Information Sheet on Ramsar Wetlands (RIS) – 2009-2012 version

Available for download from http://www.ramsar.org/ris/key_ris_index.htm.

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 14, 3rd edition). A 4th edition of the Handbook is in preparation and will be available in 2009.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

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1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD MM YY

Designation date | Site Reference Number

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2. Date this sheet was completed/updated:
March 16, 2009

3. Country:
USA

4. Name of the Ramsar site:

Roswell Artesian Wetlands (Bitter Lake National Wildlife Refuge and Bottomless Lakes State Park)

5. Designation of new Ramsar site or update of existing site:

This RIS is for (tick one box only)**:**
a) Designation of a new Ramsar site ☒; or
b) Updated information on an existing Ramsar site ❑

6. For RIS updates only, changes to the site since its designation or earlier update:
a) Site boundary and area

The Ramsar site boundary and site area are unchanged: ❑
or
If the site boundary has changed:
i) the boundary has been delineated more accurately ❑; or
ii) the boundary has been extended ❑; or
iii) the boundary has been restricted** ❑

and/or

If the site area has changed:
i) the area has been measured more accurately ❑; or
ii) the area has been extended ❑; or
iii) the area has been reduced** ❑

** **Important note**: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in

the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

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7. Map of site:

Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

i**) a hard copy** (required for inclusion of site in the Ramsar List): ☒;

ii**) an electronic format** (e.g. a JPEG or ArcView image) ☒;

iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** ❑.

b) Describe briefly the type of boundary delineation applied:

The Roswell Artesian Wetlands include those wetlands on Bitter Lake National Wildlife Refuge and on Bottomless Lakes State Park near Roswell, New Mexico, USA (see Map).

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8. Geographical coordinates (latitude/longitude, in degrees and minutes):

The Roswell Artesian Wetlands are located in two separate regions:
Roswell Artesian Wetlands (Bitter Lake National Wildlife Refuge) is at: 33° 27.2' N; 104° 23.9' W
Roswell Artesian Wetlands (Bottomless Lakes State Park) is at: 33° 19.2' N; 104° 19.8' W

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9. General location:

The Roswell Artesian Wetlands are located in the United States of America, in the State of New Mexico, approximately 21 km (13 miles) northeast and 19 km (12 miles) southeast of the City of Roswell, in Chavez County. The site is located roughly 323 km (201 miles) from Albuquerque, New Mexico.

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10. Elevation: (in metres: average and/or maximum & minimum)

Average elevation of the Roswell Artesian Wetlands (Bitter Lake National Wildlife Refuge) is 1063 m; Average elevation of the Roswell Artesian Wetlands (Bottomless Lakes State Park) is 1054 m;

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11. Area: (in hectares)

The total area of the Roswell Artesian Wetlands is 917hectares. There are 877 hectares of wetlands on the Bitter Lake National Wildlife Refuge and 40 hectares of wetlands on the Bottomless Lakes State Park.

The total area of Bitter Lake National Refuge total area (Middle Tract) is 4,585 hectares and the total area of Bottomless Lakes State Park is approximately 500 hectares.

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Roswell Artesian Wetlands are situated along the Pecos River but are largely fed by natural groundwater discharge from the Roswell Basin that forms a series of springs, seeps and sinkhole lakes at Bitter Lakes National Wildlife Refuge and at Bottomless Lakes State Park east of Roswell, New Mexico. These groundwater discharges form extensive saltgrass marshes, iodine bush flats, sacaton flats, and cattail and bulrush marsh communities. These wetlands provide significant habitat for a diverse assemblage of plants and animals including several endemic species as well as many waterfowl, wading birds and migratory songbirds. Notably, these wetlands are home to one of the largest collections of dragonflies and damselflies in the world (over 100 species). These springs, sinkhole lakes, creeks and wetlands are an exceptional resource for recreation, education and research and they play an important role in the hydrology of the Pecos River as well as are important economically for the communities of Chavez County and the surrounding areas in New Mexico, USA.

13. Ramsar Criteria:

Tick the box under each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11). All Criteria which apply should be ticked.

1	2	3	4	5	6	7	8	9
☒	☒	☒	☐	☒	☒	☒	☐	☐

14. Justification for the application of each Criterion listed in 13 above:

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

Substantial natural subterranean groundwater discharge occurs at the Roswell Artesian Wetlands (Bitter Lakes National Wildlife Refuge and Bottomless Lakes State Park) as manifested by a number of springs, seeps, extensive wetlands, and sinkholes formed in the gypsum bedrock of the karst terrain . The Roswell Artesian Wetlands contain unique examples of small-to-large, deep, round, steep-sided sinkholes (also known as "collapse dolines" or *cenotes*) that are fed by artesian groundwater. These sinkhole lakes were formed by solution of gypsum- and limestone-bearing rocks resulting in caverns and collapsed domed roofs that are accessible from the surface (Land 2003). Water discharging from springs, seeps and sinkholes is brackish to saline, with high sulfate, chloride, and total ion concentrations.

Additionally, permanent rivers/streams/creeks including the floodplain of the Pecos River and permanent saline/brackish/alkaline lakes occur on the Roswell Artesian Wetlands providing a critical source of water and habitats to a variety of plants and animals of the Chihuahuan Desert.

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Quality of the brackish water varies, but several sinkhole lakes and springs support unique native fish and invertebrate communities including Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's springsnail (*Juturnia kosteri*), and Noel's amphipod (*Gammarus desperatus*), which represent relict species once associated with the Permian seas that once covered this area. These 2 molluscs and a crustacean are federally-listed as endangered and are found no where else in the world. These invertebrates have only recently been described. Noel's amphipod was described as a new species in 1981 (Cole, 1981), whereas Roswell springsnail and Koster's springsnail were described as new species in 1987 (Taylor, 1987). The snails are in the family Hydrobiidae and are small, barely visible to the naked eye. Roswell springsnail and Koster's springsnail are light tan colored with shell lengths ranging from 2.5 to 4.5 mm (0.1 to 0.2 inches) and shells have four to five moderately convex whorls (Hershler 1994). Noel's amphipod is greenish-brown colored, with bands of red on the sides of the body. Noel's amphipod ranges in length from 1 to 1.5 mm (0.4 to 0.6 inches) (Cole 1981, 1988). The entire distribution of these invertebrate species consists of a few small, isolated aquatic habitats in the Roswell Artesian Wetlands. Recent population extinctions caused by habitat loss and degradation have been documented for all species (Cole 1981, 1988; Taylor, 1987; Lang 1998).

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

The Roswell Artesian Wetlands provides habitat for numerous rare and protected species including Pecos sunflower (*Helianthus paradoxus*); Wright's marsh thistle (*Cirsium wrightii*); Pecos pupfish (*Cyprinodon pecosensis*); Mexican tetra (*Astyanax mexicanus*); Pecos Gambusia (*Gambusia nobilis*); Pecos bluntnose shiner (*Notropis simus pecosensis*); greenthroat darter (*Etheostoma lepidum*); Pecos assiminea (*Assiminea pecos*), wrinkled marsh snail (Stagnicola caperata); Blanchard's cricket frog (*Acris crepitans blanchardi*); arid land ribbon snake (*Thamnophis proximus diabolicus*); least shrew (*Cryptotis parva*); Pecos River muskrat (*Ondatra zibethicus ripensis*); and, interior least tern (*Sterna antillarum*) (New Mexico Department of Game and Fish 1988).

Roswell Artesian Wetlands is one of the most biologically significant wetlands in the Chihuahuan Desert. The sinkhole lakes, streams, springs and seeps or *cienegas*, saltgrass marshes, mudflats, and seasonally and permanently flooded wetlands play a critical role in the life cycles of a remarkable diversity of species, including 24 fish species, 352 bird species, 57 mammal species, 62 amphibian and reptile species, and over 100 varieties of dragonflies and damselflies including the one of the largest dragonflies found in the United States (*Anax walsinghami*) and one of the smallest damselflies (*Ischnura hastate*).

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Staff and volunteers of Bitter Lake National Wildlife Refuge have conducted waterbird counts on wetlands on a weekly or bi-weekly basis for many years. Although large areas of the proposed Roswell Artesian Wetlands are not regularly surveyed during these efforts, counts of

waterbirds including waterfowl, cranes, rallids, wading birds, shorebirds, gulls and terns have exceeded 20,000 individuals in the months of November, December, January, and February (Research Management Consultants, Inc. 1998). Ducks numbering between 5,000 and 20,000 and geese numbering 20,000 to 40,000 can be observed during fall migrations. Large numbers terminate their migration in this area while others continue into Mexico. Food is provided on the refuge by native aquatic plants as well as cultivated crops. Many of the birds leave the wetlands daily to forage in grain fields throughout the Pecos River Valley. The most numerous birds are typically greater and lesser sandhill crane (*Grus canadensis*), American coot (*Fulica americana*), snow geese (*Chen caerulescens*), Ross's geese (*Chen rossii*), Canada geese (*Branta canadensis*), northern pintail (*Anas acuta*) , mallard (*Anas platyrhynchos*), green-winged teal (*Anas crecca*), American wigeon (*Anas americana*) , northern shoveler (*Anas clypeata*) , and ring-billed gull (*Larus delawarensis*).

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Assuming a total estimated population of more than 500,000, the Sandhill Crane is the most abundant of the world's cranes (Meine and Archibald 1996). One percent of that population would be 5,000 birds. Sandhill Cranes have been counted during migratory birds surveys on Bitter Lake National Wildlife Refuge for decades, with careful records having been kept for over 20 years (Research Management Consultants, Inc. 1998). Although numbers vary substantially from week to week and year to year, in recent years crane numbers have regularly exceeded 5,000 individuals from mid October through mid February. A peak of nearly 21,000 cranes in late October 2008 was the highest number recorded on the refuge since the early 1980s.

Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

The Roswell Artesian Wetlands are home to 24 native species of fish, which is the most diverse native fish fauna remaining in state of New Mexico. As such, the Roswell Artesian Wetlands represent perhaps the most important sites for the conservation of the unique fish fauna of the Pecos River and the Chihuahuan Desert. In addition to supporting all the life stages of Pecos gambusia, Pecos bluntnose shiner, Pecos pupfish, Mexican tetra, Pecos pupfish, and greenthroat darter, the Roswell Artesian Wetlands provide habitat for rainwater killifish (*Lucania parva*); plains killifish (Fundulus zebrinus); roundnose minnow (*Dionda episcopa*); speckled chub (*Extrarius aestivalis*); red shiner (*Cyprinella lutrensis*); plains minnow (*Hybognathus placitus*); Rio Grande shiner (*Notropis jemezanus*); fathead minnow (*Pimephales promelas*); sand shiner (*Notropis stramineus*); longnose dace (*Rhinichthys cataractae*); river carpsucker (*Carpoides carpio*); flathead catfish (*Pylodictis olivaris*); bluegill (*Lepomis macrochirus*); green sunfish (Lepomis cyanellus); bigscale logperch (*Percina macrolepida*); walleye (*Etheostoma lepidum*); largemouth bass (*Micropterus salmoides*); gizzard shad (*Dorosoma cepedianum*); and mosquitofish (*Gambusia affinis*). Unique intact communities of native fish occur in the sinkhole lakes such as Lake Saint Francis, Lea Lake, and Inkwell Lake as well as in Bitter Creek, and various impoundments, ditches, springs and wetlands and the Pecos River. Numerous studies have been conducted on these fish communities and their interactions (Blue Earth 2006; Brandenburg and Farrington 2003; Echelle and Echelle 1980; Hoagstrum and

Brooks 1999; New Mexico Department of Game and Fish 1959, 1988, 1998; Sublette et al. 1990; United States Fish and Wildlife Service 1982, 1992).

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

a) biogeographic region:

Chihuahuan Desert

b) biogeographic regionalisation scheme (include reference citation):

Olson, D.M, Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P. & Kassem, K.R. 2001. Terrestrial Ecoregions of the World: a new map of life on Earth. *BioScience* 51:933-938. (Available at: http://www.worldwildlife.org/science/ecoregions/item1267.html).

16. Physical features of the site:

The Roswell Artesian Basin, located in the lower Pecos Valley of southeastern New Mexico has been characterized as a two-aquifer system (Fiedler and Nye 1933), consisting of an eastward-dipping carbonate aquifer overlain by a leaky confining unit, which is in turn overlain by an unconfined alluvial aquifer (Land 2003). Groundwater is stored in the carbonate aquifer in multiple highly porous and transmissive zones within the middle Permian San Andres Limestone, and to a lesser extent in the overlying Grayburg and Queen Formations. Secondary porosity in the carbonate aquifer consists of cavernous limestones, solution-collapse breccias, and solution-enlarged fractures and bedding planes (Land 2003).

At the Roswell Artesian Wetlands there is a cluster of sinkhole lakes adjacent to the Pecos River. They range in depth from 5 to 27 m (17 to 90 feet), and surface acre size varies from less than 1 hectare up to 6 hectares (less than 1 to 15 acres). These lakes are sinks, formed when circulating underground water dissolved gypsum and limestone deposits to form subterranean caverns. These lakes were created and continue to be fed by groundwater originating in the Sacramento Mountains far to the west. This water travelled eastward through the San Andres Formation and then upward in the form of springs. This artesian flow caused the lakes to continuously overflow until the early 1900s, when intensive pumping of groundwater for irrigation caused regional declines of water tables and artesian pressures. Discharge from the artesian aquifer via the Roswell Artesian Wetlands flows overland and through channels and impoundments supporting adjacent wetlands and riparian areas and ultimately flows the Pecos River.

Water chemistry measurements show generally high dissolved solids at the sinkhole lakes and springs, although mineral content is highly variable (see table below; Land 2003). The highest total dissolved solids (TDS) values are from the playa called Bitter Lake (BL-4). high concentrations were also measured in the sample collected from Lake St. Francis and Lea Lake (BLSP), the largest sinkhole lakes on the Roswell Artesian Wetlands (Land 2003).

Sample	Location	TDS (mg/L)	Conductivity (µS/cm)	Chloride (mg/L)	Sulfate (mg/L)	pH
BL-1	Lake St. Francis sink	9,628	16,000	3,450	2,850	6.83
BL-2	Sinkhole 59	4,627	6,740	1,150	1,900	6.91
BL-3	Sago Spring	5,729	8,870	2,050	1,750	6.82
BL-4	Bitter Lake	95,032	105,000	53,800	11,400	8.48
BL-5	Lost River spring	6,452	9,630	2,300	1,850	7.54
BL-6	Bitter Creek	6,227	9,530	2,300	1,740	7.46
BL-7	Snail Unit spring	3,615	5,970	1,300	880	7.37
BL-8	Hunter Marsh spring	4,798	8,230	2,150	870	7.29
BL-9	Roswell spring	5,177	8,730	2,300	940	7.25
BLSP	Lea Lake spring	7,987	13,300	2,950	2,175	6.87

The Roswell Artesian Wetlands include a large variety of surface water types, including arroyos, spring-fed streams, isolated oxbow lakes, large and small playa lakes, managed impoundments, artesian springs, and approximately sixty-seven sinkhole lakes. Wetland management and ciengia systems have influenced the abundance and distribution of wetland communities (Donnelly 2008). Areas of intermediately flooded mud flats make up a large portion of the wetland but they are seasonally variable and inversely proportional the extent of open water in the impoundments. The majority of emergent wetland communities are found at the fringes of these impoundments and lakes at the minimum and maximum extent of water management levels. Areas managed for more stable water levels or as flowing spring systems, contained denser and more mature vegetative communities (Donnelly 2008).

Deleted: ¶

17. Physical features of the catchment area:

The physiography around the Roswell Artesian Wetlands include deep depressions or grabens filled with sediment to form flat to rolling basins. Surface basins are either alluvial basins surrounding the Pecos River or internally drained. Surficial and bedrock geology is Permian, Quaternary and some late Tertiary alluvium and erosional materials from surrounding mountains, including unconsolidated basin deposits of silt, sand, and gravel as well as piedmont and fan alluvium, river alluvium, lacustrine and playa deposits, eolian deposits, and calcretes. Soil orders include Aridisols and Entisols. Mean annual precipitation ranges from 23 to 33 cm (9-13 inches). Mean annual frost free days range from 190 to 220. Mean January temperature ranges from -4 to 14 C (25° to 57° F) and Mean July temperature ranges from 19 to 35 C (66° to 95° F). The rainy season usually runs from mid-June to late August, and the average relative humidity is 48 percent. Late winter and spring are the seasons most closely associated with moderate to strong winds, which can bring blowing dust. Surrounding area consists of shrubland, desert grasslands, and barren land. Land uses include wildlife habitat, limited livestock grazing, public and private land. Nearby land use includes some irrigated cropland of mostly hay and alfalfa, with some cotton, chile peppers, onions, pecans, and corn or sorghum for silage. Also, oil and gas extraction, dairy operations and some urban land occurs near Roswell, New Mexico.

18. Hydrological values:

The Pecos River is the largest tributary of the Rio Grande. 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. This groundwater also preserves perennial flows in the Pecos River. These wetlands have a perennial source of water that is not readily affected by

drought and as such they have preserved animal species such as molluscs and crustaceans for thousands of years.

19. Wetland Types

a) presence:

Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • O • P • Q • R • Sp • Ss • Tp Ts • U • Va • Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

The Roswell Artesian Wetlands are approximately:
345 hectares Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools;
182 hectares R -- Seasonal/intermittent saline/brackish/alkaline lakes and flats;
43 hectares Sp -- Permanent saline/brackish/alkaline marshes/pools;
109 hectares Q -- Permanent saline/brackish/alkaline lakes;
83 hectares 6, 9 – Human-made impoundments, ditches and canals;
68 hectares W -- Shrub-dominated wetlands;
53 hectares M -- Permanent rivers/streams/creeks;
18 hectares N -- Seasonal/intermittent/irregular rivers/streams/creeks.
18 hectares Zk(b) – Karst and other subterranean hydrological systems, sinks;
Annex 1

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

According to Donnelly (2008), the plant communities in the Roswell Artesian Wetlands are influenced significantly by the hydrology of the Pecos River and artesian spring systems that occur there. Within managed wetlands of the spring systems (cienegas) salt grass (*Distichlis spicata*), alkali bulrush (*Schoenoplectus maritimus*), pickle weed (*Salicornia* spp.) and iodine bush (*Allenrolfea occidentalis*) are most common. Areas of the historic Pecos River floodplain are dominated by alkali sacaton (*Sporobolus airoides*) while riparian shrub species occupy the active floodplain adjacent to the river channel.

Alkali sacaton (*Sporobolus airoides*) occurrs within the floodplain and playas associated with iodine bush. The community commonly occurs in very robust sod like mats on low benches and transition zones adjacent to playas or cienegas wetlands interspersed with salt grass and low densities of iodine bush (*Allenrolfea occidentalis*). It also occurs in alkaline flats along the margins of salt lakes, in depressions among gypsum ridges, and along washes in saline overflow areas. These communities occur at sites which are seasonally moist or flooded and where evaporation concentrates transported salts, leaving visible mineral crusts at the soil surface. The nominal species can cover large acreages, with little else except barren soil. Within playas, sparse areas of iodine bush was often co-dominate or a dominate species to alkali sacaton.

Intermittently flooded salt grass (*D. spicata*) communities occur at playas, swales and terraces along washes that are intermittently flooded. The flooding is usually the result of highly localized thunderstorms. The unpredictable nature of the flooding is the key environmental factor separating this alliance from similar alliances with more predictable flooding regimes. Soils in the area are calcareous and generally have an impermeable layer and therefore are poorly drained. This intermittently flooded grassland of playas and ephemeral streams has a sparse to dense herbaceous layer that is dominated by *D. spicata*, sometimes occurring in nearly pure stands. The level of salinity in the soil may restrict associated species. Pecos sunflower cienega wetlands are also found in the margins of emergent ciengea wetlands occurring as a dense monotypic over story, usually within an under story of saltgrass. Dense, monospecific stands of *Phragmites australis*, narrowleaf cattail, and broadleaf cattails occurred in flooded marshes, ditches, impoundments and river backwaters (Donnelly 2008).

The uplands and mesas around the Roswell Artesian Wetlands can be characterized as Chihuahuan Gypsophilous Grassland and Steppe. These areas are dominated by gypsiferous soils and associated grassland and shrubland; gyp dropseed (*Sporobolus nealleyi*), gyp grama (*Bouteloua breviseta*), fourwing saltbush (*Atriplex canescens*) and hairy clinklemat (*Tiquilia hispidissima*). The eastern edge of the Roswell Artesian Wetlands touches the western escarpment of the Llano Estacado. This area is characterized by the red sandstone cliffs of the seven rivers geologic formation that rise from the Pecos river floodplain. Alluvial fans at the base of the escarpment are predominately alkali sacaton (*Sporobolus airoides*), but can be dominated by associated shrubland species; fourwing saltbush (*Atriplex canescens*) and honey mesquite (*Prosopis glandulosa*) as well. The rocky escarpments and mesa tops contain both grassland and shrubland similar to those species compositions found on the western uplands of the refuge, but are characterized more typically shrubland.

Permanent and seasonally flooded saltgrass and iodine bush communities made up the largest vegetated portion of wetland communities types, or approximately half of the total wetland communities in the Roswell Area Wetlands. Other emergents communities such as alkali bulrush, American bulrush (*Schoenoplectus americanus*), cattail (*Typha* spp.), phragmites (*Phragmites australis*), Pecos sunflower (*Helianthus paradoxus*), prairie cordgrass (*Spartina pectinata*) and pickleweeed were prevalent across the wetlands, but only abundant in specific areas of the wetland system (Donnelly 2008).

These wetlands serve as feeding, resting and breeding habitat for a variety of animal communities. Management emphasis on these wetlands emphasize protecting and enhancing habitat for rare species, maintaining biological diversity, maintaining and improving wintering crane and waterfowl habitat, and monitoring and maintaining natural ecosystem values.

21. Noteworthy flora:

Pecos Sunflower (*Helianthus paradoxus*) was listed as threatened under the federal Endangered Species Act on 20 October 1999. Habitat of Pecos sunflower is saturated, saline soils of desert wetlands associated with rivers and spring systems from 3,300 to 6,600 feet elevation. The species is restricted to saline wetland habitats and requires saturated soils for seed germination; adult plants grow well in standing water (New Mexico Rare Plant Technical Council 2005). The largest populations of Pecos sunflower occur on the Roswell Artesian Wetlands. Pecos sunflower is an annual, herbaceous plant. It grows 1-3 m (3.3 - 9.9 feet) tall and is branched at the top. The leaves are opposite on the lower part of the stem and alternate at the top, lance-

shaped with three prominent veins, and up to 17.5 cm (6.9 inches) long by 8.5 cm (3.3 inches) wide. The stem and leaf surfaces have a few short, stiff hairs. Flower heads are 5-7 cm (2.0-2.8 inches) in diameter with bright yellow rays around a dark purplish brown center (the disc flowers). Pecos sunflower looks much like the common sunflower seen along roadsides throughout the West, but differs from common sunflower by having narrower leaves, fewer hairs on the stems and leaves, smaller flower heads and narrower bracts around the bases of the heads.

22. Noteworthy fauna:

The Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's springsnail (*Juturnia kosteri*), and Noel's amphipod (*Gammarus desparatus*) are listed as endangered under the Endangered Species Act of 1973, as amended. The Roswell springsnail and Koster's springsnail are snails (mollusks), while Noel's amphipod is a crustacean.

The Pecos pupfish (*Cyrpinodon pecosensis*) was listed as a threatened species by the State of New Mexico in 1988. The Pecos pupfish is a small, stout-bodied fish that seldom exceeds 60 mm (2.4 inches) and has rounded fins (Echelle and Echelle 1980). Pupfish are said to derive their common name from the mating habits of the males, whose activities resemble puppies at play. The Pecos pupfish formerly occupied in the Pecos River, several small tributaries, saline springs and sinkhole lakes in the Pecos River Valley from Roswell, New Mexico to the Rio Grande in Texas. However, Pecos pupfish was largely eliminated from the Pecos River by the introduction of the nonnative sheepshead minnow (*Cyprinodon variegates*) which hybridize with Pecos pupfish. Pecos pupfish can survive periods of depressed oxygen concentrations and are common in habitats having elevated salinities ranging from 3,000 to 50,000 mg/L total dissolved solids (Hoagstrum and Brooks 1999). Pecos pupfish are now associated with off-channel habitats in the Roswell Artesian Wetlands and Salt Creek in Texas. Fish barriers have been constructed on the largest surface water connections between the Roswell Artesian Wetlands and the Pecos River to thwart migration of the sheepshead minnow into Pecos pupfish habitat.

Least shrew (*Cryptotis parva*) is most often found in mesic habitats, including marshy areas (Frey 2005). The fur of least shrew is short, dense and velvety. In winter the upper fur is reddish brown to black and the underside is white. Least shrew may construct burrows. Nests are constructed of loosely piled grass or leaves. Nesting is communal and breeding likely occurs mainly in spring and summer. Litter size ranges from three to seven. Young reach near adult size about 30 days after birth. Least shrews are voracious carnivores and consume insects, arthropods, snails and earthworms. Least shrew forages mainly at night, but may be active all day (Frey 2005). Suitable habitat for least shrew is found throughout the Roswell Artesian Wetlands and the species was recently collected at Lea Lake marsh (Frey 2005).

Historically, bluntnose shiner (*Notropis simus*), were found in main channel habitats of the Rio Grande and Pecos River in New Mexico and Texas. The Rio Grande subspecies (*Notropis simus simus*) went extinct by 1970 and only the Pecos River subspecies (*Notropis simus pecosensis*) remained. In 1987, the Pecos bluntnose shiner was listed as threatened. Water diversion, groundwater withdrawl, and intermittent water flow was identified as the greatest threat to the shiner and its habitat. The Pecos bluntnose shiner is a relatively small, moderately deep-bodied minnow, rarely exceeding 8 cm (3.2) 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. Female shiners spawn in response to rapid increases in river flow caused by summer rainstorms. Females release semi-buoyant 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 or they perish. Current restoration of oxbow lakes connected to the Pecos River on the Roswell Artesian Wetlands may offer conditions that reduce downstream displacement and provide low-velocity habitats are favorable for successful shiner survival and recruitment.

Sandhill crane (*G. canadensis*) is a large, gray, long-necked, long-legged bird of open grasslands and freshwater marshes. Their average wingspan is 200 cm (79 inches). They can live up to 20 years in age and mated pairs stay together year round, and migrate south as a group with their offspring. Sandhill cranes migrate from across the hemisphere to the Roswell Artesian Wetlands in winter. Large flocks of cranes feed mostly on grains and seeds, some insects, other invertebrates, and small vertebrates in the wetlands and surrounding agricultural areas and roost in the wetlands during the evenings. They are noted for their distinctive, penetrating bugling calls and for their elaborate courtship rituals.

The Roswell Artesian Wetlands have an exceptionally high diversity of dragonfly and damselfly species. Its location in eastern New Mexico puts these wetlands within the range of many eastern, western and southern dragonfly and damselfly species. The life cycle of these insects require water and wetlands: thus, the rich species diversity is supported by the Roswell Artesian Wetland's wide variety of aquatic habitats; including seeps and springs, brackish lakes, marshes, and the Pecos River with its old oxbows that are an ideal place to find dragonflies and damselflies. Larson (2005) has reported over 100 species of darners, skimmers, cruisers, dancers, spreadwings, forktails, pennants, bluets, clubtails and pondhawks including the one of the largest dragonflies found in the United States (*Anax walsinghami*) and one of the smallest damselflies (*Ischnura hastate*) at these wetlands.

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23. Social and cultural values:

a) Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

In the 1800's, the sinkhole lakes were a stopover for those herding cattle through New Mexico Territory on the Goodnight-Loving Trail. After cowboys tried unsuccessfully to find the bottom of the lakes with their lariats tied together, they dubbed the lakes "bottomless," even though the deepest of the lakes, Lea Lake, is only 90 feet deep. Lea Lake was named for Captain Joseph C. Lea, an early rancher and the founder of the city of Roswell, New Mexico. The Bottomless Lakes State Park was established as a park in 1933 and at that time, a group from the Civilian Conservation Corps (CCC) constructed the Lea Lake Recreation Building and the Lea Lake Tower that have a great deal of historic significance. These buildings display the meticulous rockwork of the CCC era. They are well-preserved examples of CCC recreational structures. Despite the modifications to the Lea Lake Recreation Building, both buildings retain architectural integrity and renovations can restore both to their original appearance. The Bottomless Lakes State park offers a variety of recreational experiences on the Lea Lake including swimming, scuba diving, boating, sailboarding and sailing.

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No.

If Yes, tick the box ❑ and describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

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24. Land tenure/ownership:
a) within the Ramsar site:

The portion of the Roswell Artesian Wetlands on Bitter Lake National Wildlife Refuge is owned by the United States Fish and Wildlife Service, a bureau of the Department of the Interior for the United States Government.

The portion of the Roswell Artesian Wetlands on Bottomless Lakes State Park is owned by the New Mexico State Parks, a Division of the Energy, Minerals, and Natural Resources Department of the State of New Mexico. Note that privately-owned land and other State of New Mexico land within Bottomless Lakes State Park (including Pasture Lake, Cottonwood Lake, and portions of Mirror Lake and Lazy Lagoon) are not included at this time.

b) in the surrounding area:
Privately owned land, land owned by the New Mexico State Land Office, and lands owned by the United States Bureau of Land Management, a federal bureau of the Department of the Interior are in the in the surrounding area of the Roswell Artesian Wetlands.

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25. Current land (including water) use:
a) within the Ramsar site:

The portion of the Roswell Artesian Wetlands on Bitter Lake National Wildlife Refuge is managed as a National Wildlife Refuge. Management emphasis on the Refuge is placed on the protection and enhancement of habitat for endangered species and federal candidate species, maintenance and improvement of wintering crane and waterfowl habitat, and monitoring and maintenance of natural ecosystem values. Habitat management to maintain populations of important neotropical migrants, shorebirds, and resident species associated with the lower Pecos ecosystem are also major objectives.

The portion of the Roswell Artesian Wetlands on Bottomless Lakes State Park is managed as a New Mexico State Park. Management emphasis on the Refuge is placed on interpretation and

education of the recreating public. The Park provides a quality outdoor recreation experience to all visitors through the protection of the natural environment, preservation of historic resources, and educational programming.

b) in the surroundings/catchment:

Nearby privately owned land, land owned by the New Mexico State Land Office, and land owned by the United States Bureau of Land Management are managed for agriculture, rangeland, grazing, oil, gas and mineral extraction, homesteads, recreation, fishing, hunting and conservation.

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:
a) within the Ramsar site:
b) in the surrounding area:

Threats to the Roswell Artesian Wetlands and surrounding area during the past, present and future include increased groundwater use surface water diversion, introduced and invasive species, population growth and development, air and water pollution, climate change, habitat degradation and changes in land use.

Ground water and surface water in the Pecos River basin are linked. The Roswell Basin provides unique conditions yielding large base water flows that emerge from the ground to form the Roswell Artesian Wetlands and flow to the Pecos River. These base flows are dependent on hydrologic factors and ground water pumping from both shallow and deep aquifers in the Roswell Groundwater Basin. During the 1930s to the 1960s, annual base flow gains in the Pecos River decreased to an average of 20 to 50 percent of early records. Intensive development of the ground water resources for irrigation supplies in the Roswell basin has significantly reduced base inflows compared to predevelopment levels (BR&NMISC 2006). Most of this decline was attributed to ground water development for irrigation water supplies (DBS&A 1995). By the late 1990s, base flows were stabilized by metering, reduced ground water pumping rates, and water conservation (BR&NMISC 2006).

The Roswell Artesian Wetlands have been invaded by the non-native plant species including the tree/shrub, saltcedar (*Tamarix chinensis*). Saltcedar is present through most of the Pecos River valley where it has been battled for decades due to its consumption of water, its tendency to increase soil salinity and to outcompete and replace many native plants, its reduced value as wildlife habitat, and its proclivity to promote wildfires, which it is able to tolerate better than most native trees and shrubs. Saltcedar reproduces and spreads rapidly and forms nearly impenetrable, monotypic stands in many riparian and wetland areas.

27. Conservation measures taken:
a) List national and/or international category and legal status of protected areas, including boundary relationships with the Ramsar site:

Portions of the Roswell Artesian Wetlands (Bitter Lake National Wildlife Refuge) are designated as a National Natural Landmark as well as a Research Natural Area.

b) If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate):

Ia ❑;Ib ❑; II ❑; III ❑; IV ❑; V ❑; VI ❑

c) Does an officially approved management plan exist; and is it being implemented?:

The Comprehensive Conservation Plan for Bitter Lake National Wildlife Refuge serves as a management tool used by Refuge staff and its partner's in the preservation and restoration of the ecosystem's natural resources (Research Management Consultants, Inc. 1998).

The Management and Development Plan for Bottomless Lakes State Park (New Mexico State Parks 2001) serves as a management tool used by the Administration to provide direction for the management and development of the state parks in a manner that enhances recreational opportunities, protects park resources, provides for public input and protects the natural environment.

d) Describe any other current management practices:

28. Conservation measures proposed but not yet implemented:

Restoration of portions of these Roswell Artesian Wetlands has been proposed on both the Bitter Lake National Wildlife Refuge (available at the Internet location: http://www.usbr.gov/uc/albuq/envdocs/ea/bitterlake/index.html) and Bottomless Lakes State Park (see Blue Earth (2006) and announcement available at the Internet location: http://www.spa.usace.army.mil/fonsi/Bottomless%20Lakes/Final/Notice%20of%20Availability%20of%20Final%20DPR%20and%20EA.pdf)

29. Current scientific research and facilities:
e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Project specific and ongoing monitoring and research is conducted by volunteers or biologists from various state and federal agencies, and local universities.

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

In 2008 the Joseph R. Skeen Visitor Centre was opened at Bitter Lake National Wildlife Refuge. In addition to hosting thousands of visitors each year Refuge staff frequently participate in youth education programs in the surrounding communities. Together, Bottomless Lakes State Park and Bitter Lake National Wildlife Refuge have developed and an Outdoor Classroom curriculum endorsed by the State of New Mexico Public Education Department.

31. Current recreation and tourism:
State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

In 2006, the Bottomless Lakes State Park had over 190,500 visitors that engaged in activities such as camping, picnicking, swimming, fishing, boating, sailing, diving, hiking, wildlife observation and geologic exploration and educational programs for adults and children. The

Park offers an interpretive program, "Enchanted Evenings at Bottomless Lakes" that is held on the Lea Lake beach every Saturday evening from Memorial Day through Labor Day.

In 2006, the Bitter Lake National Wildlife Refuge had over 71,000 visitors that engaged in activities such as hiking, hunting, scientific research and wildlife. The refuge is open year round during daylight hours (dawn to dusk). An annual Dragonfly Festival provides tours, activities and educational information about the wetlands.

32. Jurisdiction:
Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

The United States Government owns all lands associated with the Bitter Lake National Wildlife Refuge. The Department of Interior, United States Fish and Wildlife Service, is the managing agency of the refuge. The portion of the Roswell Artesian Wetlands on Bottomless Lakes State Park is owned by the State of New Mexico. The State Energy, Minerals, and Natural Resources Department, New Mexico State Parks, is the managing agency of the state park.

33. Management authority:

Steve Patterson, Park Administrator
Bottomless Lakes State Park
545 Bottomless Lakes Road, HC 12 Box 1200
Roswell, New Mexico 88201 USA
steve.patterson@state.nm.us
http://www.emnrd.state.nm.us/PRD/bottomless.htm

Joe Saenz, Refuge Manager
Bitter Lake National Wildlife Refuge
4067 Bitter Lake Road
Roswell, New Mexico 88201 USA
Joe_Saenz@fws.gov
http://www.fws.gov/southwest/refuges/newmex/bitterlake/

34. Bibliographical references:
Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

Blue Earth (Blue Earth Ecological Consultants, Inc.). 2006. Ecological Inventory and Analysis Report for Lea Lake Marsh. Bottomless Lakes State Park, Section 206 Aquatic Habitat Restoration Feasibility Study, U.S. Army Corps of Engineers, Albuquerque District. Blue Earth Ecological Consultants, Inc., Santa Fe, New Mexico.

Bureau of Reclamation and New Mexico Interstate Stream Commission (BR&NMISC). 2006. Carlsbad Project Water Operations and Water Supply Conservation Final Environmental Impact Statement. U.S. Bureau of Reclamation, Albuquerque, New Mexico. Available at the Internet location of http://www.usbr.gov/uc/albuq/library/eis/carlsbad/feis/index.html

Brandenburg, W. H. and M. A. Farrington. 2003. Population monitoring of Pecos pupfish, *Cyprinodon pecosensis*, in the Bureau of Land Management's Overflow Wetlands Wildlife Habitat Area, New Mexico. Prepared for the Bureau of Land Management, Roswell Field

Office by the American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Cole, G. A. 1981. *Gammarus desperatus*, a new species from New Mexico (Crustacea: Amphipoda). Hydrobiologia 76: 27-32.

Cole, G. A. 1988. A Report on Noel's Amphipod (*Gammarus desperatus*). Professional Services Contract 519-77-02, Endangered Species Program, New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Daniel B. Stephens and & Associates (DBS&A), 1995. Comprehensive Review and Model of the Hydrogeology of the Roswell basin, Volume 1: Report Text, Plates." Prepared for the New Mexico Office of the State Engineer.

Donnelly, P. 2008. Bitter Lake (Middle Unit) National Wildlife Refuge: Vegetation Inventory 2008. United States Fish and Wildlife Service, Southwest Region, National Wildlife Refuge System, Albuquerque, New Mexico.

Echelle, A. A., and A. F. Echelle. 1980. Status of the Pecos gambusia (*Gambusia nobilis*). United States Fish and Wildlife Service, Albuquerque, New Mexico.

Fiedler, A. G. and Nye, S. S. 1933. Geology and ground-water resources of the Roswell artesian basin: U.S. Geological Survey, Water-Supply Paper 639, 372 p.

Frey, J. K. 2005. Status and habitat of the least shrew (*Cryptotis parva*) in New Mexico. Conservation Services Division Report, New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Hershler, R. 1994. A Review of the North American Freshwater Snail Genus Pyrgulopsis (Hydrobiidae). Smithsonian Contributions to Zoology No. 554.

Hershler, R. 2001. Systematics of the North and Central American Aquatic Snail Genus Tryonia (Rissooidea:Hydrobiidae). Smithsonian Contributions to Zoology No. 612.

Hoagstrom, C. W. and J. E. Brooks. 1999. Distribution, status, and abundance of the Pecos pupfish, *Cyprinodon pecosensis*. Technical Report No. 2, New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Kelley, V. C. 1971. Geology of the Pecos country, southeastern New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 24, Soccoro, New Mexico. 78 p.

Land, L. A. 2003. Evaporite karst and regional groundwater circulation in the lower Pecos Valley in southeastern New Mexico. In: Johnson, K.S. and Neal, J.R. (editors). Evaporite karst and engineering environmental problems in the United States. Oklahoma Geological Survey Circular 109, Tulsa, Oklahoma.

Lang, B. K. 1998. Status of Aquatic Mollusks of New Mexico. Completion Report (E-20-6), Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.

Larsen, R.R. 2005. The dragonflies of New Mexico. Webpage at the Internet location: http://www.rt66.com/~kjherman/odonata/NMdrgnfly.html.

Meine, Curt D. and George W. Archibald (editors). 1996. The cranes: Status survey and conservation action plan. IUCN, Gland, Switzerland, and Cambridge, U.K. 294pp. Northern Prairie Wildlife Research Center Online. (Version 02MAR98). (Available at the internet location: http://www.npwrc.usgs.gov/resource/birds/cranes/index.htm).

New Mexico Department of Game and Fish. 1959. Basic Survey of the Bottomless Lakes. Job Completion Report, Job No. A-2-2, Federal Aid Project F-10-R-4. New Mexico Department of Game and Fish, Santa Fe, New Mexico.

New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Santa Fe, New Mexico.

New Mexico Department of Game and Fish. 1998. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish Project E-20-6, Santa Fe, NM.

New Mexico Rare Plant Technical Council. 2005. New Mexico rare plants. Albuquerque, New Mexico, New Mexico Rare Plants Home Page, http://nmrareplants.unm.edu (latest update: 9 June 2005).

New Mexico State Parks. 2001. Bottomless Lakes State Park management and development plan. New Mexico Energy, Minerals, and Natural Resources Department, State Parks Division, Santa Fe, New Mexico. (Available at the internet location: http://www.emnrd.state.nm.us/PRD/documents/BottomlessLakeStatePark.pdf).

Platania, S.P. and C. S. Altenbach. 1998. Reproductive Strategies and Egg Types of Seven Rio Grande Basin Cyprinids. Copeia 1998(3):559-569.

Research Management Consultants, Inc. 1998. Final Bitter Lake National Wildlife Refuge Comprehensive Conservation Plan, Roswell, New Mexico. United States Fish and Wildlife Service, Region 2, Albuquerque, New Mexico, USA. (Available at the internet location: http://library.fws.gov/CCPS/bitterlake_final98.pdf).

Sublette, J. E., M. D. Hatch, and M. Sublette. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

Taylor, D. W. 1987. Fresh-Water Mollusks from New Mexico and Vicinity. New Mexico Bureau of Mines and Mineral Resources Bulletin 116, Socorro, New Mexico.

United States Fish and Wildlife Service. 1982. Pecos Gambusia (*Gambusia nobilis*) recovery Plan. United States Fish and Wildlife Service, Albuquerque, New Mexico. iii +41 pp.

United States Fish and Wildlife Service. 1992. Pecos Bluntnose Shiner recovety Plan. U. S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico. 57 pp.