies (*Notropis simus simus*) was last collected in 1964 and was determined to be extinct during the 1970s. In 1976, the State of New Mexico gave formal protection to the Pecos River subspecies (*Notropis simus pecosensis*). In 1987, the Service listed the shiner as threatened and defined critical habitat. At the time of listing, intermittent water flow in the river was identified as the greatest threat to the shiner and its habitat. Water diversions, groundwater and river water pumping, and water storage have reduced the amount of water in the channel and altered the hydrograph with which the shiner evolved (US Fish and Wildlife Service 2006). The current range of Pecos bluntnose shiner is believed to be limited to the mainstem Pecos River between Sumner Dam and Brantley Reservoir, but it may now be extirpated from the 14-mile section between Sumner Dam and the FSID Diversion Dam (Platania and Altenbach 1998). A preliminary study indicates that the shiner population is not genetically divergent between spatially distinct sampling localities throughout its current range (Osborne and Turner 2006) .

The Pecos bluntnose shiner is a relatively small, moderately deep-bodied minnow, rarely exceeding 3.1 inches total length. The shiner primarily feeds on plant matter, filamentous algae, aquatic invertebrates, and terrestrial invertebrates, such as ants, wasps, flies, and midges. The shiner's average life span is two to three years. The shiner is found in wide river channels with a shifting sandbed and erosive banks. Sandbeds are maintained by a combination of sediment and floodwater inflows. Erosive bed and banks allow channel configurations to change in response to flows. Flood inflows from many uncontrolled tributaries on the Pecos River contribute to favorable river channel conditions but occur too infrequently to maintain a wide channel in many places. Throughout much of the shiner's range, impoundments that control floods and block sediment transport have eliminated many of these features (US Fish and Wildlife Service 2006).

Female shiners spawn in response to rapid increases in river flow caused by summer rainstorms and reservoir releases (Dudley and Platania 2000, 2007). Platania (1993) found that females released an average of 370 eggs with each spawning and spawn multiple times during the spawning season. Spawning occurs from late April to September, usually peaking during July and August. Females release nonadhesive semibuoyant eggs into the water column where they are immediately fertilized by the males. Eggs remain suspended in the current for 24 to 48 hours until they hatch (Platania and Altenbach 1998). Within two to three days after hatching, blood begins to circulate, the yolk sac is absorbed, and the swim bladder, mouth, and fins develop. If not retained in back water or low velocity areas, larvae continue to drift downstream until they are sufficiently strong to seek suitable habitats (Dudley and Platania 2000, 2007). It is believed that the changes from a natural hydrograph have increased the downstream transport of eggs and larvae to Brantley Reservoir, where they do not survive. Small juveniles are also susceptible to downstream displacement but are better able to seek low-velocity habitats. Channel conditions that reduce downstream displacement and provide low-velocity habitats are favorable for successful shiner survival and recruitment (US Fish and Wildlife Service 2006). Successful shiner reproduction is also unlikely when fish are confined to isolated pools due to flow intermittence. Loss of reproductive cues, isolation from reproductive individuals, predation, and extremes in water chemistry reduce or eliminate reproduction (Davenport 2008).

There have been ongoing studies to determine the life requisites of the shiner for each of its stages, its depth and velocity preferences, and habitat availability in the Pecos River (for example, see Brooks et al. 1991, 1994, 1995; Hatch 1982; Hatch et al. 1985; Hoagstrom 1997, 1999, 2000, 2002, 2003; Hoagstrom et al. 2008a, 2008b; Kehmeier et al. 2004a; Platania and Altenbach 1998; Roberts et al. 2004). Recent studies have clarified the habitat and flow requirements of the shiner through its life stages. The subsegments of the Pecos River, which are occupied by the core population of the shiner, are buffered from the direct effects of dams and irrigation releases, high subsegment length, substantial sediment inputs from uncontrolled tributaries, substantial base flow, high channel width in relation to discharge, and lower salinity (Hoagstrom et al. 2008a, 2008b). Long-term monitoring has indicated that significant decreases in shiner abundance and density followed surface flow intermittence and extreme low flow.

Surface flow intermittence should be recognized as the primary threat to the remaining population of shiners (Davenport 2008).

The maintenance of a dynamic sand bed channel with low-velocity areas is also an important component of good supporting habitat. The ongoing drought, combined with the continued demands on the river for irrigation and compact deliveries to Texas, may be putting additional strain the remaining population and thus the long-term survival of the shiner.

The shiner has been found in every major habitat type within its range except for stagnant pools. Hatch et al. (1985) found the shiner most often in water 6.7 to 16 inches deep, with smooth nonturbulent flow and sandy substrate. In a series of studies conducted from 1992 to 1999, Hoagstrom found that larger fish are present in higher-velocity flows. Adults most frequently use velocities between 0.33 and 1.4 feet/second (ft/s), typically found in open-water runs, riffles, and shallow pools. Juveniles most frequently use velocities between 0.03 and 0.91 ft/s, which are most commonly associated with shoreline areas. A variety of depths are used by different fish size classes. Adult shiners most frequently use depths between 5.1 and 13 inches. Juvenile shiners use a variety of depths from 2 to 17 inches (Hoagstrom 2002, 2003). Use of a variety of depths may be caused by the need to avoid high-velocity areas, regardless of depth. The shiner showed a preference for depths greater than 20 inches and velocities ranging from 0 to 28 inches per second (Hoagstrom 2003). Larvae presumably use backwater habitats with negligible velocity, relatively high water temperature, and high water clarity (Platania and Altenbach 1998).

Kehmeier et al. (2004a) reported that water depths and velocities overlapped considerably for habitats used by small-bodied minnows in the Pecos River, including the shiner. In this study the shiner were observed to select or avoid certain mesohabitat types that provided particular combinations of features, such as depth, velocity, substrate, turbulence, cover, and food. The shiner and other small-bodied minnows strongly selected perpendicular and parallel plunge habitats, with average depths of 9 inches and average velocities of 7 inches per second. These habitats were characterized by sudden increases in depth and reduced velocity, often with vertical recirculation or an eddy effect that have the potential to provide areas for resting, food entrainment, and adjacent cover for escape from predators. More than 60 percent of shiners were collected in these plunge habitats, which made up a very small percentage of all available habitats at all flows. These habitats were found to be available in similar quantities at the low- and high-flow river conditions.

Designated critical habitat for the shiner is divided into two reaches. The upper critical habitat extends from the confluence of Taiban Creek downstream to the Crockett Draw. The lower critical habitat reach is from Hagerman to Artesia. The upper critical habitat has a wide sandy river channel with only moderately incised banks and provides habitat suitable for all age classes. The lower critical habitat is deeply incised, has a narrow channel, and has a compacted bed. Although the lower critical habitat has permanent flow, the habitat is less suitable for shiners and only smaller size classes are common in this reach. Lack of growth, reduced survival, and reduced recruitment in this reach is

attributed to poor habitat conditions and the periodic downstream displacement of eggs, larvae, and small juveniles (US Fish and Wildlife Service 2006). Although it is not part of the designated critical habitat, the area with the highest densities of shiner is below the upper critical habitat, between river miles 605 and 588, just above the Acme gage (Davenport 2008). This reach was not designated as critical habitat because portions have been subject to intermittency in the past under drought conditions.

The Bitter Lake NWR is between the two critical habitat reaches. The Middle Tract of the Bitter Lake NWR is just south of the Acme gage and is also the boundary between the Rangelands and the Farmlands reaches of the Pecos River. These designations have been used for fish surveys and habitat descriptions for many years (US Fish and Wildlife Service 2006). Downstream of the Acme gage in the Middle Tract and the Farmlands reach, the river gains water from artesian aquifer inflows and irrigation returns and is not subject to drying (FLO Engineering 1999; US Fish and Wildlife Service 2006).

The Rangelands reach is considered a stronghold for the shiner because of good habitat availability and suitability and the presence of relatively stable populations of shiner of all size classes (Hoagstrom 2003). Generally the current channel morphology is maintained in this reach through block releases, but the peak flows are much less than those that occurred before the upstream dams were built. This altered hydrograph encourages the proliferation of nonnative vegetation, such as saltcedar, which armors the banks and causes channel narrowing. Channel narrowing increases water velocity, reduces backwater areas, and leads to the removal of fine sandy sediments. Consequently, the habitat becomes much less suitable for the shiner.

From 1992 to 1999, shiner density within the Rangelands reach showed a gradual increase. During these years there was a normal snow pack and spring runoff, frequent local summer precipitation, and experimental Sumner Dam operations, all of which contributed to sustaining perennial flows from Sumner Dam to Brantley Reservoir (Hoagstrom 1999, 2000; US Fish and Wildlife Service 2006). In 1999, New Mexico entered a period of sustained drought, which worsened over the next five years. Surface flow intermittence occurred in the Rangeland section, where most adult Pecos bluntnose shiner population occurs during the reproductive period. The Farmland section was maintained by spring flow, but significant decreases in population still occurred, due in part to impacts on the breeding population upstream (Davenport 2008; US Fish and Wildlife Service 2006).

From the long-term population surveys, it appears that the prolonged and extensive intermittency that occurred from 2002 to 2004 in the Rangelands, in combination with limited spawning opportunities, had a negative impact on the shiner population. Abundance declined to 1992 levels. No other physical or biological factors have been identified that would lead to such a pronounced decline in population density. Both the relative abundance and shiner density dropped precipitously in the Rangelands reach, where the habitat is the best and where the population would be the most resilient (Davenport 2008; US Fish and Wildlife Service 2006). Reclamation and other agencies have multiple efforts in progress to conserve the shiner and irrigation water supplies by

maintaining target flows, expanding a fish conservation pool at Sumner Lake, acquiring water, and restoring habitat (US Bureau of Reclamation. 2006a; US Fish and Wildlife Service 2006).

3.7 Cultural Resources

Cultural resources are locations of human activity, occupation, or use. The term includes archaeological sites, buildings, structures, and places associated with the traditional cultural practices or beliefs of a living community.

NEPA requires consideration of "important historic, cultural, and natural aspects of our natural heritage." Consideration of cultural resources under NEPA includes the necessity to independently comply with the applicable procedures and requirements of other federal and state laws, regulations, and executive orders. The principal federal law addressing cultural resources is the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC Section 470), and its implementing regulations (36 CFR 800). The regulations commonly referred to as the Section 106 process describe the procedures for identifying and evaluating historic properties, for assessing the effects of federal actions on historic properties, and for project proponents consulting with appropriate agencies to avoid, reduce, or minimize adverse effects. Historic properties are cultural resources that meet specific criteria for listing on the National Register of Historic Places (NRHP). The Proposed Action is a federal undertaking, as defined by 36 CFR 800.3, and is subject to the Section 106 process and consideration under other federal and state requirements. The Section 106 process requires consultation with the State Historic Preservation Office (SHPO) and other parties.

Archaeological investigations in the Pecos River Basin indicate human use for perhaps 11,000 years. Broad shifts in the archaeological evidence of native adaptations are observed from the Paleo-Indian through the Archaic and Ceramic to the Protohistoric Periods. Spanish contact and settlement came later to this region than to other parts of New Mexico along the Rio Grande. Attempts at Spanish and American settlement of this frontier were hindered by the lack of security from Apache and Comanche raiding that continued through much of the 19th century. When native populations were subdued, agriculture and ranching provided the economic basis for the region.

Site and survey records were researched to determine the presence and potential for cultural resources to be present within the Area of Potential Effects (APE) for the Proposed Action. Research was conducted through the Archaeological Records Management System of the New Mexico Historic Preservation Division in Santa Fe. Cultural resource locations are generally confidential, except in the case of historic structures, and are not published in order to prevent disturbance and unauthorized collecting.

No surveys have been conducted in the immediate vicinity of the Proposed Action, and no sites have been recorded within the APE. There are two old records (LA 8834, LA 8835) with poor locational information of lithic and lithic/ceramic scatters approximately 1400 and 1900 meters to the west of the APE. Lithics and ceramics have also been recorded as close as two miles away on top of a large upland mesa above the floodplain. This mesa has been extensively surveyed for cultural resources as a result of oil exploration and development, and several prehistoric archaeological sites have been recorded. Federally recognized tribes and pueblos with potential ties to the project area were notified via letter of the proposed project. The only responses received requested notification should archaeological resources or human remains be found during restoration. No concerns or traditional cultural properties were identified by the parties consulted.

With the exception of the staging and river access locations, work would be conducted in active or recently active floodplains, channels, or oxbows. Access to these areas would be through refuge roads. The APE has experienced episodic flooding, refuge maintenance actions, channel diversion and shaping, and parking and associated earthmoving activities over the years, resulting in a highly disturbed setting. Portions of the APE are inaccessible due to dense vegetation and/or perennial water. No structures are present. Surveys have not been conducted, but the possibility of finding intact cultural resource sites retaining integrity is low. Although unlikely, consideration must also be given to the possibility of buried or undiscovered cultural resources that could be found during restoration.

3.8 Recreation/Visitor Facilities

The Bitter Lake NWR attracts approximately 35,000 to 40,000 visitors annually. Principal recreational activities include wildlife observation, hiking, photography, environmental education, and limited hunting and camping.

A 6,000-square-foot visitor center was recently constructed that includes a gift shop, interpretive displays, and a small theatre/meeting room. Films and exhibits highlight the unique qualities of the refuge's water resources and wildlife. A main feature is a large deck and rear panel of windows set directly above a bluff that overlooks refuge wetlands.

An 8.5-mile auto tour route circles most refuge wetlands and provides visitors with an opportunity to view a variety of habitats and diverse wildlife from several stops and overlooks. There are four short and two longer hiking trails adjacent to the wildlife drive or refuge headquarters. The Bitter Lake NWR is identified as a Watchable Wildlife Site in New Mexico and the most popular public use activity on the refuge is wildlife observation. Traditionally, late fall and early winter are the most popular times for visitors who come to witness the large concentrations of ducks, geese, and sandhill cranes. Some observation areas are wheelchair accessible and include interpretive panels. The refuge also has an observation area for the South Tract along Highway 380.

Endangered species tours are scheduled from October through May to take visitors into areas normally closed to the public, allowing them to see some of the unique sinkholes and springs protected by the refuge. In late summer there is a dragonfly festival conducted with the assistance of the Friends of Bitter Lake NWR, which works with the refuge to increase public awareness and appreciation of the refuge and to support school outreach and special projects.

A variety of other wildlife-oriented activities attract visitors to the refuge. Photography is popular with both amateurs and professionals, and typically about twenty percent of visitors comment that they were taking photographs during their visit. Bicycling has become more popular and is permitted on the auto tour loop or the refuge's paved four-mile (round trip) bike trail. The entire North Tract is open to hiking and horseback riding, the latter being the most popular activity in the Salt Creek Wilderness. Camping is allowed in the Salt Creek Wilderness by special use permit only, but few visitors make use of this area for backpacking or camping due to the lack of drinking water in the area. The refuge also provides a small camping area about one mile east of headquarters for organized scout and youth groups. The area is available to groups by special use permit. Waterfowl, sandhill crane, quail, dove, pheasant, and deer hunting are available at the refuge seasonally. Fishing is prohibited at the Bitter Lake NWR to protect native fish species (Research Management Consultants 1998).

3.9 Visual Resources

Visual resources refer to both the natural and artificial landscape features that contribute to perceived visual images and the aesthetic value of a view. This value is determined by contrasts, forms, and textures exhibited by geology, hydrology, vegetation, wildlife, and human-made features. Individuals respond differently to changes in the physical environment, depending on prior experiences and expectations and proximity and duration of views. Therefore, visual effects analyses tend to be highly subjective. Because of the land use as a wildlife refuge and primary visitor use as a location for wildlife observation, the refuge is more visually sensitive than an area used for industrial, commercial, or residential purposes.

The visual resources of the Bitter Lake NWR have not been formally assessed. The proposed project area is east of the auto tour loop in the Middle Tract of the Bitter Lake NWR. Typical views from the west side of the auto tour loop and the visitor center site include a broad valley that ends abruptly on the east side with a mesa. Playa lakes and human-made impoundments dominate the valley floor. The river corridor is just below the mesa, and the oxbows extend to the west. The river itself is not visible, but its location is outlined by native and nonnative riparian vegetation. Riparian and wetland vegetation are also associated with the impoundments, playa lakes, and ditches. Other vegetation is sparse and includes typical Chihuahuan shrub/grassland species with some weedy areas. There are some areas that have been cleared. The east side of the auto tour

loop is in the valley and is east of most of the impoundments. Views to the project area do not include the visual quality available from the west side.

3.10 Noise

Noise is generally defined as unwanted or harmful sound. Noise may be intermittent or continuous, steady or impulsive. Vibration is an element of impulsive noise that can cause annoyance and structural damage. Human response to noise is extremely diverse and varies according to the type of noise source, the sensitivity and expectations of the receptor, the time of day, and the distance between the source and the receptor. Noise also can adversely affect and disturb wildlife. Noise analyses focus on the effects on sensitive receptors.

There are no noise studies at the Bitter Lake NWR, but noise levels are very low and typical of remote areas. Visitor and refuge vehicles, maintenance activities and equipment, and aircraft are the primary sources of occasional and intermittent noise. As a wildlife refuge and a location for wildlife observation, there is a higher degree of sensitivity to increases in noise levels.

3.11 Socioeconomic Resources

The Bitter Lake NWR is in Chaves County. The population, demographic, and economic characteristics of Chaves County are detailed in Table 3-2, along with comparable data from the state of New Mexico and the US. The estimated population of the county in 2006 was 62,474, an increase of 1.8 percent from 2000 (61,382). During the same period, New Mexico's population increased by 7.5 percent (from 1,819,046 to 1,954,599), and the US population increased by 6.4 percent (from 281,421,906 to 299,393,484). Roswell is the largest city in Chaves County, with a population of 45,582 in 2006. Major employers include government, health care and social assistance, accommodations and food service, manufacturing, agriculture, construction, transportation, and warehousing. Total non-farm employment in the county increased by 4.2 percent from 2000 to 2005, compared with an 8.4 percent increase in New Mexico and an 2.0 percent increase in the US. Per capita personal income increased in the area by 11.9 percent from 1993 to 2003. This compares with a 15.5 percent increase in New Mexico and a 15.6 percent increase in the US (Fedstats 2008; US Census 2006; NMDWS 2008a, 2008b; USDA ERS 2008a, 2008b, 2008c; and Service 2005c).

Table 3-2
Population, Demographics, Economic Characteristics, and Poverty Status

	Chaves County	New Mexico	United States
Total Population (2006 Estimate)	62,474	1,954,599	299,398,484
Percent White (2006)	94.1	84.6	80.1
Percent Black (2006)	2.3	2.5	12.8
Percent American Indian, Eskimo, or Aleut (2006)	1.4	9.8	1.0
Percent Asian (2006)	0.9	1.3	4.4
Percent Native Hawaiian or Other Pacific Islander (2006)	..01	0.1	.2
Percent reporting two or more races (2006)	1.2	1.6	1.6
Percent reporting Hispanic/Latino Origin (2006; may be of any race)	47.4	44.0	14.8
Percent unemployment rate (2007)	3.6	3.5	4.6
Personal income per capita (2003)	$22,300	$25,670	$31,472
Median household income (2005)	$32,124	$37,603	$46,242
Percent Below Poverty (2005)	22.5	18.4	13.3

Original data were gathered from a variety of sources and may have been derived using different methods.
Race and ethnic categories are based on self-reporting during the decennial census.
Sources: Fedstats 2008, US Census 2006, NMDWS 2008a, 2008b; USDA ERS 2008a, 2008b, 2008c; and Service 2005c

The Roswell Chamber of Commerce lists the refuge as one of the area's main attractions. Visitor recreation expenditures for the refuge totaled $666,400 in 2004, with nonresidents accounting for $457,300 (69 percent of total expenditures). Refuge visitor spending in 2004 totaled $908,000. In turn, this generated 11 jobs (both full-time and part-time), with total job income of $227,000. Total county, state, and federal tax revenue generated by the refuge amounted to $179,000 (US Fish and Wildlife Service 2005c).

3.12 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. This Executive Order requires federal agencies to identify and address disproportionately high or adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income populations. Consideration of environmental justice concerns includes race and ethnicity data and the poverty status of populations, as shown in Table 3-2. The 2005 estimated median household income in Chaves County was $32,124, and 22.5 percent of the residents were classified as living in poverty, a higher percentage than in New Mexico or in the US. Minority populations, as defined by the US Census Bureau, are present in the county (NMDWS 2008a, 2005b; USDA ERS 2005a, 2005b, 2005c).

3.13 Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in assets held in trust by the United States through the Department of the Interior, Bureau of Indian Affairs, for Indian tribes or individual Indians. This trust responsibility requires that all federal agencies, including Reclamation, ensure their actions protect Indian Trust Assets.

"Assets" are anything owned that has monetary value. The asset need not be owned outright but could be some other type of property interest, such as a lease or a right of way. They can be real property, physical assets, or intangible property rights. Common examples of trust assets may include lands, minerals, hunting and fishing rights, water rights, other natural resources, and money. "Legal interest" means there is a primary interest for which a legal remedy, such as compensation or injunction, may be obtained if there is improper interference. Trust assets do not include things in which a tribe or individual have no legal interest, such as off-reservation sacred lands in which a tribe has no legal property interest. It should be noted that other federal laws pertaining to religious or cultural laws should be addressed if impacts on such lands were to occur from Reclamation actions.

No issues involving Indian Trust or specific ITAs were identified in the Pecos River Basin during the preparation of the Carlsbad EIS (Reclamation 2006a). Letters regarding the proposed restoration at Bitter Lake NWR were sent to representatives of 12 tribes and Native American pueblos on June 20, 2007 (See Chapter 6). No ITA issues have been identified to date.