3.5 Northwestern New Mexico Uranium Milling Region

3.5.1 Land Use

The Northwestern New Mexico Uranium Milling Region defined in this GEIS lies within the Navajo section of the Colorado Plateau (U.S. Geological Survey, 2004). This region includes McKinley County and the northern part of Cibola County (Figure 3.5-1). Past, current and potential uranium milling operations are found in two areas: (1) the central western part of McKinley County, east of Gallup, New Mexico and (2) the southeastern part of McKinley County and the northern part of Cibola County, east and northeast of Grants, New Mexico. These two areas are parts of the Grants Uranium District (Figure 3.5-2). Details on the geology and soils of this district and its subdivisions are provided in Section 3.5.3.

Land distribution statistics in Table 3.5-1 were calculated using the Geographic Information System used to construct the map shown in Figure 3.5-1. The data show that 91 percent of the Northwestern New Mexico Uranium Milling Region is composed of private (surface ownership) land (50 percent), Indian Reservation land (27 percent), and U.S. national forest land (14 percent).

Indian Reservation land, administered by the Bureau of Indian Affairs, comprises Acoma Pueblo, Laguna, Navajo, Ramah Navajo, and Zuni Indian land. Navajo land forms the northwest corner of McKinley County and abuts the northwestern part of the Grants Uranium District. Portions of any potential new ISL facility in this area of this district could fall within Navajo allottees, who own the surface and mineral rights. Bureau of Indian Affairs administers the leases needed for both the surface use and mineral rights on such land. In this area of McKinley County, the Crownpoint and Church Rock Chapters of the Navajo Nation are part of an area known as the checkerboard due to its mixed private tribal and government property rights. Certain properties are under the Navajo Tribal Trust while individual Navajo allotments are privately held, with some Bureau of Indian Affairs oversight. In this area, the Crownpoint Unit 1 site is located on allotted land and the Church Rock site is located on Navajo Tribal Trust land (NRC, 1997).

Land use issues in the area of the Navajo Nation are a sensitive issue and consideration should be paid to ongoing jurisdictional disputes over the checkerboard lands. In addition, contamination of water supplies within the Rio San Jose Basin as a result of uranium milling has further heightened the Navajo Nation’s sensitivity to land uses that may affect their ability to use tribal lands for raising livestock.

BLM lands occupy only approximately 8 percent of the region and are mostly concentrated in the northeastern corner of McKinley County (Figure 3.5-1). Other federal lands managed by the U.S. Department of Defense (Fort Wingate Military Reservation) and the National Park Service represent less than 1 percent of the region.

Although sparsely populated, this region has three fairly large population centers: Gallup, with more than 20,000 people; Grants, with approximately 9,000 people; and Zuni Pueblo, with about 6,400 people. Smaller communities are scattered along the Interstate 40 corridor (Figure 3.5-2). Generally, private, federal, and Indian Reservation lands in this region are rural, mainly undeveloped, sparsely populated, and mostly used for livestock grazing and to a lesser extent for timber and agricultural production. In McKinley County, for example, more than 85 percent of the land is used for agricultural purposes and 83 percent of that land is used for livestock grazing. Only 9 percent and 0.6 percent of the land is used for timber production and for dry

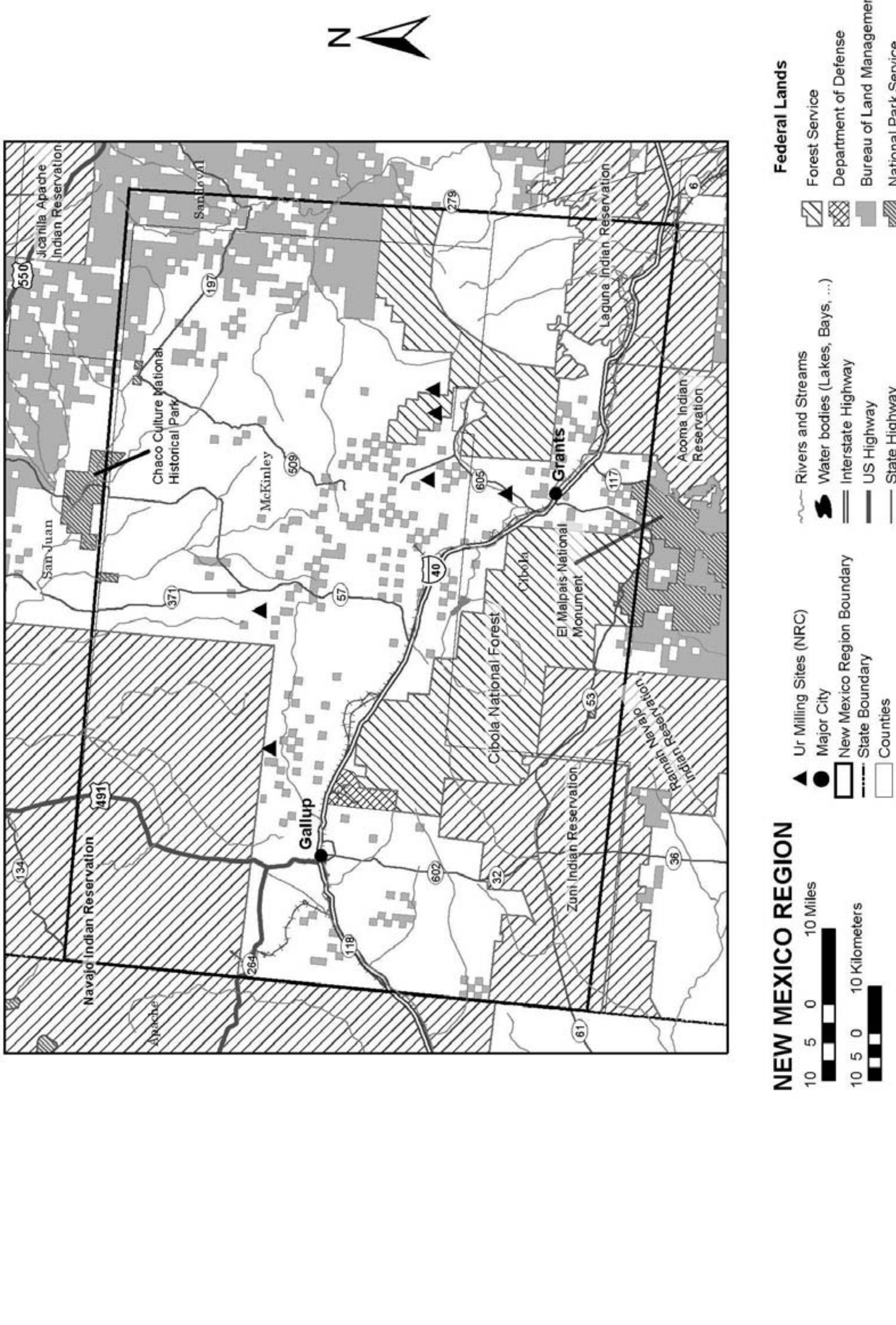


Figure 3.5-1. Northwestern New Mexico Uranium Milling Region General Map With Current and Future Uranium Milling Site Locations

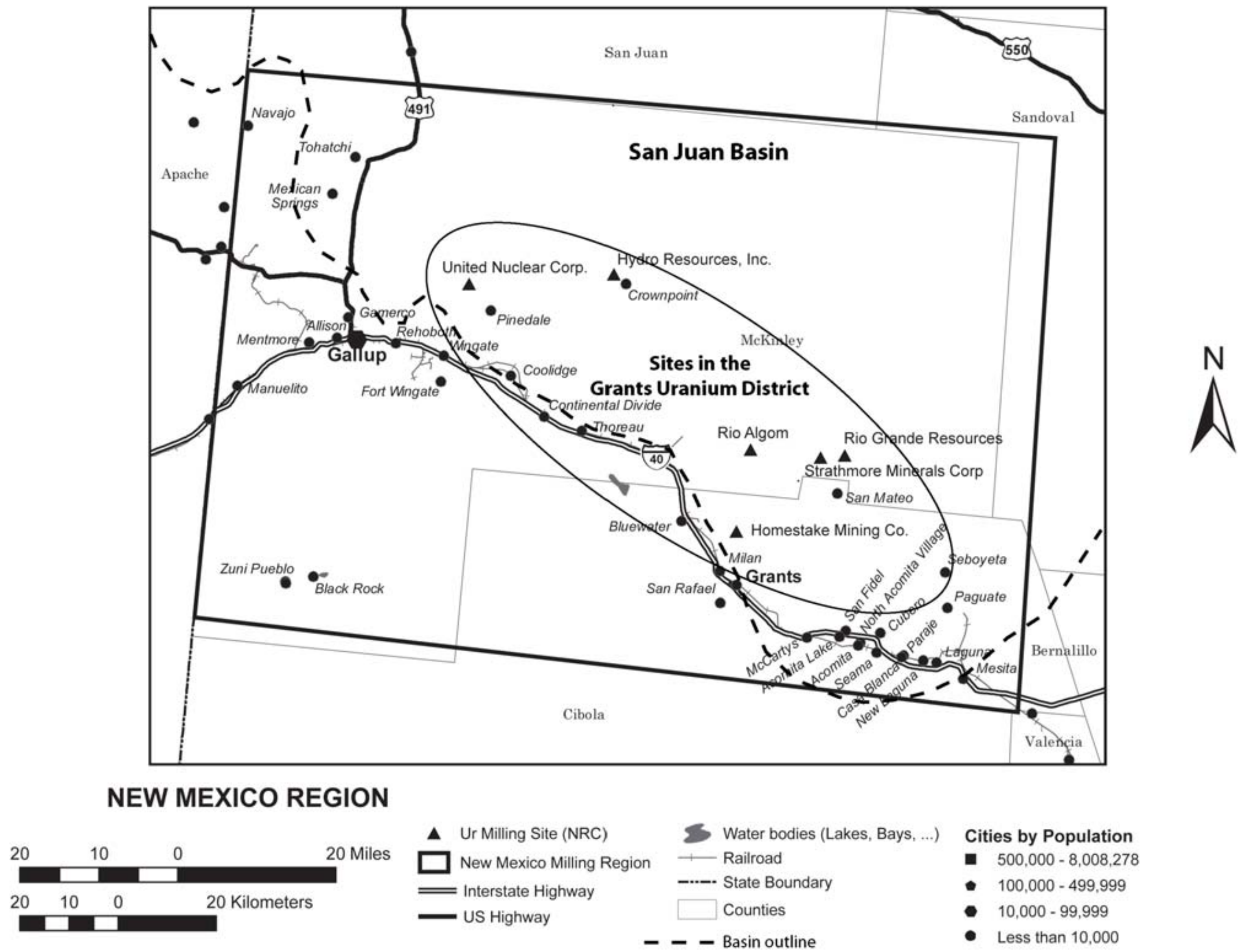


Figure 3.5-2. Map Showing Outline of the Northwestern New Mexico Region and the Location of the Grants Uranium District Along the Southern Margin of the San Juan Basin

Table 3.5-1. Land Surface Ownership and General Use in the Northwestern New Mexico Uranium Milling Region			
Land Surface Ownership and General Use	**Area (mi^2)**	**Area (km^2)**	**Percent**
State and Private Lands	3,682	9,537	50.1
Bureau of Indian Affairs, Indian Reservations	1,999	5,176	27.2
U.S. Forest Service, National Forest	1,028	2,662	14
U.S. Bureau of Land Management (BLM), Public Domain Land	579	1,501	7.9
U.S. Department of Defense (Army)	29	75	0.4
National Park Service, National Monument	25	64	0.3
National Park Service, National Historic Park	6	16	0.08
BLM, National Conservation Area	1	2	0.01
BLM, Wilderness	0.5	1	0.01
Totals	7,350	19,035	100

and irrigated crop production, respectively. Coal and uranium milling activities use less than 1 percent of the land in McKinley County (NRC, 1997).

Recreational and cultural activities for the public are available in the Mount Taylor Ranger District, part of the Cibola National Forest. This forest includes the Zuni Mountains to the west of Grants and the San Mateo Mountains and Mount Taylor, about 24 km [15 mi] to the east-northeast of Grants. Mount Taylor is designated by the Navajo Nation as one of six sacred mountains. In Navajo tradition, Mount Taylor has a special significance as it represents the southern boundary of the Navajo traditional homeland (USFS, 2006). On June 14, 2008, the New Mexico Cultural Properties Review Committee approved a 1-year emergency listing of more than 171,000 ha [422,000 acres] of land surrounding Mount Taylor on the New Mexico Register of Cultural Properties (Los Angeles Times, 2008) (see Section 3.5.8.3).

El Malpais National Monument in Cibola County and the Chaco Culture National Historical Park, which has several sites in McKinley County and San Juan County farther north, are the two main recreational and cultural areas managed by the National Park Service in the Northwestern New Mexico Uranium Milling Region.

3.5.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of most goods and personnel (Section 2.8). As shown in Figure 3.5-3, the Northwestern New Mexico Uranium Milling Region is accessed from the east and west by Interstate 40, from the north by U.S. Highway 491 (formerly U.S. Highway 666) and State Routes 371 and 509, and from the south by State Routes 36 and 602. A rail line traverses the region east and west along the path of Interstate 40.

Areas of past, present, or future interest in uranium milling in the region are shown in Figure 3.5-3. These areas are located in three subregions when considering site access by local roads. Areas of milling interest from west to east include areas near Pinedale northeast of Gallup, the area near Crownpoint north of Thoreau, and the area northeast of Milan and Grants near Ambrosia Lake and San Mateo. All these areas have access to Interstate 40 to the south using local access roads to State Routes 566 near Pinedale, 371 near Crownpoint, and 509 and 605 near Ambrosia Lake and San Mateo.

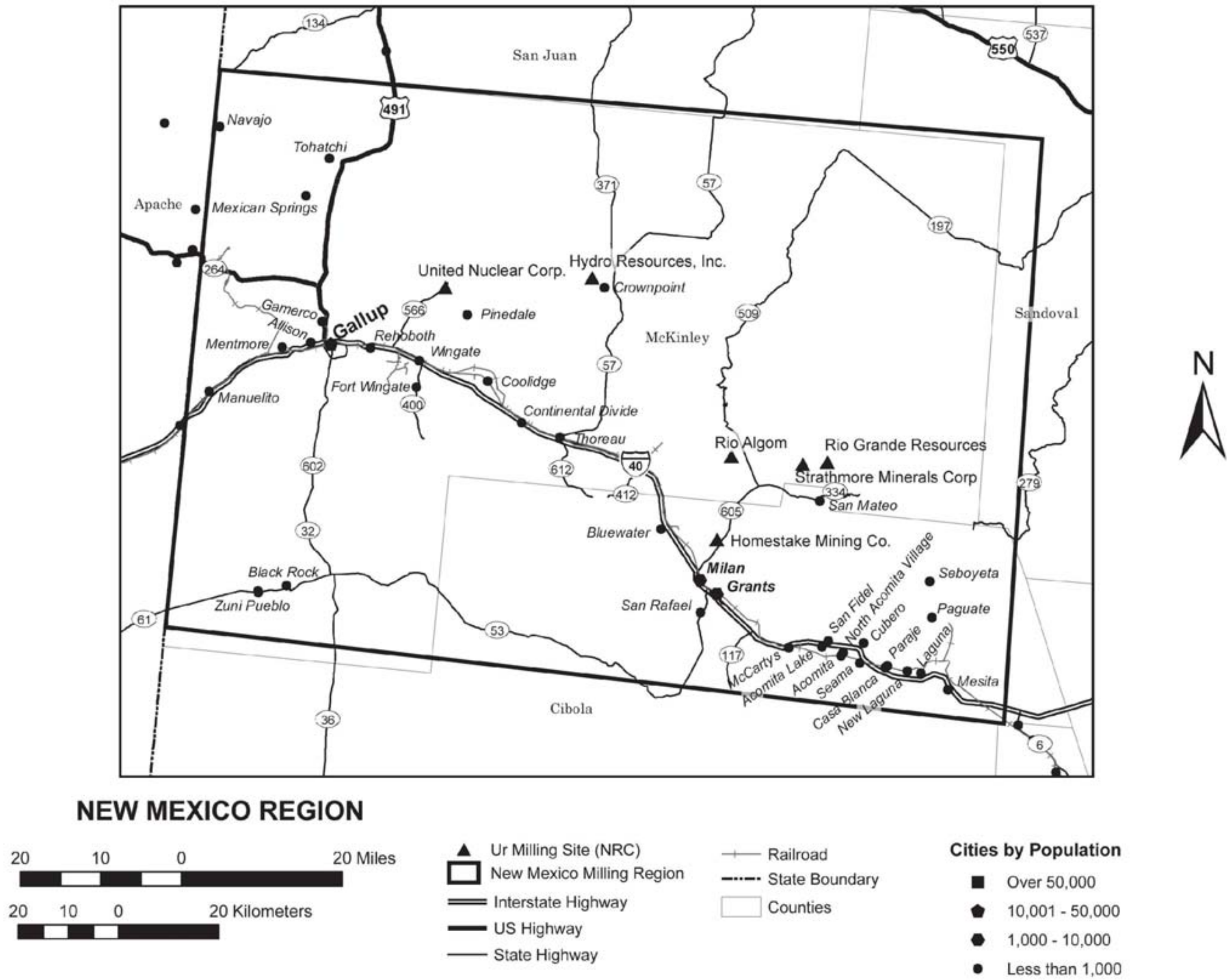


Figure 3.5-3. Northwestern New Mexico Uranium Milling Region Transportation Corridor Locations

Table 3.5-2 provides available traffic count data for roads that support areas of past, present, or future milling interest in the Northwestern New Mexico Uranium Milling Region**.** Counts are variable, with the minimum all-vehicle count at 330 vehicles per day on State Route 509 North at State Route 605 and the maximum on Interstate 40, Thoreau Interchange North at 11,709 vehicles per day. Most all vehicle counts in the Northwestern New Mexico Uranium Milling Region are above 1,500 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.5-3 describes representative routes and distances for shipments of yellowcake from locations of uranium milling interest in the Northwestern New Mexico Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

3.5.3 Geology and Soils

New Mexico ranks second in uranium reserves in the United States. In the Northwestern New Mexico Uranium Milling Region, uranium resources are located primarily within the Morrison

Table 3.5-2. Average Annual Daily Traffic Counts for Roads in the Northwestern New Mexico Uranium Milling Region*

Road Segment	County	All Vehicles	
		2005	**2006**
State Route 566 North at State Route 118	McKinley	4,605	4.637
State Route 371 at Interstate 40 (Thoreau)	McKinley	5,514	5,552
State Route 371 North at Navajo 9 to Mariano Lake	McKinley	3,842	3,868
State Route 605 North at County Line North of Milan	McKinley	2,522	2,488
State Route 605 North at State Route 509 to Ambrosia Lake	McKinley	1,595	1,562
State Route 509 North at State Route 605	McKinley	338	330
Interstate 40, Thoreau Interchange North	McKinley	11,676	11,709
State Route 605 North at State Route 122 in Milan	Cibola	1,232	1,196
Interstate 40, Grants-Milan Interchange	Cibola	10,186	9,993

*NMDOT. "Road Segments by Traffic (AADT) Info." Data for Cibola and McKinley Counties from the New Mexico State Highway and Transportation Department's Consolidated Highway Data Base, provided by request. Santa Fe, New Mexico: New Mexico Department of Transportation. April 2008.

Table 3.5-3. Representative Transportation Routes for Yellowcake Shipments From the Northwestern New Mexico Uranium Milling Region*

Origin	Destination	Major Links	Distance* (mi)
North of Pinedale, New Mexico	Metropolis, Illinois	Local access road to State Route 566 State Route 566 south to Interstate 40 Interstate 40 east to Memphis, Tennessee Interstate 55 north to Interstate 155 Interstate 155 north to Interstate 24 Interstate 24 north to Metropolis, Illinois	1,360
Crownpoint, New Mexico	Metropolis, Illinois	Local access road to State Route 371 State Route 371 south to Interstate 40 Interstate 40 east to Metropolis, Illinois (as above)	1,360
North of San Mateo, New Mexico	Metropolis, Illinois	Local access road to State Route 334 at San Mateo State Route 334 west to State Route 605 State Route 605 to Interstate 40 at Milan near Grants	1,300

*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.

Formation in the Grants Uranium District (see Figure 3.5-2). The Grants Uranium District includes a belt of sandstone-type uranium deposits stretching 135 km [85 mi] along the south side of the San Juan Basin. The Grants Uranium District consists of eight subdistricts, which extend from east of Laguna to west of Gallup (Figure 3.5-4) (McLemore and Chenoweth, 1989). The sandstone-type uranium deposits in the Grants Uranium District are generally in a geologic setting favorable for exploitation by ISL milling. More than 150,000 metric tons [170,000 tons] of U_3O_8 have been produced from these deposits from 1948 to 2002, accounting for 97 percent of the total production in New Mexico and more than 30 percent of the total production in the United States (McLemore and Chenoweth, 1989). Estimates of uranium reserves indicate that there are an additional 150,000 metric tons [170,000 tons] of U_3O_8 in the Morrison Formation (McLemore, 2007).

The San Juan Basin is a structural depression occupying a major portion of the southeastern Colorado Plateau physiographic province (Hunt, 1974). The plateau encompasses much of western Colorado, eastern Utah, northeastern Arizona, and northwestern New Mexico. The San Juan Basin is underlain by up to 3,000 m [10,000 ft] of sedimentary strata, which generally dip gently from the margins toward the center of the basin. The margins of the basin are characterized by relatively small elongate domes, uplifts, and synclinal depressions.

Uranium mineralization in the Grants Uranium District occurs within Upper Jurassic (144- to 159-million-year-old) and Cretaceous (65 to 144 million year old) sandstones. Stratigraphic descriptions presented here are limited to formations that would be involved in potential milling operations or formations that may have environmental significance, such as important aquifers and confining units above and below potential milling zones. A generalized stratigraphic column of formations in the Grants Uranium District is shown in Figure 3.5-5.

The Morrison Formation is composed of the Recapture, Westwater Canyon, and Brushy Basin Members and is the host formation for major uranium deposits in the Grants Uranium District. Most of the deposits are within the main sandstone bodies of the Westwater Canyon Member. In addition, the Westwater Canyon is an important regional aquifer. Large uranium deposits are

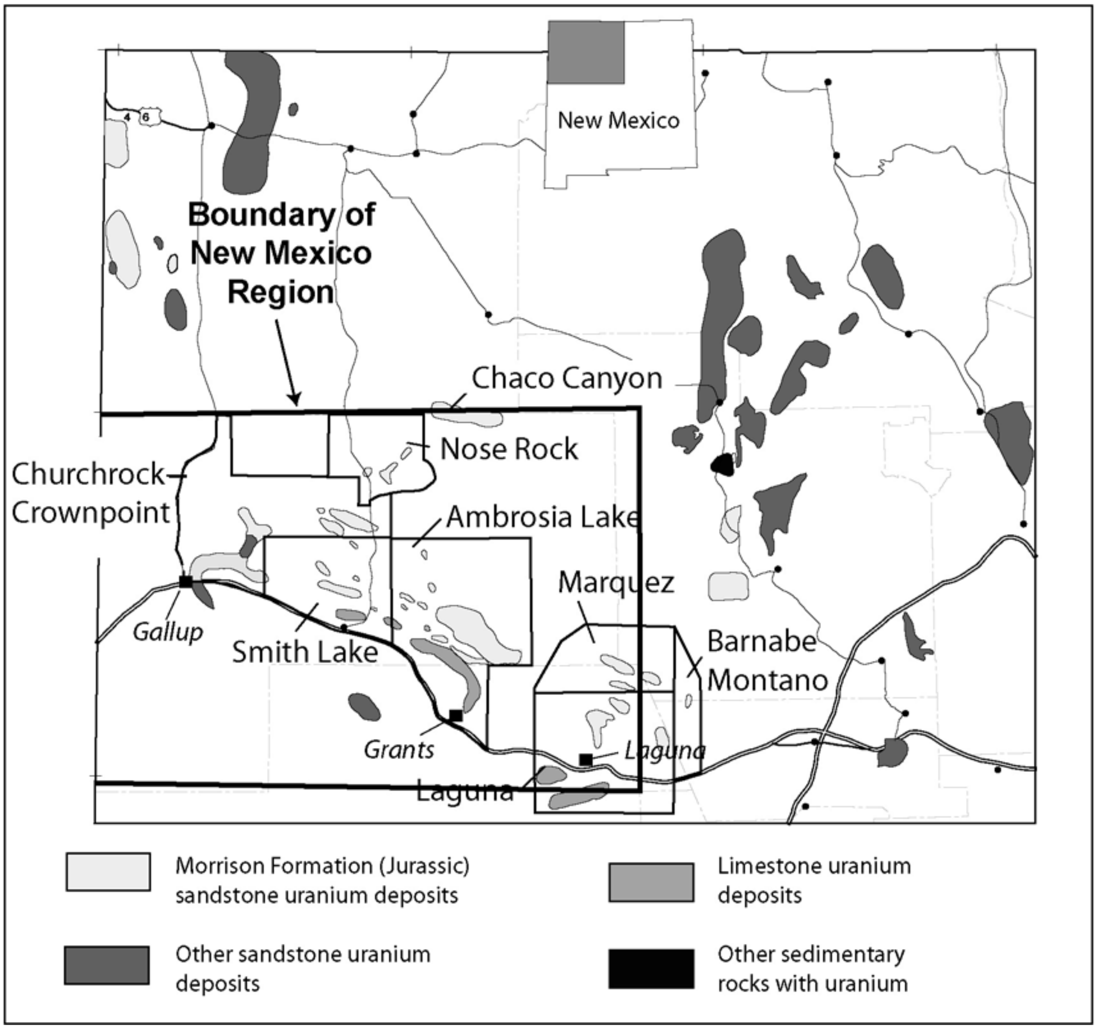


Figure 3.5-4. Index Map of the Grants Uranium District, San Juan Basin, New Mexico, Showing Eight Subdistricts (Modified From McLemore, 2007)

also found in a series of sandstone beds, known collectively as the Poison Canyon sandstones of economic usage, which occur near the base of the Brushy Basin Member in the Blackjack (Smith Lake), Poison Canyon, and Ambrosia Lake mining areas (Holen and Hatchell, 1986). Deposits also occur in sandstone lenses higher in the Brushy Basin in the Blackjack (Smith Lake) mining area. In the Laguna district, a bed of sandstone overlying the Brushy Basin, the Jackpile Sandstone Member of the Morrison (Owen, 1984), contains the large Jackpile-Paguate, L-Bar, and Saint Anthony deposits. Relationships of the deposits in the various Morrison units are shown in Figure 3.5-6.

Elsewhere in the San Juan Basin, significant but relatively small sandstone-type deposits also occur in the Dakota Sandstone in the Church Rock area and in the Burro Canyon Formation in the Carjilon area (Holen and Hatchell, 1986). The Todilto Limestone in the Grants Uranium District, which has accounted for about 2 percent of total production, is quite impermeable and is unlikely to be amenable to production by ISL. Beyond the San Juan Basin, significant but

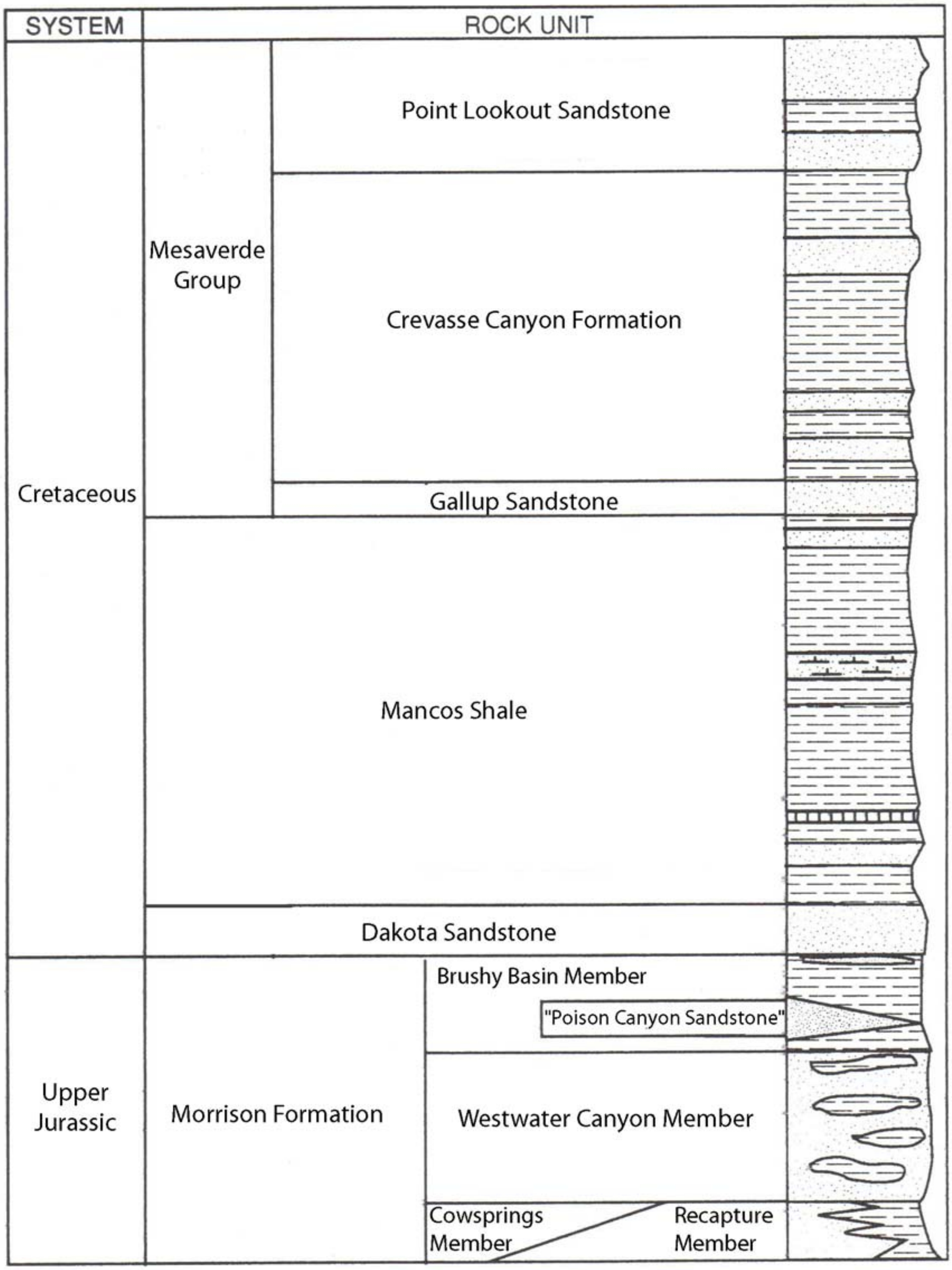


Figure 3.5-5. Generalized Stratigraphic Section of Upper Jurassic and Cretaceous Formations in the Grants Uranium District (NRC, 1997)

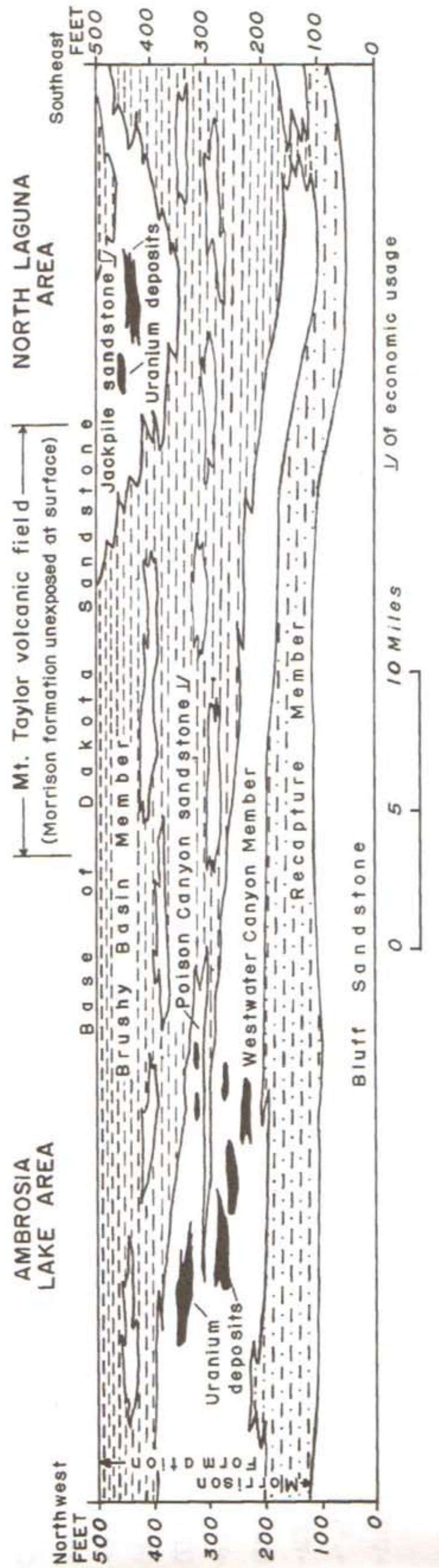


Figure 3.5-6. Generalized Geologic Section Showing the Stratigraphic Relations of the Morrison Formation Between the Ambrosia Lake and Laguna Areas (From Hilpert, 1969)

relatively small sandstone-type deposits occur in the Galisteo Formation in the Hagan Basin, and in the Crevasse Canyon and Baca Formations in the Riley-Pie Town areas.

The following regional descriptions of the stratigraphic units within the San Juan Basin are derived from reports by Green and Pierson (1977), Hilpert (1963, 1969), Chenoweth and Learned (1980), and Holen and Hatchell (1986).

The Recapture Member is the bottommost member of the Morrison Formation. It is as thick as 150 m [500 ft] northwest of Gallup but thins to 45 to 90 m [150 to 300 ft] in outcrops near Gallup and eastward. The Recapture is one of the most variable stratigraphic units in the area. It occurs in the Gallup Mining District as a sequence of interbedded siltstone, mudstone, and sandstone strata. Individual strata range from centimeters to meters [inches to feet] in thickness. Sandstone beds are generally less than 5 m [15 ft] thick (Hilpert, 1969). The Recapture is believed to interfinger with the underlying Cow Springs Sandstone, and several authors have combined the two units as one. No significant uranium deposits occur in the Recapture Member.

The Westwater Canyon Member of the Morrison Formation consists of interbedded fluvial red, tan, and light-gray arkosic sandstone (i.e., sandstone containing a significant fraction of feldspar), claystone, and mudstone. It is a major water-bearing member of the Morrison. The unit ranges from 53 to 85 m [175 to 275 ft] thick in outcrops from Gallup to the Continental Divide (Hilpert, 1969) and is known to be considerably thicker locally. In most places, the Westwater Canyon displays one or more mudstone units that range from thin partings to units up to 6 m [20 ft] thick. The mudstone units have limited lateral continuity, and only the thicker ones are extensive. The Westwater Canyon is host for the major uranium deposits in the region. The uranium occurs in coarse-grained, poorly sorted sandstone units and is closely associated with the carbonaceous material that coats the sand grains.

Three types of stratabound uranium deposits are present in the Westwater Canyon Member: primary (trend or tabular), roll front (redistributed), and remnant-primary sandstone uranium deposits (Figure 3.5-7) (Holen and Hatchell, 1986; McLemore, 2007). Primary sandstone-hosted uranium deposits, also known as prefault, trend, blanket, and black-band ores, are found as blanketlike, roughly parallel ore bodies along sandstone trends. These deposits are characteristically less than 2.5 m [8 ft] thick, average more than 0.20 percent U_3O_8, and have sharp ore-to-waste boundaries. The largest deposits in the Grants Uranium District contain more than 13,600 metric tons [15,000 tons] of U_3O_8.

During the Tertiary (1.8 to 65 million years ago) period, oxidizing groundwaters migrated through the Morrison Formation and remobilized some of the primary sandstone uranium deposits (Saucier, 1981). Uranium was reprecipitated ahead of the oxidizing waters forming roll-front sandstone uranium deposits (see Section 3.1.1). Roll-front uranium deposits are also known as postfault, stack, secondary, and redistributed ores. A schematic diagram of the formation of a redistributed or roll-front uranium deposit is shown in Figure 3.1-5. They are discordant, asymmetrical, irregularly shaped, and characteristically more than 2.5 m [8 ft] thick; have diffuse ore-to-waste contacts; and cut across sedimentary structures. The average deposit contains approximately 8,500 metric tons [9,400 tons] U_3O_8 with an average grade of 0.16 percent. Some redistributed uranium deposits are vertically stacked along faults (see Figure 3.5-7).

Remnant sandstone-hosted uranium deposits were preserved in sandstone after oxidizing waters that formed roll-front uranium deposits had passed. Some remnant sandstone-hosted

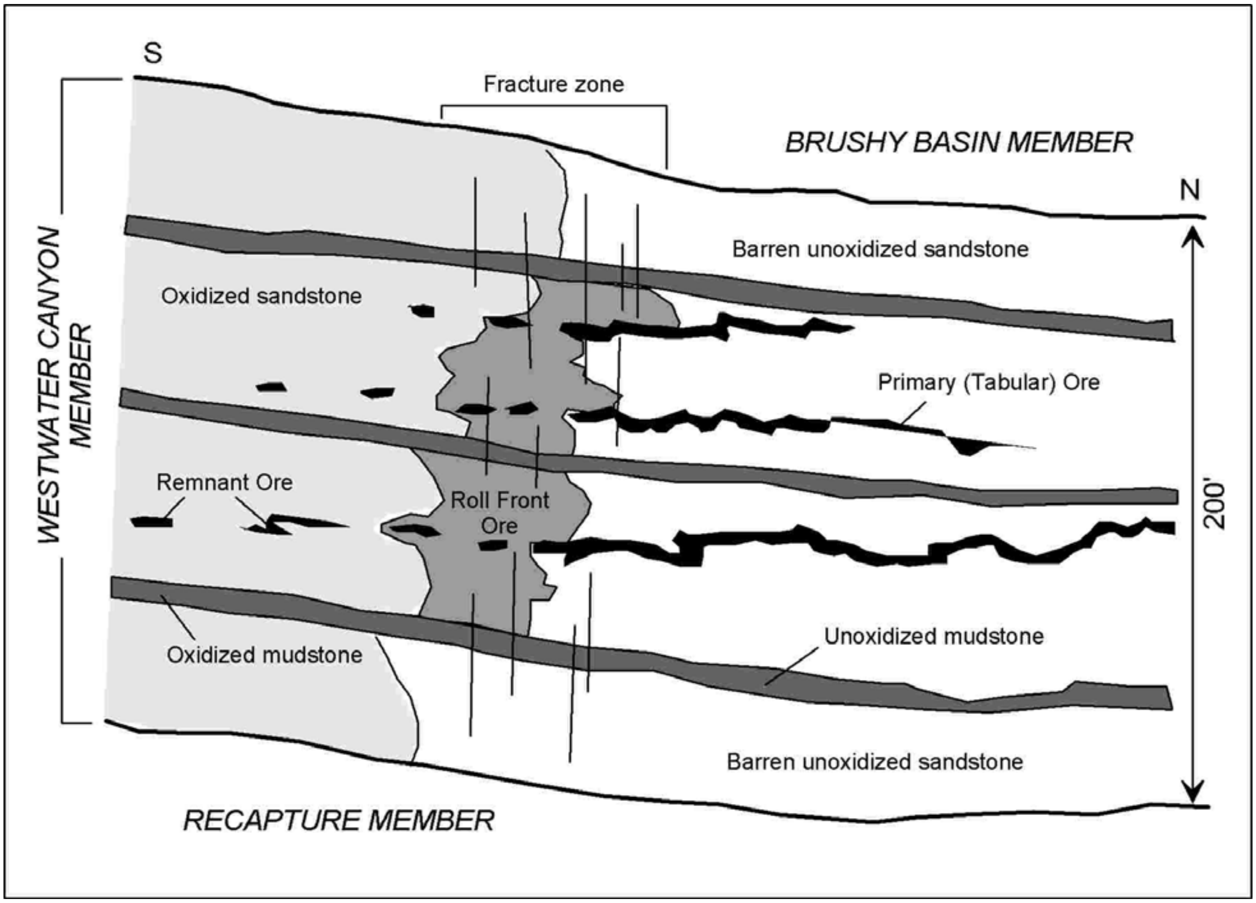


Figure 3.5-7. Schematic Diagram of the Different Types of Uranium Deposits in the Morrison Formation, Grants Uranium District, New Mexico (Modified From Holen and Hatchell, 1986). See Text for Description.

uranium deposits were preserved because they were surrounded by or found in less permeable sandstone and could not be reached by oxidizing groundwaters. These deposits are similar to primary sandstone-hosted uranium deposits, but are difficult to locate because they occur sporadically within the oxidized sandstone. The average size is approximately 1,200 metric tons [1,400 tons] U_3O_8 at a grade of 0.20 percent.

There is no consensus on the origin of the Morrison Formation sandstone uranium deposits and the source of uranium is not well constrained (Sanford, 1992). Uranium could be derived from alteration of volcanic detritus and shales within the Morrison Formation (Thamm, et al., 1981; Adams and Saucier, 1981) or from groundwater derived from a volcanic highland to the southwest. The majority of the proposed models for their formation suggests that deposition occurred at a groundwater interface between two fluids of different chemical compositions and/or oxidation/reduction states. Bleaching of the Morrison sandstones and the geometry of tabular uranium bodies floating in sandstone beds supports the reaction of two chemically different waters, most likely a dilute meteoric water and saline brine from deeper in the basin (McLemore, 2007).

The Brushy Basin Member overlies the Westwater Canyon and ranges from 12 to 40 m [40 to 125 ft] thick in the Gallup region. It is mainly composed of light greenish gray and varicolored claystone, interbedded with sandstone lenses having similar lithology and appearance to sandstones found in the Westwater Canyon Member (Ristorcelli, 1980). The mudstones are largely derived from volcanic ash falls (Peterson, 1980) and contain considerable amounts of bentonite. The contact between the Brushy Basin and the Westwater Canyon is gradational and interfingering.

The Dakota Sandstone is the basal formation of the Cretaceous System and unconformably overlies the Morrison Formation. The Dakota is a gray-brown quartz sandstone with some interbedded conglomerate, shale, carbonaceous shale, and coal. The Dakota Sandstone is marine in origin and is considered to represent the earliest transgression of late Cretaceous seas. The Dakota crops out around the margins of the San Juan Basin and thickens toward the center of the basin to about 60 m [200 ft]. The Mancos Shale overlies the Dakota Sandstone and is a thick, mostly uniform gray marine shale containing thin lenses of fine-grained sandstone.

Approximately 227 metric tons [250 tons] of U_3O_8 have been produced from roll-front uranium deposits in the Dakota Sandstone in the southern part of the San Juan Basin (Chenoweth, 1989). Uranium deposits in the Dakota Sandstone are typically tabular masses that range in size from thin pods a few meters [feet] long and wide to masses as much as 760 m [2,500 ft] long and 300 m [1,000 ft] wide. The larger deposits are only a few meters [feet] thick, but a few are as much as 8 m [25 ft] thick (Hilpert, 1969). Ore grades range from 0.12 to 0.30 percent and average 0.21 percent U_3O_8. Uranium is found with carbonaceous plant material near or at the base of channel sandstones or in carbonaceous shale and lignite and is associated with fractures, joints, or faults and with underlying permeable sandstone of the Brushy Basin or Westwater Canyon Members. The largest deposits in the Dakota Sandstone are found in the Old Church Rock mine in the Church Rock subdistrict, where uranium is associated with a major northeast-trending fault. More than 81 metric tons [90 tons] of U_3O_8 have been produced from the Dakota Sandstone in the Old Church Rock mine (Chenoweth, 1989).

The San Juan Basin is part of the Colorado Plateau physiographic province, which is generally characterized by rough, broken terrain, including small steep mountainous areas, plateaus, cuestas, and mesas intermingled with steep canyon walls, escarpments, and valleys. Thick colluvium deposits are commonly found forming a mantle on steep slopes surrounding sandstone mesas and cuestas in the San Juan Basin. In contrast, Quaternary alluvium is found on the valley floors of the region. These deposits consist of fine sand, silt, and clay derived from the weathering of sandstone, siltstone, and mudstone exposed at the surface. Alluvial deposits generally are thin but are known to exceed a thickness of 10 m [30 ft] in larger valleys.

General soils information associated with landforms in the southern part of the San Juan Basin was obtained from the Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NRCS, 2001). For site-specific evaluations at proposed ISL milling facilities, more detailed soils information would be expected to be obtained from published county soil surveys or the U.S. Department of Agriculture NRCS.

In the southern part of the San Juan Basin, soils on hills and mountains vary greatly in horizon development, from soils with no development to soils that have well-developed clay horizons. Gravelly clay loams having little or no horizon development are usually found on steeper slopes where erosional activity is greatest. Clay loam soils that have well-developed horizons are generally found on gently sloping to moderately steep slopes, where erosion is slight to moderate. Gravelly to fine-sand loam soils characterized by well-developed clay horizons are found on mesa summits and cuesta dip slopes, which are nearly level to gently sloping. Sandy to fine sandy loam soils with little or no horizon development are found on the escarpment of mesas and cuestas and on hogbacks, where erosional activity is great. Fine sandy loam soils are found on the summits of ridges and are mostly shallow, whereas sandy loam soils are found on the side slopes of ridges and are generally shallow but sometimes deeper. Soils on alluvial fans are generally very deep, and their soil textures are highly variable, depending on the local geology. Soils found on alluvial fans include clay loam and fine sandy loam. Soils on stream terraces are underlain by stratified sand, gravel, loamy, silty, or clayey sediments and, in some cases, buried paleosols. Typical soils that represent stream terraces are sandy clay loam and silt loam. Soils on floodplains and drainageways are generally very deep, with soil textures that are highly variable, depending on the local geology. Clay loam and fine-sand loam soils are found in drainageways, and fine sand and clay loam soils are found on floodplains.

3.5.4 Water Resources

3.5.4.1 Surface Waters

The Northwestern New Mexico Uranium Milling Region includes McKinley and the northern portion of Cibola County and a small portion western Bernalillo County. Average annual surface runoff, in terms of average annual flow per unit area of a watershed in the Northwestern New Mexico Uranium Milling Region, is generally less than 2.5 cm/yr [1 in\yr]. Watersheds in the Northwestern New Mexico Uranium Milling Region are Rio San Jose, Zuni, Chaco Canyon, Upper Puerco River,[1] Arroyo Chico, and a small portion of Rio Puerco (EPA, 2008) (Figure 3.5-8). The named uranium deposits shown in Figure 3.5-4 are listed with their corresponding watershed in Table 3.5-4. The unnamed uranium deposits northeast of Chaco Canyon are located in the Arroyo Chico and Rio Puerco watersheds. Historical and potential uranium milling sites are located in the Upper Puerco, Chaco, Arroyo Chico, and Rio San Jose watersheds. The Zuni River watershed does not contain any identified uranium deposits that are being considered for ISL uranium recovery. The Rio San Jose is the only watershed with perennial stream reaches within the area of potential uranium milling.

The Rio San Jose and associated tributaries drain the south-central portion of McKinley County and northeastern portion of Cibola County. The Rio San Jose flows into Rio Puerco east of the Northwestern New Mexico Uranium Milling Region. The state-designated uses of Rio San Jose and its tributaries are listed in Table 3.5-5 along with known impairments to these uses. Impairments to water quality within the Rio San Jose watershed include elevated nutrients, metals (aluminum), turbidity, temperature and sediment. Flow of the Rio San Jose is not gauged within the region.

The Rio Puerco drains a small portion of the east-central part of the Northwestern New Mexico Uranium Milling Region (Figure 3.5-8). The Rio Puerco flows southeast to the Rio Grande southeast of the Northwestern New Mexico Uranium Milling Region. The mainstem of the Rio Puerco is east of the Northwestern New Mexico Uranium Milling Region, and none of the tributaries of Rio Puerco are perennial within the Northwestern New Mexico Uranium Milling Region.

[1]The Rio Puerco watershed is located in north-central New Mexico and drains into the Rio Grande. The Puerco River watershed is located in west-central New Mexico and drains into the Little Colorado River in Arizona.

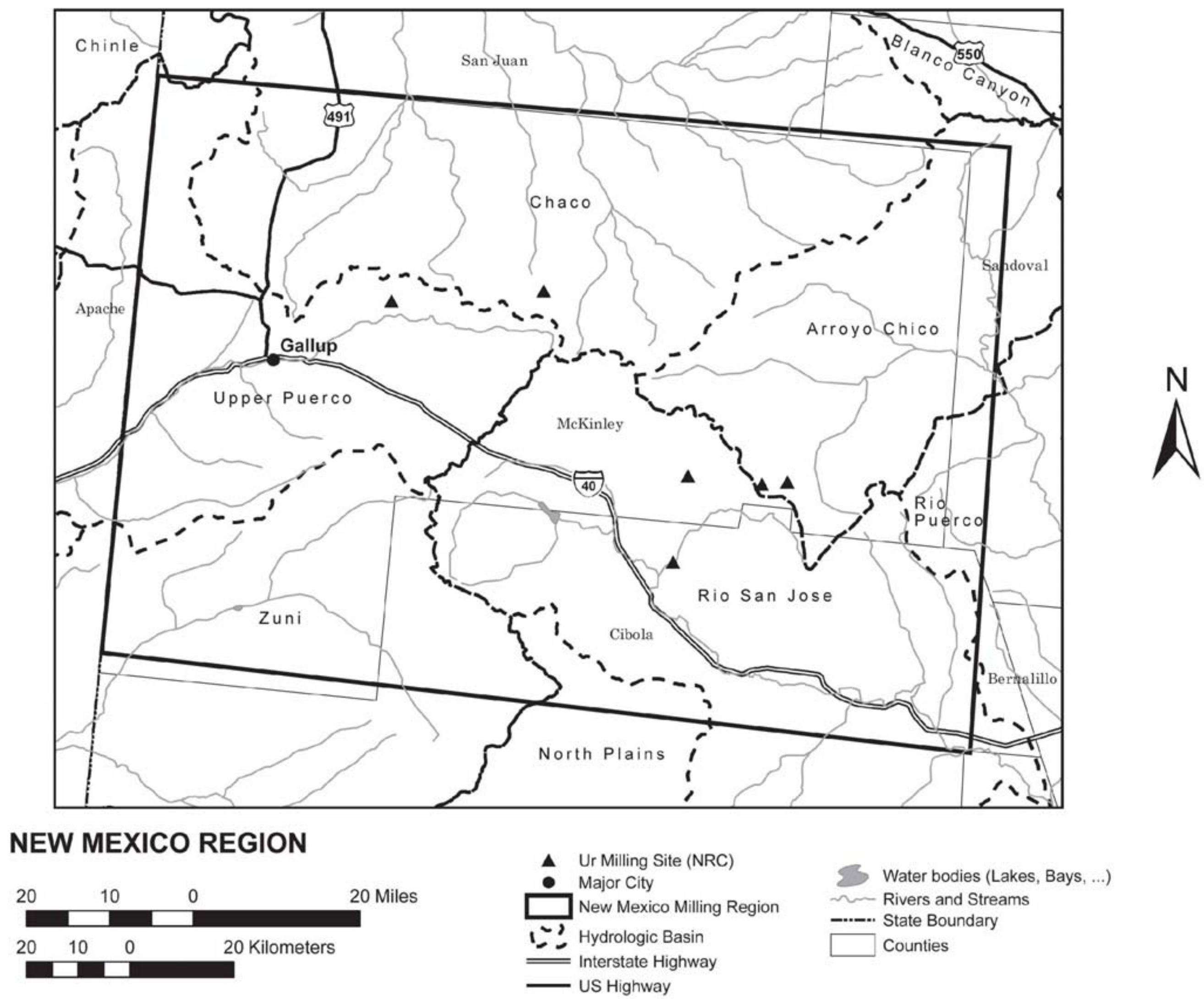


Figure 3.5-8. Watersheds in the Northwestern New Mexico Uranium Milling Region

Table 3.5-4. Named Uranium Deposits in New Mexico and Corresponding Watersheds	
Uranium Deposit	**Watershed**
Barnabe Montano	Rio San Jose
Marquez	Rio San Jose
Laguna	Rio San Jose
Grants	Rio San Jose
Smith Lake	Rio San Jose
Nose Rock	Chaco Canyon
Chaco Canyon	Chaco Canyon
Church Rock	Puerco River
Crownpoint	Chaco Canyon

Table 3.5-5. Primary Watersheds in New Mexico, Designated Uses, and Known Impairments

Watershed	Tributary or Reach	State-Designated Uses	Known Impairments
Rio San Jose	Bluewater Creek	Wildlife Habitat Irrigation Fish Culture Domestic Water Supply Cold Water Fishery Primary Contact Livestock Watering	Nutrients Aluminum Turbidity Temperature Sedimentation
	Bluewater Lake	Wildlife Habitat Irrigation Fish Culture Domestic Water Supply Cold Water Fishery Primary Contact Livestock Watering	None
	Rio Moquino	Wildlife Habitat Irrigation Fish Culture Domestic Water Supply Cold Water Fishery Primary Contact Livestock Watering	Temperature Sedimentation

Table 3.5-5. Primary Watersheds in New Mexico, Designated Uses, and Known Impairments (continued)			
Watershed	Tributary or Reach	State-Designated Uses	Known Impairments
	Rio Paquate	Wildlife Habitat Irrigation Fish Culture Domestic Water Supply Cold Water Fishery Primary Contact Livestock Watering	Selenium Temperature Sedimentation
	Rio San Jose	Wildlife Habitat Livestock Watering	None
	Seboyeta Creek	Wildlife Habitat Irrigation Fish Culture Domestic Water Supply Cold Water Fishery Primary Contact Livestock Watering	None
Rio Puerco	No Perennial Reaches in New Mexico Region		
Upper Puerco River	No Perennial Reaches in New Mexico Region		
Arroyo Chico	No Perennial Reaches in New Mexico Region		
Chaco	No Perennial Reaches in New Mexico Region		
Zuni River	No Known Uranium Recovery Activities in Zuni Watershed		

The other watersheds within the area of potential uranium recovery of the Northwestern New Mexico Uranium Milling Region contain ephemeral streams that flow only after precipitation events. The only surface water features in these watersheds are springs and stock ponds. Many springs are present within the Northwestern New Mexico Uranium Milling Region in McKinley and Cibola Counties. These springs occur on the flanks of mountainous areas, such as the Chuska Mountains in the western portion of the region and the Mount Taylor area in the southeastern portion of the region as well as in the intermontane areas. These springs are fed by both local and regional aquifer systems (see Section 3.5.4.3).

3.5.4.2 Wetlands and Waters of the United States

Wetlands and other shallow aquatic habitats occupy only about 1–5 percent of the land surface in this region (USACE, 2006).

Within this region no digital data are available. However, hardcopy National Wetland Inventory Maps can be obtained from the U.S. Fish and Wildlife Service. In general, Waters of the United States in this region consist of ephemeral stream/arroyos with few perennial rivers. Bands of wetlands are concentrated along rivers and streams within this region. Seasonally emergent wetland areas may be found within woody habitat at high elevations. Within this region, springs and seeps often support small marshes (cienegas), oases, and other wetland types (USACE, 2006). Desert playas are intermittent shallow lakes that develop in the flat, lower portions of arid basins during the wet season. Most are unvegetated and may not contain water every year.

Waters of the United States and special aquatic sites that include wetlands would be expected to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be expected to be obtained from the local USACE district. Within this region, the state does not regulate wetlands; however, Section 401 state water quality certification is required for work in Waters of the United States.

3.5.4.3 Groundwater

Groundwater resources in the Northwestern New Mexico Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of New Mexico. Uranium-bearing aquifers exist within these regional aquifer systems in the Northwestern New Mexico Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in northwester New Mexico, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

3.5.4.3.1 Regional Aquifer Systems

The Colorado Plateau aquifers underlie northwestern New Mexico and most parts of the Northwestern New Mexico Uranium Milling Region (Robson and Banta, 1995). The principal aquifers are present only in the San Juan Basin in northwest New Mexico. The geographical region in New Mexico underlain by the Colorado Plateaus aquifers is sparsely populated, and the quality and quantity of the groundwater pumped from these aquifers are suitable for most agricultural or domestic uses. The aquifers are typically composed of permeable sedimentary rocks of Permian to Tertiary ages.

Robson and Banta (1995) grouped the Colorado Plateau aquifers into four principal aquifers from shallowest to deepest: the Uinta-Animas aquifer, the Mesaverde aquifer, the Dakota-Glen Canyon aquifer system, and the Coconino-De Chelly aquifer. These four principal aquifers are hydraulically separated by relatively impermeable confining layers. The Mancos shale confining unit that underlies the Mesaverde aquifer and the Chinle-Moenkopi confining unit that underlies the Dakota-Glen Canyon aquifer system are the thickest confining layers. Among these four aquifer systems, the Mesaverde aquifer system (for water supplies) and the Dakota-Glen Canyon aquifer system (for water supplies and uranium milling) are the most important aquifer systems in the Northwestern New Mexico Uranium Milling Region.

The Mesaverde Aquifer: The Mesaverde aquifer is a regionally important aquifer for water supplies. It consists of sandstone, coal, siltstone, and shale of the Mesaverde Group in the San Juan Basin. The formations of the Mesaverde Group extensively interbedded with the Mancos Shale and, to a lesser extent, with the Lewis Shale. The thickness of the Mancos Shale typically ranges from 305 to 1,830 m [1,000 to 6,000 ft], and in general it forms a thick barrier to vertical and lateral groundwater flow. The maximum thickness of the Mesaverde aquifer is about 1,370 m [4,500 ft] in the southern part of San Juan Basin. The recharge to aquifer is by precipitation and discharge from aquifer is to streams, springs, and seeps; by upward movement across confining layers and into overlying aquifers; and by withdrawals. In general, water pumpage from the Mesaverde aquifer is small; therefore, water-level declines are usually localized. The altitude of the potentiometric surface ranges from 1,525 to 2,440 m [5,000 to 8,000 ft] in the San Juan Basin. In most parts of the basin, transmissivity of the Mesaverde aquifer is typically less than 4.65 m^2/day [50 ft^2/day]. However, where the aquifer is fractured, the local transmissivities could be 100 times higher.

The water quality in the Mesaverde aquifer is variable. The dissolved solids concentration ranges from about 1,000 to 4,000 mg/L [1,000 to 4,000 ppm] in parts of the San Juan Basin, which exceed EPA's Secondary Drinking Water Standard of 500 mg/L [500 ppm].

Dakota-Glen Canyon Aquifer System: Large depths to the water table or poor water quality make the aquifers of the Dakota-Glen Canyon aquifer system unsuitable for production in most parts of the Northwestern New Mexico Uranium Million Region. Where an aquifer is close to the land surface, however, it can be important source of water. The Dakota-Glen Canyon aquifer system is confined by the Mancos confining unit above and by the Chinle-Moenkopi confining unit below. The thickness of the Chinle-Moenkopi confining unit is typically 305 to 610 m [1,000 to 2,000 ft]. These confining units substantially limit the Dakota-Glen Canyon aquifer system's hydraulic connection with the overlying and underlying aquifers.

The Dakota-Glen Canyon aquifer system consists of four major aquifers: the Dakota aquifer (including the Dakota Sandstone and adjacent water-yielding rocks), the Morrison aquifer (including water-yielding rocks generally of the lower part of the Morrison Formation), the Entrada aquifer (including the Entrada Sandstone and the Preuss Sandstone), and the Glen Canyon aquifer (including the Glen Canyon Sandstone or Group and the Nugget Sandstone). The aquifer systems typically include confining units that separate these aquifers. At the regional scale, recharge areas, discharge areas, groundwater flow directions, and water quality are similar among these four aquifers.

The top of the Dakota aquifer is less than 610 m [2,000 ft] below the surface in the San Juan Basin. The transmissivity of the Dakota aquifer is poorly defined in the region. The Dakota aquifer is underlain by the Morrison Formation. In most parts of the basin, the relatively impermeable Morrison confining unit is present in the upper parts of the Morrison Formation. The middle and lower parts of the Morrison Formation forms the Morrison aquifer, but only the coarser-grained strata generally yields water. In the San Juan Basin, the Morrison aquifer includes two underlying water-yielding sandstone units: the Cow Springs and Junction Creek Sandstones. In most places, the Morrison aquifer is underlain by the relatively impermeable Curtis-Stump confining unit.

The Entrada aquifer underlies either the Curtis-Stump confining unit or the Morrison aquifer. The Entrada aquifer consists mainly of the Entrada Sandstone. In the western part of the Uinta Basin, the aquifer is composed of the Preuss Sandstone, which is an equivalent of the Entrada aquifer. In part of the basins, the Entrada aquifer directly overlies the Glen Canyon aquifer that consists of Wingate Sandstone, Kayente Formation, and the Navajo Sandstone. The Glen Canyon is the thickest and where fractured has relatively high transmissivities. The transmissivity of the Glen Canyon aquifer typically ranges from about 9.23 to 92.9 m^2/day [100 to 1,000 ft^2/day]. Groundwater flow in the Glen Canyon aquifer is toward major discharge areas along the San Juan Rivers. The depth to the top of the Glen Canyon aquifer is typically less than 610 m [2,000 ft]. The dissolved-solids concentration in the Glen Canyon aquifer is less than 1,000 mg/L [1,000 ppm].

3.5.4.3.2 Aquifer Systems In the Vicinity of Uranium Milling Sites

The underlying hydrogeological system in past and current areas of uranium milling interest in the Northwestern New Mexico Uranium Milling Region consists of a thick sequence of primarily sandstone aquifers and shale aquitards.

Areas of uranium milling interest at the Crownpoint, Unit 1, and Church Rock areas are underlain, from shallowest to deepest, by water-bearing layers in the Mesaverde Formation, the Dakota sandstone, the Morrison Formation (including the uranium-bearing Westwater Canyon aquifer), the Cow Springs Sandstone, and Entrada Sandstone. The Mesaverde Formation is regionally important for water supplies. The uranium-bearing Westwater Canyon aquifer at the active uranium milling sites is also important for water supplies in the milling region. Little information is available for the Cow Springs sandstone aquifer, but the existing data suggests that the Cow Springs aquifer underlying the Westwater Canyon aquifer contains good quality water (Hydro Resources, Inc., 1996). Although the Dakota sandstone at the town of Crownpoint is qualified as a drinking water supply according to EPA's National Primary Drinking Water Regulations, it is locally (e.g., in McKinley County) unused as a water supply because of its poor water quality (NRC, 1997).

3.5.4.3.3 Uranium-Bearing Aquifers

The most important uranium deposits in the Northwestern New Mexico Uranium Milling Region are hosted by the Westwater Canyon sandstone aquifer in the Morrison Formation (NRC, 1997; McLemore, 2007). The uranium-bearing sandstone aquifers in the Westwater Canyon aquifer and the Dakota sandstone near the town of Crownpoint must be exempted (Section 1.7.2) by EPA's UIC program (40 CFR § 144.3) before ISL operations begin.

Hydrogeological characteristics: The groundwater flow velocities in the Westwater Canyon aquifer at the Crownpoint site ranged from 3.9 m/yr [12.9 ft/yr] in the east to 2.4 m/yr [8 ft/yr] in the west side of the site. Transmissivity estimates for the Westwater Canyon aquifer range from 235 to 250 m^2/day [2,550 to 2,700 gal/day/ft]. The storage coefficient values ranged from 4.50×10^{-5} to 1.39×10^{-4} (NRC, 1997).

At Unit 1, the aquifers are the same as those at the Crownpoint site. The calculated average groundwater velocity is 1.5 m/yr [5 ft/yr] in the Westwater Canyon aquifer. In the Westwater Canyon aquifer, transmissivity ranges from 84 to 133 m^2/day [905 to 1,432 gal/day/ft], and the storage coefficient values range from 9.40×10^{-5} to 1.60×10^{-4} (NRC, 1997).

The aquifers located beneath the Church Rock site are similar to those beneath the Crownpoint and Unit 1 sites. The average groundwater flow velocity in the Westwater Canyon at Church Rock is 2.7 m/yr [8.7 ft/yr]. Transmissivity of the Westwater Canyon aquifer ranges from 86 to 123 m^2/day [926 to 1,326 gal/day/ft], and the storage coefficient ranges from 8.90×10^{-5} to 4.13×10^{-4} (NRC, 1997).

The average storage coefficient of the Westwater Canyon aquifer is on the order of 10^{-5}–0^{-4} at the Crownpoint, Unit 1, and Church Rock sites, indicating the confined nature of the production aquifer [typical storage coefficients for confined aquifers range from 10^{-5}–10^{-3} (Driscoll, 1986)].

Level of confinement: At the Crownpoint site, the Westwater Canyon aquifer is confined below by the Recapture Shale and confined above by the Brushy Basin Shale. The upper aquitard is about 80 m [260 ft] thick and is continuous at the site. The lower confinement unit consists entirely of shale and is continuous at the site. Aquifer tests revealed no significant vertical flow across the Recapture Shale and Brushy Basin Shale aquitards. At Unit 1, both the upper (Brushy Basin Shale) and lower (Recapture Shale) aquitards that confine the Westwater Canyon aquifer are continuous beneath Unit 1. No significant vertical flow across the aquitards was detected. At the Church Rock site, the upper aquitard above the Westwater Canyon aquifer (Brushy Basin Shale) is 4–9 m [13–28 ft] thick. The thickness of the lower aquitard (Recapture Shale) was reported to be 55 m [180 ft] thick (NRC, 1997).

Groundwater quality: At the Crownpoint site, the artesian uranium-ore bearing Westwater Canyon sandstone aquifer is a valuable resource for high-quality groundwater, which fits the definition of underground sources of drinking water in the EPA National Primary Drinking Water Regulations (NRC, 1997). The TDS concentrations in groundwater range from 281 to 3,180 mg/L [281 to 3,180 ppm] and average 773 mg/L [773 ppm]. The TDS levels in four town water wells ranged from 325 to 406 mg/L [325 to 406 ppm], which are lower than the EPA's Secondary Drinking Water Standard of 500 mg/L [500 mg/L]. Even though the town's water supply wells are completed in sandstones that contain uranium deposits, radionuclide concentrations in the Crownpoint public water supply are low. The uranium and radium-226 concentrations at the Crownpoint ISL site's monitoring wells were in the range of less than 0.001 to 0.007 mg/L [0.001 to 0.007 ppm] and 0.3 to 0.6 pCi/L, respectively {EPA's drinking water standard for uranium is 0.03 mg/L [0.03 ppm] and for radium-226 is 5.0 pCi/L} (NRC, 1997).

At the Unit 1 site, groundwater in the Westwater Canyon aquifer in general meets New Mexico drinking water quality standards, except for radium-226 and uranium concentrations. The average radium-226 concentration at the Unit 1 ISL site's monitoring wells is 10.3 pCi/L, which exceeds the EPA drinking water standard for radium-226 (5.0 pCi/L). The average uranium concentration at the Unit 1 site is about 2.0 mg/L [2 ppm], which is higher than at the Crownpoint site. The average TDS of 285.0 mg/L [285 ppm] was lower than the EPA drinking water standard of 500 mg/L [500 ppm] (NRC, 1997).

At the Church Rock site, the groundwater quality is generally good in Westwater Canyon aquifer and meets the New Mexico drinking water quality standards, except for radium-226 concentration. However, the average radium-226 concentration at the monitoring wells was 10.2 pCi/L, exceeding the EPA drinking water standard of 5.0 pCi/L for radium. The average uranium concentration was 0.01 mg/L [0.01 ppm]. The average TDS of 369.75 mg/L [369.75 ppm] was lower than the EPA drinking water standard of 500 mg/L [500 ppm] (NRC, 1997).

Current groundwater uses: Groundwater in the Northwestern New Mexico Uranium Milling Region area is in general suitable for drinking. Groundwater has been used for domestic supplies, especially in the Crownpoint and Unit 1 areas. Most of the wells in and near the Church Rock site either owned by Hydro Resources, Inc. or are private wells (NRC, 1997).

3.5.4.3.4 Other Important Surrounding Aquifers for Water Supply

The Dakota Sandstone at the town of Crownpoint is qualified as a drinking water supply according to EPA's National Primary Drinking Water Regulations. Little information is available for the Cow Springs aquifer, but the existing data suggest that Cow Springs aquifer underlying the Westwater Canyon aquifer contains good quality water (Hydrology Resources Inc., 1996).

3.5.5 Ecology

3.5.5.1 Terrestrial

Northwestern New Mexico Flora

According to EPA, the Northwestern New Mexico Uranium Milling Region contains two ecoregions: the Arizona/New Mexico Plateau and the Arizona/New Mexico Mountains (Figure 3.5-9). This regions and subregions are as follows. The Grants Uranium District in the region is located in the Semi Arid Tablelands, Conifer Woodlands, and Savannas ecoregions and near the San Juan/Chaco Tablelands and Mesas ecoregions.

The Arizona/New Mexico Plateau is a transitional region between shrublands and wooded higher relief tablelands of the Colorado Plateaus in the north, the lower less vegetated Mojave Basin and Range in the west, and forested mountain ecoregions that border the region on the northeast and south. The topography in the region changes from a few meters [feet] on plains and mesa tops to well over 305 m [1,000 ft] along tableland side slopes. This region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley (Griffith, et al., 2006).

The San Juan/Chaco Tablelands and Mesas ecoregion of plateaus, valleys, and canyons contains a mix of desert scrub, semidesert shrub-steppe, and semi-desert grasslands. Native vegetation found within the region include shadscale, fourwing saltbush (*Atriplex canescens*), mat saltbush, greasewood, mormon tea (*Ephedra* spp.), Indian ricegrass, alkali sacaton, galleta (*Pleuraphis jamesii)*, and blue and black gramas. Rocky Mountain juniper (*Juniperus scopulorum*), one-seed (*Juniperus monosperma*), and Utah junipers (*Juniperus osteosperma*) can be found on higher mesas (Griffith, et al., 2006).

The Semiarid Tablelands consists of mesas, plateaus, valleys, and canyons. This region contains areas of high and low relief plains. Grass, shrubs, and woodland cover the tablelands. The vegetation is not as sparse as that found in the San Juan/Chaco Tablelands to the north or the Albuquerque Basin to the east. Scattered junipers occur on shallow, stony soils and are dense in some areas. Pinyon-juniper woodland is also common in some areas. Fourwing saltbush, alkali sacaton, sand dropseed (*Sporobolus cryptandrus*), and mixed grama grasses are common species found in this region (Griffith, et al., 2006).

The Lava Malpais can be found in the south central portion of the region. The lava substrate has the ability to trap and retain moisture, allowing for a more mesophytic vegetation, such as stunted Douglas fir and ponderosa pine, to occur in some areas. Other species that are found in this region include grasses like blue grama and side oats grama (*Bouteloua curtipendula*) with shrubs of Apache plume (*Fallugia paradoxa*) and New Mexico olive (*Forestiera pubescens*) (Griffith, et al., 2006).

The Near-Rockies Valleys and Mesas ecoregion is a region comoised of mostly pinyon-juniper woodland, juniper savanna, and mesa and valley topography, with influences of higher elevation vegetation in drainages from the adjacent Southern Rockies. Other natural species that can be found in this region include one seed and Rocky Mountain junipers, Indian ricegrass, big sagebrush, sand dropseed, gallets, threeawns (*Aristida* spp.), blue grama, and rabbitbrush (Griffith, et al., 2006).

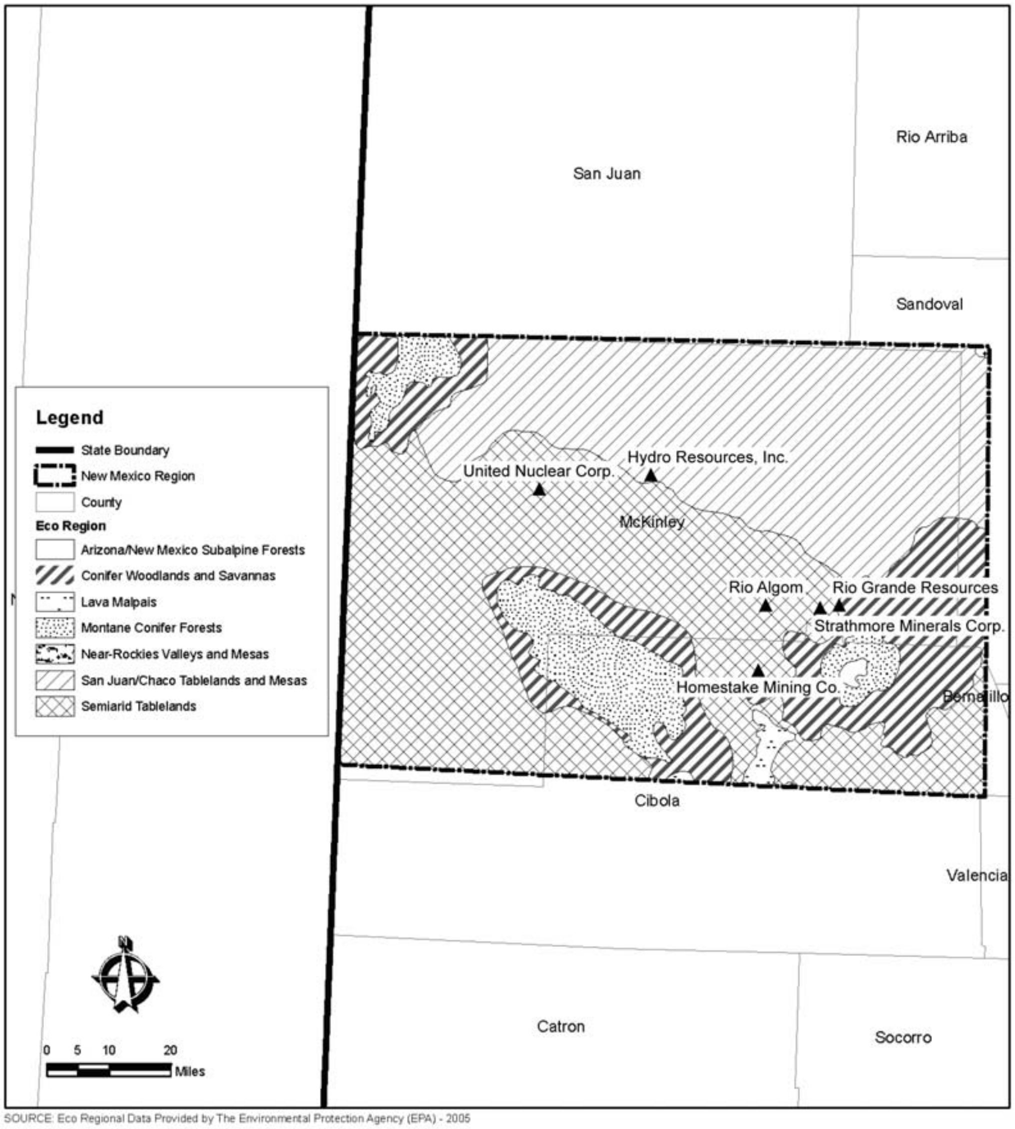


Figure 3.5-9. Ecoregions for the Northwestern New Mexico Uranium Milling Region

The Arizona/New Mexico Mountains region is distinguished from neighboring mountainous ecoregions by lower elevations and associated vegetation indicative of drier, warmer environments. Forests of spruce, fir, and Douglas fir, which are common in mountainous regions, are limited to the highest elevations in this region. Chaparral is common at lower elevations in some areas; pinyon-juniper and oak woodlands are found at lower and middle elevations. Higher elevations in the region are mostly covered with open to dense ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands (Griffith, et al., 2006).

The Montane Conifer Forests are found west of the Rio Grande at elevations from about 2,130 to 2,900 m [7,000 to 9,500 ft]. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry (*Amelanchier alnifolia*). Some Douglas fir, southwestern white pine (*Pinus strobiformis*), and white fir (*Abies concolor*) occur in a few areas (Griffith, 2006). This region also includes mixed conifer/aspen stands. Seven different conifers can be found growing in the same region, and there are a number of common cold-deciduous shrub and grass species, including a few maple (*Acer* spp.), blueberry (*Vaccinium* ssp), gray alder (*Alnus incana*), kinnikinnick (*Arctostaphylos uva-ursi*), water birch (*Betula occidentalis*), redosier dogwood (*Cornussericea*), Arizona fescue (*Festuca arizonica*), fivepetal cliffbush (*Jamesia Americana*), creeping barberry (*Mahonia repens*), Oregon boxleaf (*Paxistima myrsinites*), Kuntze mallow ninebark (*Physocarpus malvaceus*), New Mexico locust (*Robinia neomexicana*), mountain snowberry, and Gambel oak (*Quercus gambelii*). Herbaceous species include fringed brome (*Bromus ciliatus*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*Carex rossii*), dryspike sedge (*Carex siccata*), screwleaf muhly, bluebunch wheatgrass, sprucefir fleabane (*Erigeron eximius*), Virginia strawberry (*Fragaria virginiana*), smallflowered woodrush (*Luzula parviflora*), sweetcicely (*Osmorhiza berteroi*), bittercress ragwort (*Packera cardamine*), western meadow-rue (*Thalictrum occidentale*), and Fendler's meadow-rue (*Thalictrum fendleri*) (New Mexico Department of Game and Fish, 2006).

The Conifer Woodlands and Savannas ecoregion is an area of mostly pinyon-juniper woodlands consisting of one-seed, alligator, and Rocky Mountain junipers with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands consisting of blue grama, junegrass, gallet, and bottlebrush squirreltail (*Elymus elymoides*). In addition, some areas may have Gambel oak. Utah juniper and big sagebrush can be found in the Chuska Mountains. At lower elevations, yuccas and cactus can be found (Griffith, et al., 2006)

The Arizona/New Mexico Subalpine Forests occur west of the Rio Grande at the higher elevations, generally above about 2,900 m [9,500 ft]. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. Although there are some vegetational differences from mountain range to mountain range within the region, the major forest trees include Engelmann spruce, corkbark fir (*Abies lasiocarpa var. arizonica*), blue spruce (*Picea pungens*), white fir, and aspen. Some Douglas fir occurs at lower elevations (Griffith, et al., 2006).

Northwestern New Mexico Fauna

According to the Biota Information System of New Mexico (2007), more than 1,100 species of amphibians, reptiles, mammals, birds, invertebrates, and fish are found throughout the state. Bird fauna is diverse with more than 500 species. Mammal diversity is high compared to other southwestern states, with approximately 184 species. New Mexico has approximately 26 species of amphibians and over 100 species of reptiles.

Common mammals found within the Northwester New Mexico Uranium Milling Region include numerous myotis bat species, black bear, bobcat, numerous rodents, coyotes, bighorn sheep, Gunnison's prairie dogs, skunks, and squirrels. In addition, critical elk winter habitat and calving areas are located in the area (Figure 3.5-10). Currently, most of the proposed or existing ISL facilities are located within designated critical elk winter habitat. Most of the habitat in this region is found within the southern half of McKinley County and most of Cibola County. Common bird species found in the region include bluebirds, buntings, doves, ducks, cormorants (*Phalacrocorax* spp.), hummingbirds, jays, flycatchers, kingbirds, mockingbird, sparrows, and ravens. Raptor species include hawks such as the ferruginous hawk, red-tailed hawk, sharp shinned hawk, and Swainson's hawk; noted owl species found in the counties are the barn owl (*Tyto alba*), burrowing owl (*Athene cunicularia*), elf owl (*Micrathene whitneyi*), flammulated owl (*Otus flammeolus*), great horned owl (*Bubo virginianus*), pygmy owl (*Glaucidium* spp.), and Mexican spotted owl (*Strix occidentalis lucida*). The climax raptor found in the region is the golden eagle (Biota Information System of New Mexico, 2007).

Individual county listings can be obtained through the Biota Information System of New Mexico. A comprehensive listing of habitat types and species (with their scientific names) found within New Mexico are compiled as part of the Southwest Regional Gap Analysis Project (New Mexico State University, 2007).

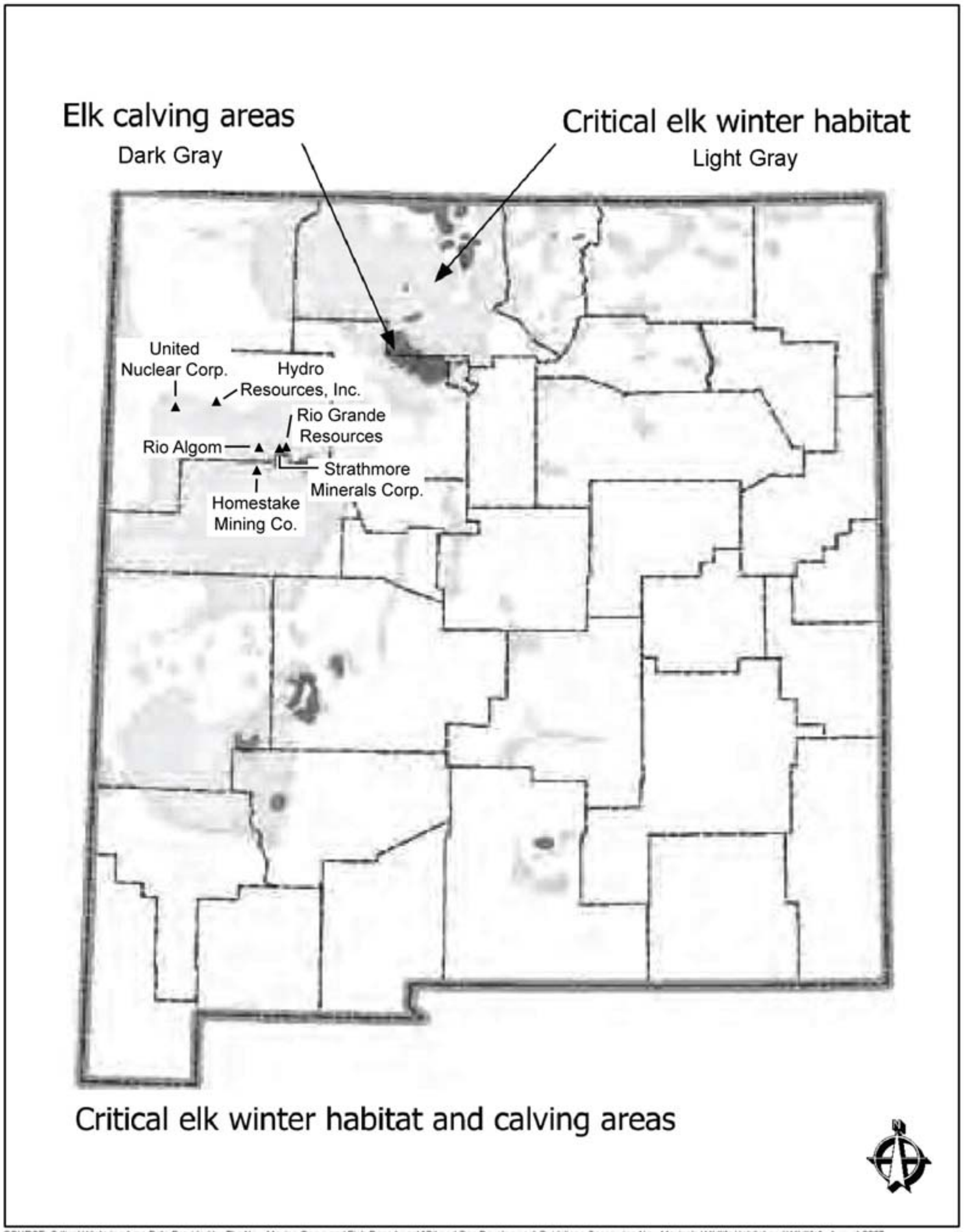
3.5.5.2 Aquatic

There are approximately 161 different species of fish located within the state, with approximately 48 species found in the watersheds of the region (Table 3.5-6) (Biota Information System of New Mexico, 2007). The New Mexico Comprehensive Wildlife Conservation Strategy Plan indicates that the majority of the areas in which milling would occur lie within the Zuni, Rio Grande, and the lower portion of the San Juan watersheds (New Mexico Department of Game and Fish, 2006).

The Zuni watershed also encompasses the upper Puerco watershed. The Zuni watershed has an impacted water system due to settlement changes, overgrazing, and logging. The loss of vegetative cover led to increased erosion, gullying, head cutting, wide discharge fluctuations, and loss of water in the system (New Mexico Department of Game and Fish, 2006). Eight nonnative fish have been found in the watershed, with the green sunfish (*Lepomis cyanellus*), fathead minnow, and the plains killifish comparatively common and widespread. Several sport fish have been introduced to the system such as northern pike (*Esox lucius*), rainbow trout, and channel catfish. Crayfish (O*rconectes virilis*) have also been introduced into the system (New Mexico Department of Game and Fish, 2006).

Two fish, the roundtail chub (*Gila robusta*) and Zuni bluehead sucker (*Catostomus discobolus yarrowi*) and one crustacean (*Hyalella* spp.) have been identified as species of greatest conservation need (New Mexico Department of Game and Fish, 2006).

The Rio Grande watershed originates in the San Juan Mountains of Southern Colorado and flows south through the entire length of New Mexico. This waters shed also encompasses the Arroyo Chico, Rio San Jose and Rio Puerco watersheds as previously discussed. The aquatic habitats in the Rio Grande consist of reservoirs, marshes, and perennial streams (New Mexico Department of Game and Fish, 2006). Numerous species have been introduced into the Rio Grande Watershed. Common carp (*Cyprinus carpio*) are widespread and nonnative



SOURCE: Critical Wintering Area Data Provided by The New Mexico Game and Fish Department "Oil and Gas Development Guidelines Conserving New Mexico's Wildlife Habitat and Wildlife" - August 2007

Figure 3.5-10. Elk Winter Habitat and Calving Areas for the Northwestern New Mexico Uranium Milling Region (Modified From New Mexico Department of Game and Fish, 2007)

Table 3.5-6. Native Fish Species Found in New Mexico	
Common Name	**Scientific Name**
Largemouth Bass	*Micropterus salmoides salmoides (NM)*
Smallmouth Bass	*Micropterus dolomieui*
Striped Bass	*Morone saxatilis*
White Bass	*Morone chrysops*
Bluegill	*Lepomis macrochirus*
Smallmouth Buffalo	*Ictiobus bubalus*
Black Bullhead	*Ameiurus melas*
Yellow Bullhead	*Ameiurus natalis*
Common Carp	*Cyprinus carpio*
Grass Carp	*Ctenopharyngodon idella*
River Carpsucker	*Carpiodes carpio carpio*
Blue Catfish	*Ictalurus furcatus*
Channel Catfish	*Ictalurus punctatus*
Chihuahua Catfish	*Ictalurus* sp *(NM)*
Flathead Catfish	*Pylodictis olivaris*
Chub Flathead	*Platygobio gracilis*
Gila Chub	*Gila intermedia*
Rio Grande Chub	*Gila pandora*
Roundtail Chub	*Gila robusta*
Black Crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*
Longfin Dace	*Agosia chrysogaster*
Longnose Dace	*Rhinichthys cataractae*
Speckled Dace	*Rhinichthys osculus (Gila pop.)*
Speckled Dace	*Rhinichthys osculus (Non-Gila pop.)*
Rainwater Killifish	*Lucania parva*
Fathead Minnow	*Pimephales promelas*
Loach Minnow	*Tiaroga cobitis*
Roundnose Minnow	*Dionda episcopa*
Rio Grand Silvery Minnow	*Hybognathus amarus*
Yellow Perch	*Perca flavescens*
Gizzard Shad	*Dorosoma cepedianum*
Threadfin Shad	*Dorosoma petenense*
Golden Shiner	*Notemigonus crysoleucas*
Red Shiner	*Cyprinella lutrensis*
Rio Grande Shiner	*Notropis jemezanus*
Spikedance	*Meda fulgida*
Central Stoneroller	*Campostoma anomalum*
Zuni Bluehead,Sucker	*Catostomus discobolus yarrowi (NM)*
Desert Sucker	*Catostomus clarki*
Rio Grande Sucker	*Catostomus plebeius*
Sonora Sucker	*Catostomus insignis*
White Sucker	*Catostomus commersoni*
Green Sunfish	*Lepomis cyanellus*
Brown Trout	*Salmo trutta*
Gila Trout	*Oncorhynchus gilae*

Table 3.5-6. Native Fish Species Found in New Mexico (continued)	
Common Name	**Scientific Name**
Rainbow Trout	*Oncorhynchus mykiss*
Western Mosquito Fish	*Gambusia affinis*

salmonids, including rainbow trout, cutthroat subspecies (*O. clarki*) brook trout, and brown trout live in mountain streams. Kokanee salmon (*Oncorhynchus nerka*), rainbow trout, and brown trout are present in reservoirs. Warm/cool water fish include largemouth bass, smallmouth bass, walleye, northern pike, white bass (*Morone chryops*), crappie (*Pomoxis* spp.), and sunfishes (*Lepomis* spp.) (New Mexico Department of Game and Fish, 2006).

Eleven fish species have been designated as a species of greatest conservation need. The Mexican tetra (*Astyanax mexicanus*), speckled chub (*Macrhybopsis aestivalis*), Rio Grande shiner (*Notropis jemezanus*), blue sucker (*Cycleptus elongates*), and gray redhorse (*Moxostoma congestum*) have disappeared from key habitats in the Rio Grande watershed. The following fish are in conservation need: Rio Grande cutthroat trout, Rio Grande chub, Rio Grande sucker, smallmouth sucker, and blue catfish (New Mexico Department of Game and Fish, 2006).

Noted native fish species historically found within the watersheds associated with sites in the Grants Uranium District include blue catfish (*Ictalurus furcatus*), desert sucker (*catostomus clarki*), Gila chub (*Gila intermedia*), Gila topminnow (*Poeciliopis occidentalis*), Gila trout (*Oncorhynchus gilae*), loach minnow (*Rhinichthys cobitis*), Rio Grande sucker (*Catostomus plebeius*), Rio Grande silver minnow (*Hybognathus amarus*), Rio Grande shiner, Rio Grande cutthroat trout (O*hcorhynchus clarki virgininalis*), Rio Grande chub (*Gila pandora*), roundtail chub, spikedace (*Meda fulgida*), smallmouth buffalo (*Ictiiobus bubalus*), Sonora sucker (*Catostomus insignis*), and the Zuni bluehead sucker (Biota Information System of New Mexico, 2007).

The San Juan watershed that contains many first and second order streams found in the Chaco watershed within the milling region. The San Juan River Basin is the second largest of the three subbasins that comprise the Upper Colorado River Basin. The San Juan River Basin drains about 97,300 km^2 [38,000 mi^2] of southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah (U.S. Fish and Wildlife Service, 2006). At least eight native fish species—cutthroat trout, roundtail chub, Colorado pikeminnow, speckled dace, flannelmouth sucker, bluehead sucker, razorback sucker, and mottled sculpin—are located within the basin. Colorado pikeminnow, razorback sucker, and the bonytail chub are federally listed as endangered species, with New Mexico listing the roundtail chub as endangered. Noted non native fish found within the higher order streams in the watershed include red shiner, common carp, fathead minnow, plains killifish, whiter sucker, brown trout, rainbow trout, and channel catfish (New Mexico Department of Game and Fish, 2006).

3.5.5.3 Threatened and Endangered Species

Federally listed threatened and endangered and species which are known to exist within habitats found within the region include the following:

- Bald Eagle, Delisted Monitored.
- Black-Footed Ferret, Extirpated.

- Mexican Spotted Owl (*Strix occidentalis lucida*), Critical Habitat Designated—Mexican spotted owls nest, roost, forage, and disperse in a diverse assemblage of biotic communities. Mixed-conifer forests are commonly used throughout most of the range which may include Douglas fir and/or white fir, with codominant species including southwestern white pine, limber pine, and ponderosa pine. The understory often contains the above coniferous species as well as broadleaved species, such as Gambel oak, maples, box elder, and/or New Mexico locust. In southern Arizona and Mexico, Madrean pine-oak forests are also commonly used. Spotted owls nest and roost primarily in closed-canopy forests or rocky canyons. They nest in these areas on cliff ledges, in stick nests built by other birds, on debris platforms in trees, and in tree cavities. In southern Utah, Colorado, and some portions of northern New Mexico, most nests are in caves or on cliff ledges in rocky canyons. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure, are typically uneven-aged and multistoried, and have high canopy closure. A wider variety of trees are used for roosting, but again Douglas fir is the most commonly used species (U.S. Fish and Wildlife Service, 2008)

- Pecos Puzzle Sunflower (*Helianthus paradoxus*)—This species is found in areas that have permanently saturated soils, including desert wetlands (cienegas) that are associated with springs, but may include stream and lake margins. When found around lakes, these lakes are usually natural cienega habitats that have been impounded (Center for Plant Conservation, 2008).

- South Western Willow Fly Catcher (*Empidonax traillii extimus*)—The southwestern willow flycatcher breeds in patchy to dense riparian habitats along streams, reservoirs, or other wetlands. Common tree or shrub species include willow, seep willow, boxelder, stinging nettle, blackberry, cottonwood, arrowweed, tamarisk (salt cedar), and Russian olive. Habitat characteristics vary across the subspecies' range. However, occupied sites usually consist of dense vegetation in the patch interior, or dense patches interspersed with openings, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still water, or saturated soil is present at or near breeding sites during non-drought years (U.S. Fish and Wildlife Service, 2008).

- Yellow Billed Cuckoo (*Coccyzus americanus*)—Discussed in Section 3.2.5.3.

- Zuni Bluehead Sucker (*Catostomus dicobolus yarrowi*), Candidate—More recent surveys (early to mid 1990s) determined the distribution of Zuni bluehead sucker in New Mexico to be limited mainly to the Río Nutria drainage upstream of the mouth of the Nutria Box Canyon. This included the mouth of Río Nutria box canyon, upper Río Nutria, confluence of Tampico Draw and Río Nutria, Tampico Spring, and Agua Remora. Definitive habitat associations for Zuni bluehead sucker have not been determined. Zuni bluehead sucker are primarily found in shaded pools and pool runs, about 0.3 to 0.5 m [1 to 1.5 ft] deep with water velocity less than 10 cm/s [4 in/s]. Zuni bluehead suckers were found over clean, hard substrate, from gravel and cobble to boulders and bedrock (New Mexico Department Game and Fish, 2004).

- Zuni Fleabane (*Erigeron rhizomatus)*—Zuni fleabane grows in selenium-rich red or gray detrital clay soils derived from the Chinle and Baca formations. Plants are found at elevations from 2,230-2,440 m [7,300–8,000 ft] in pinyon-juniper woodland. Zuni fleabane prefers slopes of up to 40°, usually with a north-facing aspect. Although the overall vegetative cover is usually high, there are few other competing plants on the steep easily erodible slopes that are Zuni fleabane's primary habitat. Zuni fleabane is found only in areas of suitable soils. These soils occur most extensively in the Sawtooth Mountains and in the northwestern part of the Datil Mountains in Catron County, New Mexico. There are 29 known sites in this area, which range in size from a fraction of an acre to about 105 ha [260 acres]. There are two sites on the northwest side of the Zuni Mountains in McKinley County, New Mexico, and one site in Apache County, Arizona (U.S. Fish and Wildlife Service, 2008).

- Rio Grande Silvery Minnow (*Hybognathus amarus*)—Currently, the Rio Grande silvery minnow is believed to occur only in one reach of the Rio Grande in New Mexico, a 280-km (174-mi) stretch of river that runs from Cochiti Dam to the headwaters of Elephant Butte Reservoir. Its current habitat is limited to about 7 percent of its former range. The Rio Grande silvery minnow uses only a small portion of the available aquatic habitat. In general, the species most often uses silt substrates in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, and backwaters). The Rio Grande silvery minnow is rarely found in habitats with high water velocities, such as main channel runs, which are often deep and swift. The species is most commonly found in depths of less than 20 cm [7.9 in] in the summer and 31–40 cm [12.2–15.75 in] in the winter (U.S. Fish and Wildlife Service, 2007).

State-listed threatened and endangered species for the region include the following:

- American Marten (*Martes americana*)—The American marten is broadly distributed. It extends from the spruce-fir forests of northern New Mexico to the northern limit of trees in arctic Alaska and Canada. American martens live in mature, dense conifer forests or mixed conifer-hardwood forests. They prefer woods with a mixture of conifers and deciduous trees including hemlock, white pine, yellow birch, maple, fir and spruce. Especially critical is presence of many large limbs and fallen trees in the understory, known as coarse woody debris. These forests provide prey, protection and den sites (New Mexico Department of Game and Fish, 2008).

- Arctic Peregrine Falcon (*Falco peregrinus tundrius)*—Peregrine falcons live mostly along mountain ranges, river valleys, and coastlines. Historically, they were most common in parts of the Appalachian Mountains and nearby valleys from New England south to Georgia, the upper Mississippi River Valley, and the Rocky Mountains. Peregrines also inhabited mountain ranges and islands along the Pacific Coast from Mexico north to Alaska and in the Arctic tundra (U.S. Fish and Wildlife Service, 2008).

- Bald Eagle (*Haliaeetus leucocephalus)*—In New Mexico, migrating bald eagles can be found near rivers and lakes, where occasional tall trees provide lookout perches and night roosts. Reservoirs with sizable populations of migrating bald eagles include Ute, Conchas, Ft. Sumner, Santa Rosa, Elephant Butte, Caballo, Cochiti, El Vado, Heron, and Navajo (New Mexico Department of Game and Fish, 2008).

- Baird's Sparrow (*Ammodramus bairdii)*—Breeds in native mixed-grass and fescue prairie. Winters in grasslands; specific winter habitat requirements not well described. Baird's sparrow does not inhabit prairie lands where fire suppression and changes in natural grazing patterns have allowed woody vegetation to grow excessively. Some hayfields or pastures may support Baird's sparrow where native grasses occur in sufficient quantity, but generally cultivated land is a far inferior habitat relative to true prairie. Winters from southeast Arizona, southern New Mexico, and south Texas to north-central Mexico (Cornell Laboratory of Ornithology, 2008)

- Broadbilled Hummingbird (*Cynanthus latirostris)*—In the United States this hummingbird is found in riparian woodlands at low to moderate elevations. In Guadalupe Canyon, these woodlands are characterized by cottonwoods, sycamores, white oaks, and hackberries. Nests found in Guadalupe Canyon have been in a variety of trees, shrubs, and even forests (New Mexico Department of Game and Fish, 2004).

- Brown Pelican (*Pelecanus occidentalis)*—Brown pelicans nest on small, isolated coastal islands where they are safe from predators such as raccoons and coyotes. This is a potential migrant though the region (Texas Parks and Wildlife Department, 2007)

- Common black hawk (*Buteogallus anthracinus*)—Obligate riparian nester, dependent on mature, relatively undisturbed habitat supported by a permanent flowing stream. Streams less than 30 cm [12 in] deep of low to moderate gradient with many riffles, runs, pools, and scattered boulders or lapped with branches provide ideal hunting conditions (Public Employees for Environmental Responsibility, 2008).

- Costa’s Hummingbird (*Calypte costae)*—Occurs mainly in Southern California, Arizona, Baja California, and western Mexico, but also extends into Nevada, extreme southeastern Utah, and southeastern New Mexico. Habitats occupied by Costa’s hummingbirds include Sonoran desert scrub, the Mojave Desert, California chaparral, California coastal scrub, and the Cape deciduous forest of Baja California (Audubon Society, 2007).

- Gray Vireo (*Vireo vicinior*)—Gray vireo breeds in some of the hottest, driest areas of the American Southwest, favoring dry thorn scrub, chaparral, and pinyon-juniper and oak-juniper scrub, in arid mountains and high plains scrubland. This species forages in thickets, taking most of its prey from leaves, twigs, and branches of small trees and bushes. Its diet on the breeding grounds consists of a variety of arthropods, including large grasshoppers, cicadas, and caterpillars. Winter diet differs based on locality—birds found in western Texas are primarily insectivorous, while those wintering in southern Arizona and adjacent northern Mexico feed mainly on fruit (Audubon Society, 2007).

- Interior Least Tern (*Sterna antillarum athalassos*)—Discussed in Section 3.3.5.3.

- Jemez Mountains Salamander (*Plethodon neomexicanus*)—Native to north-central New Mexico, this species has been found in various localities in the Jemez Mountains in Sandoval, Los Alamos, and Rio Arriba counties. This salamander typically lives on shady, wooded sites at elevations of about 2,300 to 2,900 m [7,500 to 9,500 ft]. In these habitats, characterized by coniferous trees, salamanders spend much of their time under and in fallen logs. Old, stabilized talus slopes, especially those with a good covering of damp soil and plant debris, are important types of cover for this species (New Mexico Department of Game and Fish, 2008).

- Meadow Jumping Mouse (*Zapus hudsonius)*—Jumping mice are nocturnal, and in New Mexico this species occurs in moist habitats dominated by damp and rich vegetation. The meadow jumping mouse inhabits areas with streams, moist soil, and lush streamside vegetation consisting of grasses, sedges, and forbs. Such habitats are in the Jemez Mountains and in the edges of permanent ditches and cattail stands in the Rio Grande Valley (New Mexico Department of Game and Fish, 2008).

- Neotropic cormorant (*Phalacrocorax brasilianus)*—This cormorant is found from southern New Mexico to southern Louisiana and southward through Central America and the Caribbean to South America. Neotropic cormorants also may wander northward to the Bernalillo area and westward to the Gila Valley. This bird is rare in southern Hidalgo County, the area near Alamogordo, and in the lower Pecos Valley from Bitter Lake National Wildlife Refuge southward (New Mexico Department of Game and Fish, 2008).

- Peregrine Falcon (*Falco peregrines*)—In New Mexico the breeding sites of peregrine falcons are on cliffs in wooded and forested habitats, with large "gulfs" of air nearby in which these predators can forage (New Mexico Department of Game and Fish, 2008).

- Rio Grande Shiner (*Notropis jemezanus*)—The Rio Grande shiner is found in the Rio Grande drainage, from just above the mouth to the Pecos River (north in Pecos River to Sumner Lake, New Mexico) and (formerly) Rio Grande, New Mexico (where now extirpated). It is absent from large sections of the Rio Grande and Pecos Rivers in western Texas; occurs in Rio San Juan, Rio Salado, and Rio Conchos, Mexico; common in the lower Rio Grande, and is less common elsewhere. It can be found in runs and flowing pools of large open weedless rivers and large creeks with bottom of rubble, gravel, and sand, often overlain with silt (NatureServe, 2008).

- Spotted Bat (*Euderma maculatum)*—The rarity of this bat and the diverse habitats in which it has been seen have caused confusion about its preferences. Some have been captured in pine forests at high elevations 2,400–2,700 m [8,000–9,000 ft]; others came from a pinyon pinejuniper association; and still others from desert scrub areas. Spotted Bats are known only from about 20 locations in western and southern New Mexico (New Mexico Department of Game and Fish, 2008).

- Southwestern Willow Flycatcher—previously described in this section as a federally listed species.

- Wrinkled Marsh Snail (*Stagnicola caperata*)—The wrinkled marsh snail occurs in such habitats as vegetated ditches, marshes, streams, and ponds, that are typically seasonally dry. Such a site is occupied by the New Mexico population in the Jemez Mountains, where the habitat is a shallow pond at 2,600 m [8,500 ft] elevation. The species also occurs in areas of perennial water, including the former population at Bitter Lake National Wildlife Refuge (USACE, 2007).

- Zuni Bluehead Sucker—previously described in this section as a federally listed species.

3.5.6 Meteorology, Climatology, and Air Quality

3.5.6.1 Meteorology and Climatology

Temperature in New Mexico is influenced more by elevation than latitude. Mean annual temperatures range from 17 °C [64 °F] in the southeast to less than 4 °C [40 °F] in the high mountains and northern valleys (National Climatic Data Center, 2005). New Mexico typically experiences variations between daytime and nighttime temperatures. Table 3.5-7 identifies two climate stations located in the Northwestern New Mexico Uranium Milling Region. Climate data for these stations are found in the National Climatic Data Center's Climatography of the United States No. 20 Monthly Station Climate Summaries for 1971–2000 (National Climatic Data Center, 2004). This summary contains climate data for 4,273 stations throughout the United States and some territories. Table 3.5-8 contains temperature data for two stations in the Northwestern New Mexico Uranium Milling Region.

The precipitation and snow that New Mexico receives comes from both the Pacific Ocean to the west and the Gulf of Mexico to the southeast. Average annual precipitation ranges from 25 cm [10 in] to more than 50 cm [20 in] at higher elevations (National Climatic Data Center, 2005). In summer, the source of precipitation is usually brief, but often intense thunderstorms. For most of the state, 30 to 40 percent of the year's annual moisture falls in July and August. Typically, New Mexico does not experience widespread floods. Heavy thunderstorms can cause local flash floods. Heavy rains or rain in conjunction with snowmelt can cause large rivers to flood.

Table 3.5-8 contains precipitation data for two stations in the Northestern New Mexico Uranium Milling Region. The wettest month for both stations identified in Table 3.5-8 is August and, based on the snow depth data, snowpack melting usually occurs earlier in the summer (National Climatic Data Center, 2004). One of the stations is in Cibola County and the other is in McKinley County. Data from the National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the majority of thunderstorms in Cibola and McKinley Counties occurs somewhat evenly between May and September (National Climatic Data Center, 2007).

Table 3.5-7. Information on Two Climate Stations in the Northwestern New Mexico Uranium Milling Region*

Station (Map Number)	County	State	Longitude	Latitude
Grants Milan AP	Cibola	New Mexico	107°54W	35º10N
McGaffey 5 SE	McKinley	New Mexico	108°27W	35º20N

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

Table 3.5-8. Climate Data for Stations in the Northwestern New Mexico Uranium Milling Region*

		Grants Milan AP	McGaffey 5 SE
Temperature (°C) †	Mean—Annual	10.4	5.9
	Low—Monthly Mean	−0.6	−4.5
	High—Monthly Mean	22.1	17.2
Precipitation (cm) ‡	Mean—Annual	27.6	51.6
	Low—Monthly Mean	1.1	1.7
	High—Monthly Mean	5.3	7.0
Snowfall (cm)	Mean—Annual	23.9	136
	Low—Monthly Mean	0	0
	High—Monthly Mean	7.4	26.9

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

In winter, the precipitation usually falls as snow in the mountains; however, the precipitation in the valleys can be either rain or snow. Table 3.5-9 contains snowfall data for two stations in the Northwestern New Mexico Uranium Milling Region.

As an example, Figure 3.5-11 shows a wind rose for Gallup, New Mexico, for 1991. Winds are predominantly from the west southwest and southwest. Wind speeds are depicted in knots where 1 knot is approximately equal to 0.51 m/s [1.7 ft/s]. Wind roses such as these should be obtained for the actual location of the facility for preferably a period of time of 1 year or longer. This data can be used for dispersion estimates.

The pan evaporation rates for the Northwestern New Mexico Uranium Milling Region range from about 114 to 152 cm [45 to 60 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data are typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

3.5.6.2 Air Quality

The general air quality general description for the Northwestern New Mexico Uranium Milling Region would be similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region.

Table 3.5-9. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in New Mexico and Arizona*

New Mexico	Arizona
Bandelier Wilderness	Chiricahua National Monument Wilderness
Bosque del Apache Wilderness	Chiricahua Wilderness
Carlsbad Caverns National Park	Galiuro Wilderness
Gila Wilderness	Grand Canyon National Park
Pecos Wilderness	Mazatzal Wilderness
Salt Creek Wilderness	Mount Baldy Wilderness
San Pedro Parks Wilderness	Petrified Forest National Park
Wheeler Peak Wilderness	Pine Mountain Wilderness
White Mountain Wilderness	Saguaro Wilderness
	Sierra Ancha Wilderness
	Superstition Wilderness
	Sycamore Canyon Wilderness

*Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005.

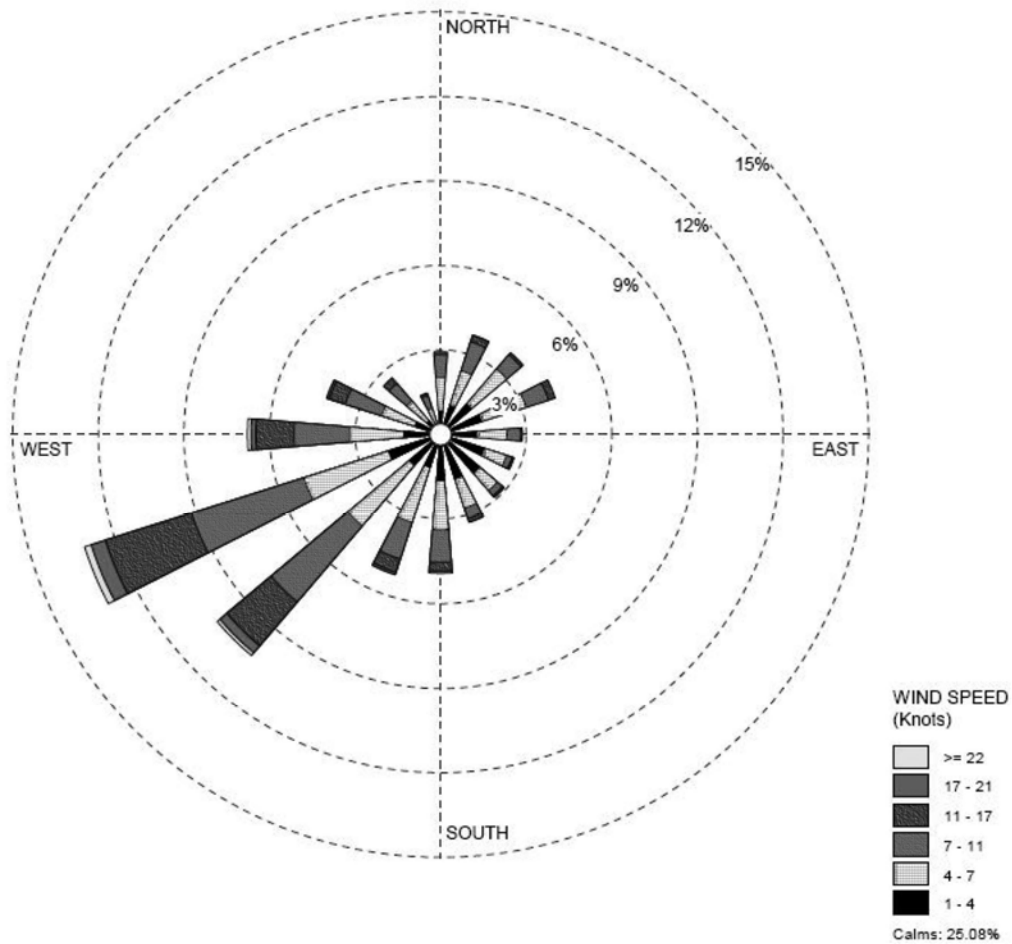


Figure 3.5-11. Wind Rose for Gallup, New Mexico, Airport for 1991 (New Mexico Environmental Department, 2007)

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. Except for Indian Country, New Source Review permits in New Mexico are regulated under the EPA-approved State Implementation Plan. For Indian Country in New Mexico, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas are in New Mexico. States may develop standards that are stricter or supplement the NAAQS. New Mexico has a more restrictive standard for carbon monoxide throughout the state and for sulfur dioxide in a small area around the city of Hurley. This area around Hurley is not within the Northwestern New Mexico Uranium Milling Region. New Mexico also has a nitrogen dioxide standard with a 24-hour averaging time (New Mexico Environment Department, 2002).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas and Class I areas have the most stringent requirements.

The Northwestern New Mexico Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and Prevention of Significant Deterioration classifications in the region.

Figure 3.5-12 identifies the counties in and around the Northwestern New Mexico Uranium Milling Region that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). The Northwestern New Mexico Uranium Milling Region covers portions of New Mexico and borders Arizona. All of the area within this milling region is classified as attainment. Portions of two counties in New Mexico are not in attainment: Bernalillo County (central New Mexico) and Doña Ana County (south central New Mexico). The city of Albuquerque in Bernalillo County is designated as maintenance for carbon monoxide. The northwest part of Bernalillo County is only several kilometers [miles] from the Northwestern New Mexico Uranium Milling Region border; however, Albuquerque is about 50 km [31 mi] from this border. The city of Anthony in Doña Ana County is designated as nonattainment for PM_{10}. The Sunland Park area of Doña Ana County was designated as nonattainment for the 1-hour ozone standard until the EPA revoked the standard in 2005. Several counties in southern Arizona, including one that borders New Mexico, are not in attainment. However, the one Arizona county (Apache County) that borders the Northwestern New Mexico Uranium Milling Region is in attainment.

Table 3.5-9 identifies the Prevention of Significant Deterioration Class I areas in New Mexico and Arizona. The Class I areas in and around the Northwestern New Mexico Uranium Milling Region are shown in Figure 3.5-13. There are no Class I areas in the Northwestern New Mexico Uranium Milling Region.

3.5.7 Noise

The existing ambient noise levels for undeveloped rural areas in the Northwestern New Mexico Uranium Milling Region would be similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region (up to 38 dB). The largest communities in the region include Gallup with a population of more than 20,000; Grants with a population of about 9,000; and Zuni Pueblo (about 6,400) (see Section 3.5.10). Urban noise levels in these communities and the smaller surrounding population centers would be similar to those (up to about 78 dB) for other urban areas (Washington State Department of Transportation, 2006).

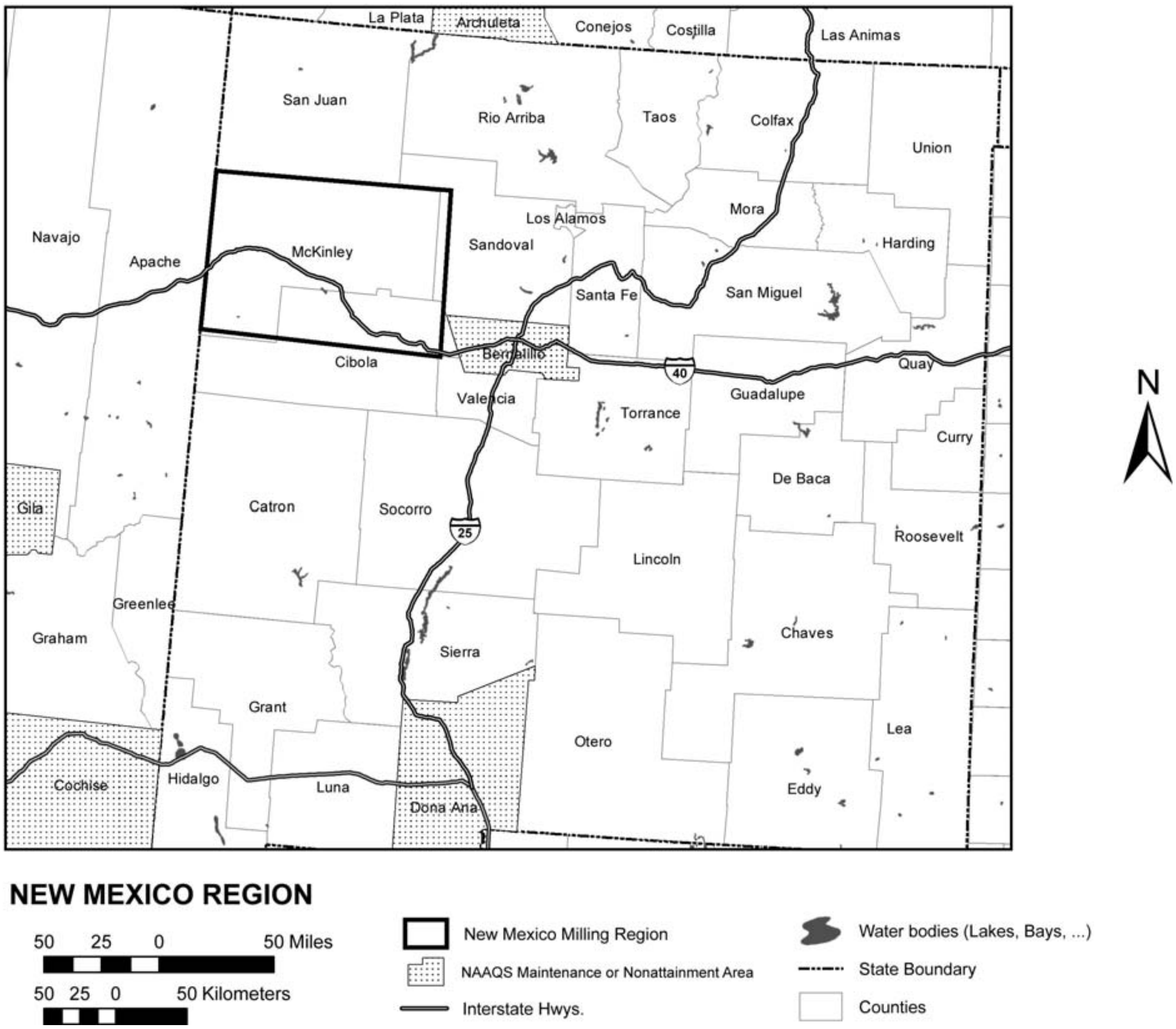


Figure 3.5-12. Air Quality Attainment Status for the Northwestern New Mexico Uranium Milling Region and Surrounding Areas (EPA, 2007a)

As described in Section 3.5.2, two major highways cross the Northwestern New Mexico Uranium Milling Region: Interstate 40 runs east west and U.S. Highway 491 runs north from Gallup. There are also several state undivided highways, but the area is only sparsely served by paved roads. Traffic counts for Interstate 40 are higher than those reported for Interstate-80 in Wyoming, with annual average daily traffic reported at about 16,500 just east of the New Mexico/Arizona line (New Mexico Department of Transportation, 2007). Traffic counts for U.S. Highway 491 are less, with annual average daily traffic of about 9,700 north of Gallup (New Mexico Department of Transportation, 2007). This suggests that ambient noise levels near these highways might be higher than the levels measured for Interstate-80 (Wyoming Department of Transportation, 2005; Federal Highway Administration, 2004; see also Section 3.2.7).

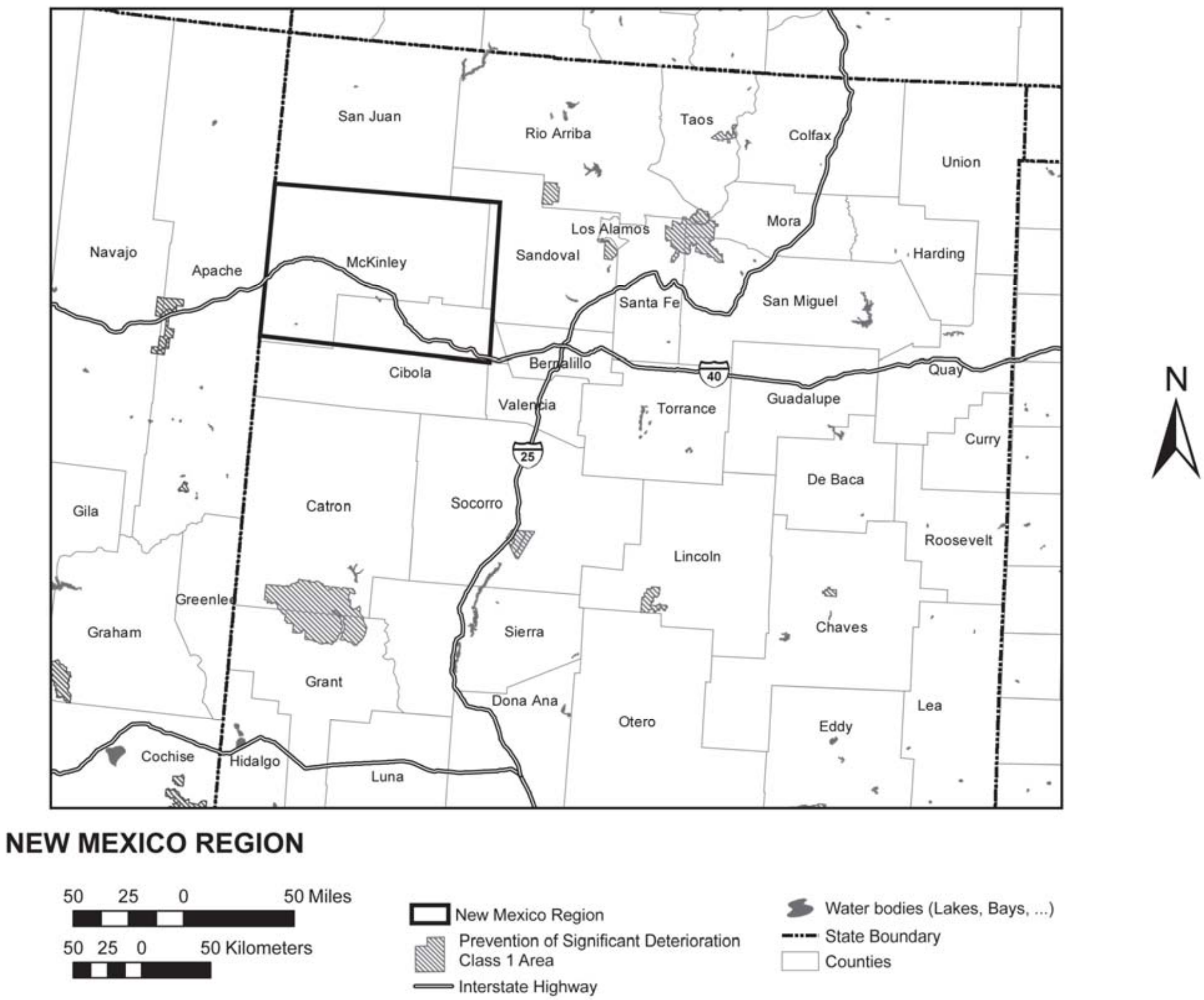


Figure 3.5-13. Prevention of Significant Deterioration Class I Areas in the Northwestern New Mexico Uranium Milling Region and Surrounding Areas (40 CFR Part 81)

The potential uranium projects in the region are more than 8 km [5 mi] from Interstate 40, and ambient noise levels would not be affected by highway noise. In some cases, such as at Crownpoint, the proposed facility would be located close to a small community, and the ambient noise levels would be expected to be slightly higher. Areas of special sensitivity to potential noise impacts could include areas of special significance to the Native American culture in the region (see Section 3.5.8).

3.5.8 Historical and Cultural Resources

The New Mexico SHPO is responsible for the oversight of federal and state historic preservation compliance laws, regulations, and statutes. The Cultural Properties Act (Sections 16-6 through 18-6-23, New Mexico Statutes Annotated 1978) was enacted in 1969 and amended several times in the ensuing years. It established the State Historic Preservation Division and Cultural Properties Review Committee, which issues permits for survey and excavation on state lands, and for the excavation of burials. Burial excavation permits are specifically required by the Unmarked Burial Statute (18-6-11.2, 1989) and the Marked Burial Statute (30-12-12, 1989) for human remains found on state or private land; whereas the NAGPRA applies to federal lands. The Reburial Grounds Act (18-6-14, 2006) provides for the designation of reburial areas for unclaimed human remains. The Cultural Properties Act also requires that state agencies provide the New Mexico SHPO with the opportunity to participate in planning activities that would affect properties on the State Register of Cultural Properties or the National Register of Historic Places. The Prehistoric and Historic Sites Preservation Act of 1969 (Sections 18-8-1 through 18-8-8, NMSA 1978) prohibits the use of state funds that would adversely affect sites on the state or national registers, unless the state agency demonstrates that there is no feasible or prudent alternative. The Cultural Properties Protection Act (Sections 18-6A-1 through 18-6A-6, New Mexico Statutes Annotated 1978) enacted in 1993 encourages state agencies to consult with the New Mexico SHPO in order to develop programs that will identify cultural properties and ensure that they will not be inadvertently damaged or destroyed. Lastly, Executive Order No. 2005-003 recognizes the sovereignty of Native American tribes in the state of New Mexico and provides that state agencies should conduct tribal consultation on the protection of culturally significant places and the repatriation of human remains and cultural items. Information on the New Mexico SHPO can be found at the following link: <http://www.nmhistoricpreservation.org>.

The U.S. government and the State of New Mexico recognize the sovereignty of certain Native American tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires executive branch federal agencies to undertake consultation and coordination with Native American tribal governments on a government-to-government basis. NRC, as an independent federal agency, has agreed to voluntarily comply with Executive Order 13175.

In addition, the NHPA provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the New Mexico SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. Both the Navajo Nation and Zuni Pueblo have a recognized THPO program. Other tribes have historic and cultural preservation offices that are not recognized as THPOs, but they should be consulted where they exist (see appended New Mexico tribal consultation list for Cibola and McKinley Counties).

The Navajo Nation has passed the Natural Resources Protection Act of 2005, which is designed to “ensure that no further damage to the culture, society, and economy of the Navajo Nation occurs because of uranium mining within the Navajo Nation …” An insight into the effects of uranium exploration on traditional Navajo life is provided in the recent publication (Udall, et al., 2007). The Navajo Nation Code also states that “the six culturally significant mountains…Tsoodzil…must be respected, honored and protected for they, as leaders, are the foundation of the Navajo Nation (Navajo Nation, 2005, pp. 22–23).” *Tsoodzil* (Turquoise Mountain) is the Navajo word for Mount Taylor, some 24 km [15 mi] north of Grants, New Mexico, and in Navajo tradition, marks the southern boundary of the Navajo Dinetah or traditional homeland.

3.5.8.1 New Mexico Historic and Cultural Resources

McKinley and Cibola Counties are rich in cultural resources. In fact, the first highway salvage archaeological excavations in the nation were conducted along old Route 66 in this vicinity during the 1950s. Archaeological compliance work continues through the 21st century in respect to a variety of economic activities, including highway construction, energy development, tourism at the national monuments, and the realignment of military installations. Cultural resource overviews and Class II surveys of the region have therefore been provided by several federal agencies; however, they date to the 1980s when most of the energy-related development was initiated. The San Juan Basin Regional Uranium Study was certainly one of the most important of these studies (Broster and Harrill, 1982; Dulaney and Dosh, 1981; Plog and Wait, 1979; Powers, et al., 1983; Tainter and Gillio, 1980).

Interstate 40 passes through Albuquerque, Grants, and Gallup, acting as a primary east-west link across the region. New Mexico State Road 491 heads north from Gallup to Shiprock and the Four-Corners area. Lastly, Grants is connected to Chaco Canyon National Monument by way of State Road 371. A variety of archaeological projects have therefore been conducted in respect to highway-related compliance work (e.g., Damp, et al., 2002; Gilpin, 2007).

McKinley and Cibola Counties have been a major focus of energy development activities, including coal, uranium, and natural gas pipeline projects. The McKinley Coal Mine and the Laguna uranium mine represent two examples of extensive surface mining operations (Allen and Nelson, 1982; Kelley, 1982). In addition, the ENRON and El Paso pipeline projects have crosscut the region to supply the west with natural gas from sources in northwest New Mexico (Winter, 1994).

Three national monuments are located within the Northwestern New Mexico Uranium Milling Region: Chaco Canyon, El Morro, and El Malpais. Although Chaco Canyon is situated to the north of Grants, New Mexico, in San Juan County, several outlying components of Chaco National Monument are present in Cibola and McKinley Counties including the Red Mesa Valley group east of Gallup, the Cebolleta Mesa Group, Puerco of the West Group, and portions of the South Chaco Slope Group (Marshall, et al., 1979; Powers, et al., 1983). El Morro and El Malpais National Monuments are also located near Grants (Powers and Orcutt, 2005a; Murphy, et al., 2003).

Fort Wingate is a closed military installation that has been extensively surveyed for cultural resources. The former Army munitions depot is located south of Interstate 40 between Gallup and Grants. These lands contain numerous archaeological sites and have ancestral ties to both Zuni Pueblo and the Navajo Nation (Schutt and Chapman, 1997; Perlman, 1997).

A total of 21,625 archaeological sites have been recorded in McKinley and Cibola Counties as of this writing. A single Class II sample survey identified an average density of 6 sites/km^2 [15 sites/mi^2] for the southern San Juan Basin (Dulaney and Dosh, 1981); however, site densities as high as 12 sites/km^2 [30 sites/mi^2] were identified on Cebolleta Mesa (Broster and Harrill, 1982). Table 3.5-10 provides a summary of sites recorded by time period for McKinley and Cibola Counties, and Figure 3.5-14 illustrates the distribution of these sites across the counties. However, this distribution only includes those areas that have been systematically surveyed for cultural resources. Together these resources represent over 10,000 years of human land-use in the region. The following is a brief review of the Native American occupation of the area.

Table 3.5-10. Number of Recorded Sites by Time Period and County		
	County	
Period	McKinley	Cibola
Paleoindian	18	34
Archaic	426	359
Ancestral Pueblo	8,211	2,742
Historic Pueblo	575	290
Navajo	4,476	378
Other Historic	518	1,057
Undetermined	2,822	2,331
Total*	15,040	6,585
*Note: Because many sites include multiple temporal components, the total number of sites presented above does not reflect the total number of components (occupations) that might exist at each site.		

Paleoindian (ca. 10,000 to 6000 B.C.)

The Paleoindian occupation of the region is primarily represented by the presence of isolated projectile points with a few campsites (Figure 3.5-15). Clovis (10,000–9,000 B.C.), Folsom (9,000–8,000 B.C.) and Late Paleoindian (8,000–6,000 B.C.) points have been identified at various locations across the landscape. The Clovis inhabitants presumably hunted a range of large animal species including mammoth, whereas Folsom hunters focused on migratory bison herds and Late Paleoindian hunters on bison, with other animal and plant species (Amick, 1994; Broster and Harrill, 1982; Judge, 2004; Stanford, 2005).

Archaic (ca. 6,000 B.C to A.D. 400)

The Archaic occupation of the region is characterized by the presence of numerous temporary campsites (Figure 3.5-16). Early Archaic (6,000–4,000 B.C.) and Middle Archaic (4,000–2000 B.C.) sites appear to be less common than those occupied during the Late Archaic (2000 B.C.–A.D. 400); however, this may be a product of differential preservation and the exposure of subsurface deposits, rather than differences in the degree to which these groups occupied the area. Early and Middle Archaic groups gathered a variety of plant species while hunting medium- to small-sized game. In contrast, domesticated maize first appeared in New Mexico by 2100 B.C., probably as a supplement to gathered plant foods, with the first evidence of simple irrigation perhaps as early as 1000 B.C. (Damp, et al., 2002; Huber and Van West, 2005; Simmons, 1986; Vierra, 2008).

Ancestral Puebloan (ca. A.D. 400 to 1540)

For many years, archaeologists referred to the prehistoric culture that arose in the San Juan Basin after the Archaic period as the “Anasazi,” a word borrowed from the Navajo that means “old people” or “enemy ancestors” (Kantner, 2004). Although this term continues to be widely used among archaeologists and the public alike, many contemporary Pueblo people find the use of Anasazi to be offensive. Although controversy about this issue continues (Kantner, 2004; Riggs, 2005), archaeologists and government agencies increasingly use the term “Ancestral Puebloan” in place of Anasazi, a practice that is followed here.

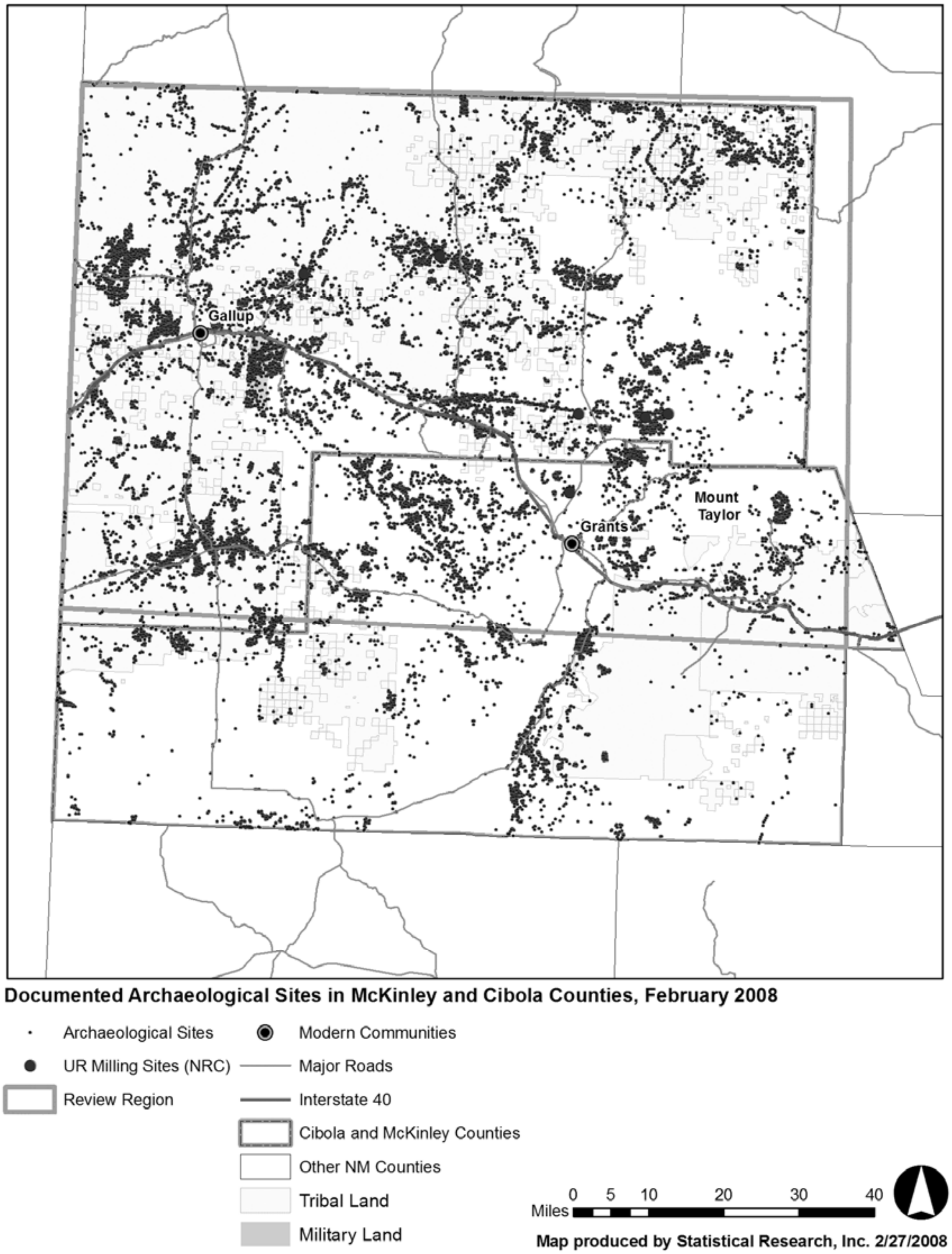


Figure 3.5-14. Distribution of Recorded Archaeological Sites in McKinley and Cibola Counties, New Mexico

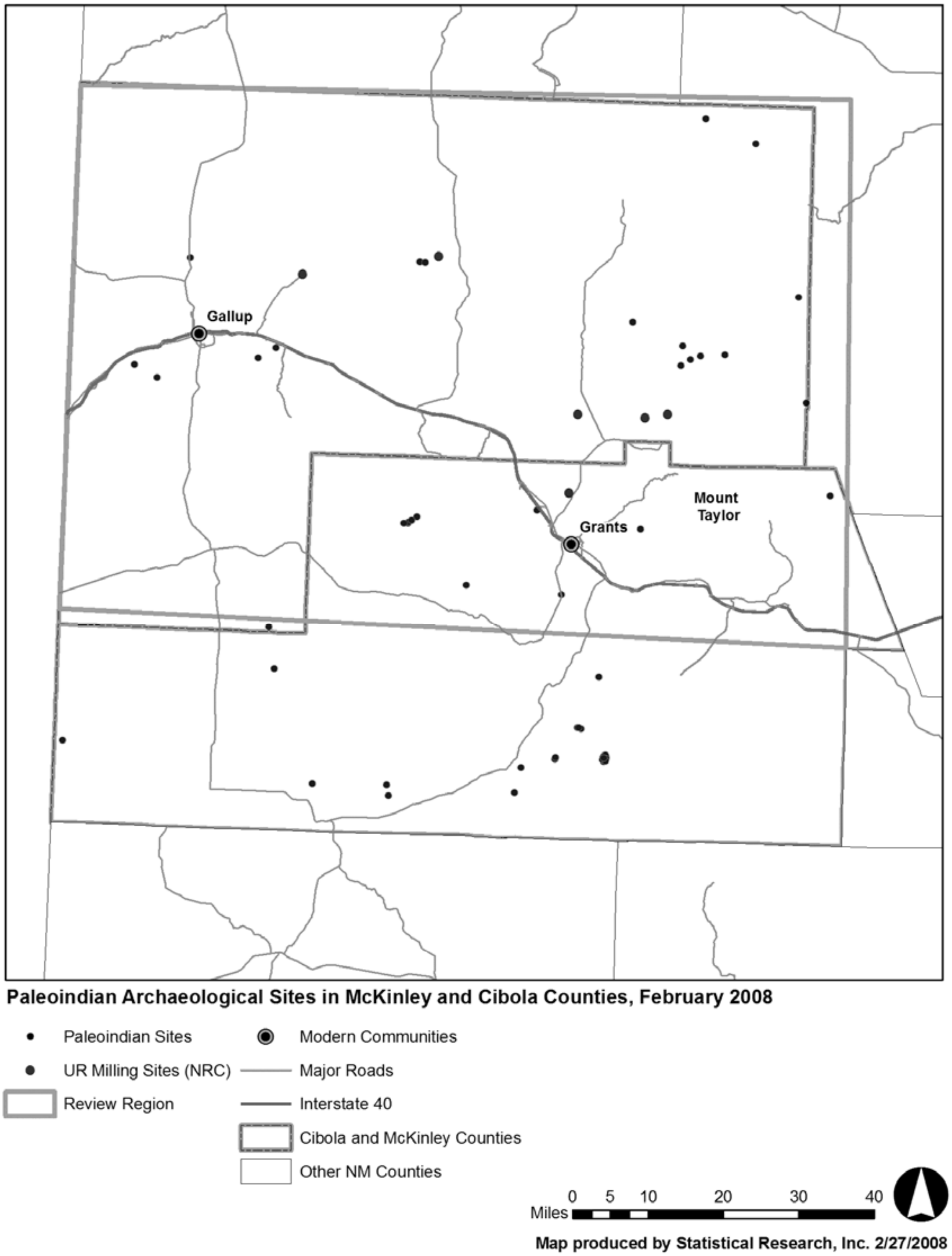


Figure 3.5-15. Paleoindian Sites

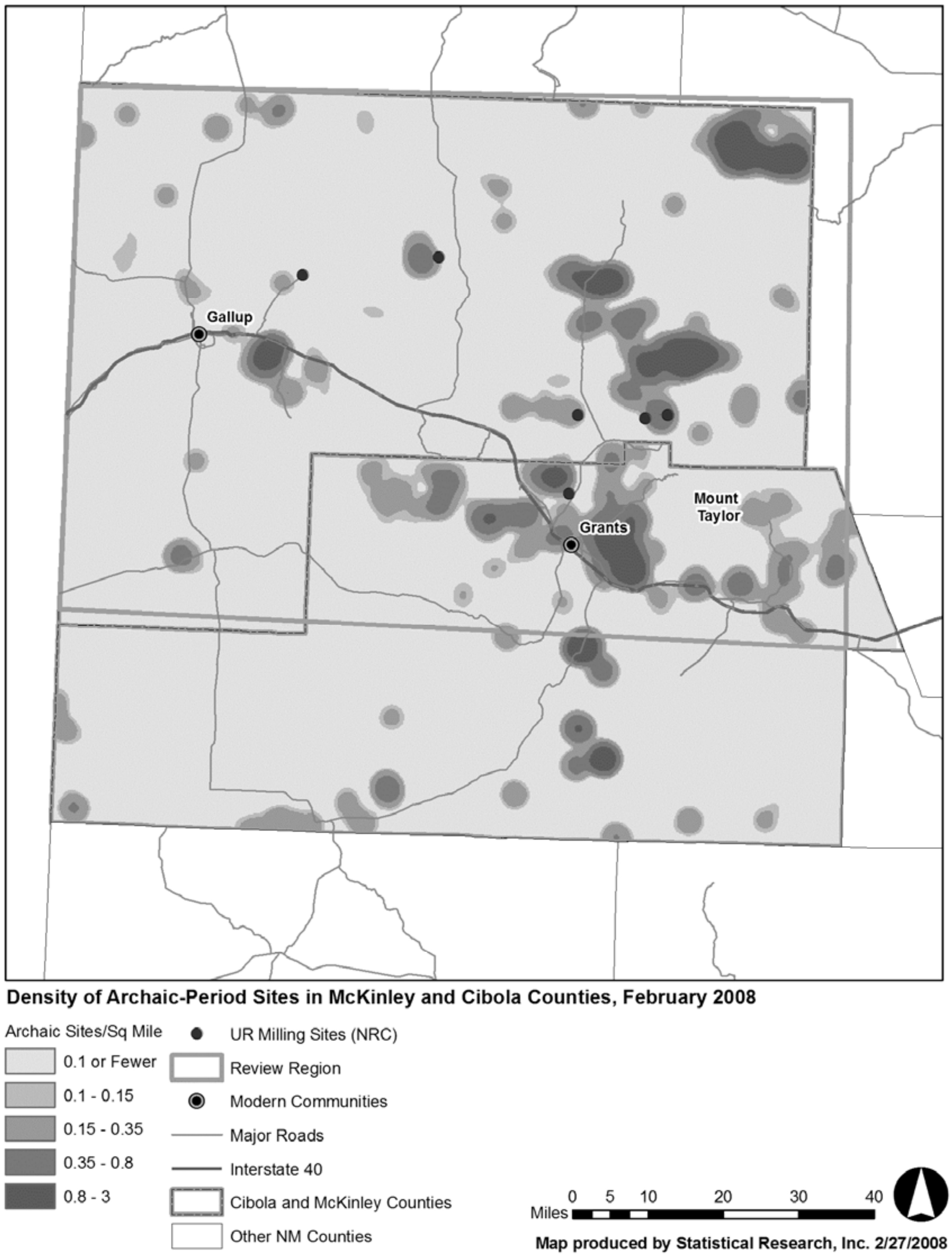


Figure 3.5-16. Distribution of Archaic-Period Sites

The Ancestral Puebloan period appears to have emerged directly from the preceding Archaic period and begins with the initial appearance of pottery and the bow and arrow, more elaborate pit structure architecture, and the more intensive use of maize agriculture. Although a number of chronological sequences for this period have been proposed for the region, the two major sequences currently in use are the Cebolleta Mesa and Pecos Chronologies (Kidder, 1927) (Table 3.5-11, Figure 3.5-17).

Basketmaker II (ca. 500 B.C. to A.D. 400)

Basketmaker II (or Late Archaic) represents a continuation of the previous hunting and gathering lifestyle. However, important changes in subsistence and social organization were occurring with a growing dependence on the cultivation of maize. Recent excavations in the region have documented habitation sites with houses, storage pits, and refuse areas. High water table farming adjacent to playa settings appears to have been an important niche for early maize cultivation, with numerous storage features having been discovered in these contexts. In addition, the earliest evidence of water diversion through irrigation channels is also represented. Lastly, important changes in technology were also occurring, including the use of ceramic containers and the bow and arrow (Damp, et al., 2002; Kearns, et al., 1998; Vierra, 1994, 2008).

Basketmaker III (ca. A.D. 400 to 700)

In comparison to the preceding Late Archaic period, Basketmaker III material culture is characterized by the introduction of the bow and arrow and fired ceramic vessels. Basketmaker III sites in the San Juan region also featured larger and more elaborate pit habitation structures, larger villages, and evidence for increased trade and greater reliance on agriculture, including both corn and beans (Reed, 2000b). Although Basketmaker III sites have been identified throughout McKinley and Cibola Counties, these sites typically date to the later portion of this time period and transition gradually into Pueblo I occupations, with few major cultural differences between them (Tainter and Gillio, 1980). In general, Basketmaker III sites are fairly rare in most of the McKinley/Cibola region compared to other areas to the north and west (Cordell, 1979; Orcutt, et al., 2005, Powers and Orcutt, 2005b; Schutt and Chapman, 1997; Tainter and Gillio, 1980). In McKinley County, however, many sites that became important during the later Pueblo II period were initially occupied at this time (Powers, et al., 1983).

Table 3.5-11. Cebolleta Mesa and Pecos Chronologies

Cebolleta Mesa Sequence	Dates B.C./A.D.	Pecos Classification
—	Ca. 500 B.C.–A.D. 500	Basketmaker II
Lobo Period	?–700 A.D.	Basketmaker III
White Mound Phase	700–800	Basketmaker III/Pueblo I
Kiatuthlana Phase	800–870	Pueblo I
Red Mesa Phase	850–950	Early Pueblo II
Cebolleta Phase	950–1100	Pueblo II
Pilares Phase	1100–1200	Pueblo III
Kowina Phase	1200–1400	Pueblo III to IV
Cubero Phase	1400–1540	Late Pueblo IV
Acoma Phase	1540–present	Pueblo V/Historic Pueblo

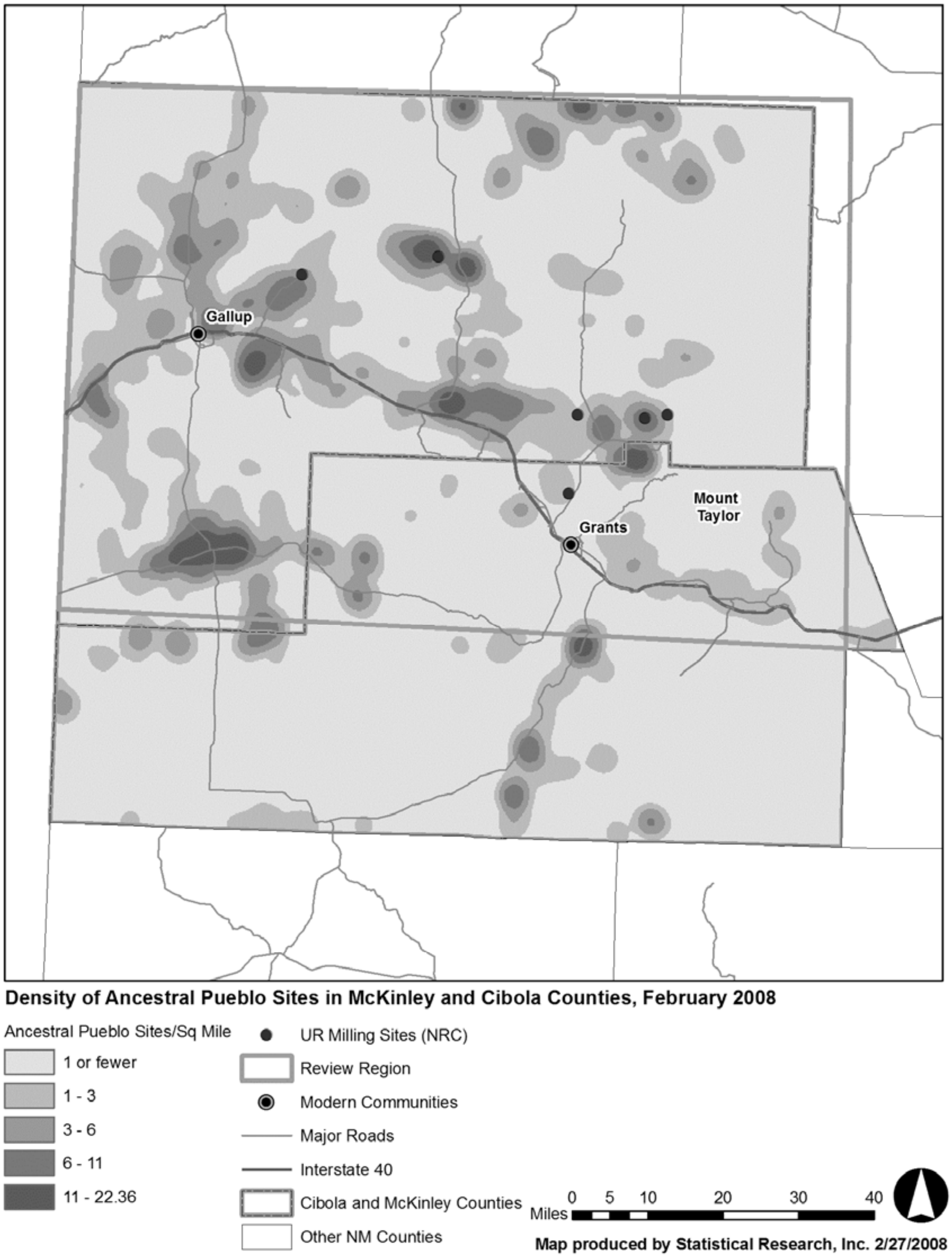


Figure 3.5-17. Distribution of Ancestral Puebloan Sites

Pueblo I (ca. A.D. 700 to 900)

The Pueblo I period is distinguished from the Basketmaker III period by the first appearance of painted black-on-white pottery. Although a shift away from living in subterranean pit structures and into aboveground rooms is also typically part of the Basketmaker III/Pueblo I transition (Reed, 2000a), pithouses remained the dominant structure type in much of McKinley and Cibola Counties until fairly late in the Pueblo I period, with small surface rooms primarily used for storage (Schutt and Chapman, 1997; Tainter and Gillio, 1980). Small aboveground pueblos constructed from masonry or jacal (wattle-and-daub) began to be used for habitation in some areas by the end of the Pueblo I period (Schutt and Chapman, 1997). Kivas—subterranean structures with a specialized ceremonial function—also made their first appearances during this period (Schutt and Chapman, 1997). Although Pueblo I-period sites are not particularly common in McKinley and Cibola Counties, they are more numerous than Basketmaker III sites and represent the first substantial Ancestral Puebloan occupations in many areas (Schachner and Kilby, 2005; Schutt and Chapman, 1997; Tainter and Gillio, 1980).

Pueblo II (ca. A.D. 900 to 1100)

The Pueblo II period represents a considerable change in Ancestral Puebloan culture throughout the Four Corners region, including the present study area (Powers, et al., 1983; Schutt and Chapman, 1997; Tainter and Gillio, 1980). Blocks of contiguous, aboveground masonry rooms become the primary focus of occupation, with belowground structures increasingly shifting to a predominantly ceremonial function (Powers and Orcutt, 2005b; Schutt and Chapman, 1997). Sites are often much larger than in the preceding Pueblo I period, and populations increase steeply throughout McKinley and Cibola Counties: in many areas, populations during Pueblo II reach a peak that is not exceeded during the prehistoric period (Tainter and Gillio, 1980).

This period also marks the development of the Chacoan regional system, an event with major repercussions for the entire Four Corners region (Kantner and Mahoney, 2000; Noble, 2004; Powers, et al., 1983). Beginning around A.D. 850, Ancestral Puebloan peoples living in Chaco Canyon, located just north of McKinley County (Judge, 2004; Powers, et al., 1983; Windes, 2004), began constructing a series of elaborate, carefully planned, multistory masonry structures today known as “great houses” (Windes, 2004). Although rooted in the Puebloan architecture of previous periods, the great houses were larger than contemporary structures anywhere else in the Puebloan world (Mills, 2002b). By the mid-13th century, when major construction ceased, at least 18 great houses had been constructed in and around the canyon, the largest reaching 4 or more stories and incorporating hundreds of rooms and an elaborate, decorative core-and-veneer masonry style (Judge, 2004; Mahoney and Kantner, 2000; Mills, 2002b).

Nor was great house construction limited to Chaco Canyon. Starting at about A.D 950, great houses began to be built beyond the canyon at numerous locations throughout the San Juan Basin. More than 200 great houses with Chacoan-style architecture and features have been identified to date across an area stretching from eastern Arizona and southern Colorado to the edges of the Jemez Mountains and the foothills of Mount Taylor. Outlier sites in McKinley and Cibola Counties include Casamero, Kin Nizhoni, and Village of the Great Kivas (Mahoney and Kantner, 2000; Marshall, et al., 1979). Southern and eastern areas near Acoma and Laguna are less clearly part of the Chaco system, exhibiting clear differences from sites in the San Juan Basin (Tainter and Gillio, 1980), but outliers may exist in these areas as well (Powers and Orcutt, 2005b). Outlying great houses are typically located among much smaller and less elaborate masonry pueblos and are often accompanied by distinctive structures including extremely large “great kivas” and Chacoan roads. These roads are intentionally constructed trails that typically measure 8 to 12 m [26 to 39 ft] in width and incorporate raised beds, borders, gates, stairways, and other features (Mahoney and Kantner, 2000; Mills, 2002b; Powers and Orcutt, 2005b). Their function is not well understood, but recent studies suggest they may link ceremonially and ritually important features of the Chacoan landscape (Kantner, 1997; Van Dyke, 2004).

The function and meaning of Chacoan great houses are not well understood, but most evidence suggests they were not simply residential structures. Excavated great houses in Chaco Canyon typically contain few rooms with cooking hearths and very little household trash, leading some archaeologists to suggest that even the largest structures never housed more than 100 permanent residents (Mills, 2002b). Most archaeologists now believe these structures served some sort of public function, perhaps as part of a ceremonial system centered around Chaco itself. However it functioned, Chaco’s far-reaching influence served to funnel trade goods into the canyon. Recent studies of ceramic and lithic artifacts, wooden roof beams, and even foodstuffs like corn from great houses in the canyon suggest that many of these goods were brought in from far-flung areas such as the Chuska Mountains in eastern Arizona, the Mesa Verde area in southern Colorado, and the Mount Taylor region (Cordell, 2004; Mills, 2002b; Toll, 2004).

Pueblo III (ca. A.D. 1100 to 1300)

Great house construction within Chaco Canyon itself ceased by about A.D. 1130, and most of the canyon’s occupants appear to have moved elsewhere by the late 12th century (Judge, 2004; Mills, 2002b). Many factors probably contributed to the demise of Chaco, but a series of major droughts that afflicted the region throughout much of the 12th century may have had a particularly influential role (Mills, 2002b). Beyond Chaco Canyon, however, many great house communities remained occupied throughout the 1100s, retaining many aspects of their Chacoan origins but incorporating new and distinctly different features as well (Mills, 2002b). Perhaps spurred by drought, populations declined throughout much of McKinley and Cibola Counties (Kintigh, 1996; Roney, 1996; Tainter and Gillio, 1980). New settlements founded during this period were frequently larger and more compact than the great house communities of the preceding period as populations aggregated in areas more conducive to conserving and managing water (Kintigh, 1996). Populations in some areas appear to have recovered and stabilized somewhat by the early 13th century (Powers and Orcutt, 2005a; Roney, 1996). The process of abandonment and aggregation began to accelerate again by the late 1200s, however, as renewed drought increasingly pushed Pueblo populations into relatively well-watered areas along the Zuni River to the west and the Rio San Jose to the east (Kintigh, 1996; Roney, 1996; Tainter and Gillio, 1980).

Pueblo IV (ca. A.D. 1300 to 1540)

The settlement reorganization that began during the Pueblo III period continued during Pueblo IV. By A.D. 1400, most of the Four Corners region was abandoned, with remnant populations concentrated in the Zuni and Rio San Jose areas and at the Hopi mesas in Arizona (Huntley and Kintigh, 2004; Kintigh, 1996; Roney, 1996). The number of sites present in these areas continued to drop as populations aggregated in large villages, but the compactly laid-out pueblos that remained were often extremely large, with several including more than 1,000 rooms (Huntley and Kintigh, 2004). By the late Pueblo IV period, the vast majority of Puebloan people in west-central New Mexico were at least part-time residents of one of these large pueblos; the smaller habitation sites that characterized earlier periods were virtually absent in many areas (Huntley and Kintigh, 2004; Roney, 1996). These newly aggregated large villages shared many similarities across the region: settlements typically consisted of blocks of contiguous rooms arranged around plaza areas used for domestic activities and public rituals. At larger sites, these roomblocks were often two or more stories tall. Sites were also frequently located in highly defensive locations, especially early in the period (Huntley and Kintigh, 2004; Roney, 1996; Tainter and Gillio, 1980).

Historic Pueblo (post A.D. 1540)

By the mid-16th century, Puebloan groups occupied no more than 10 villages in west-central New Mexico: 6 to 9 Zuni-speaking pueblos arrayed along the lower Zuni River and its tributaries south of modern Gallup (Huntley and Kintigh, 2004) and the single Keres-speaking village of Acoma, located on a mesa top in eastern Cibola county along the Rio San Jose (Adams and Duff, 2004) (Figure 3.5-18). The first contact between these villages and the Spanish came in 1539, when a small expedition led by Franciscan friar Marcos de Niza and the former slave Esteban entered the Zuni region; de Niza returned abruptly to Mexico when Esteban was killed (Ferguson and Hart, 1985; Spicer, 1962). The much larger expedition of Francisco Vasquez de Coronado fought a battle with the Zuni in July 1540 outside the village of Hawikuh and stopped briefly at Acoma on its way to the Rio Grande valley (Ferguson and Hart, 1985; Flint and Flint, 2005). More sustained contact with the Spanish empire came in 1598, when both the Zuni and Acoma areas were formally subjugated by the expedition of Juan de Oñate (Spicer, 1962).

Franciscan missions were established at both Zuni and Acoma in 1629, but the distance between Zuni and the center of Spanish power along the Rio Grande allowed the Zuni to retain a degree of cultural and religious independence (Ferguson and Hart, 1985; Spicer, 1962). Franciscan missions at Acoma and the Zuni villages of Hawikuh and Halona operated until the Pueblo Revolt of 1680, when the Spanish were driven from New Mexico for a dozen years, but missionization in the Zuni region continued only sporadically after the Spanish reconquest in the late 1600s. At both Acoma and Zuni, however, European infectious diseases and the economic demands of the colonizers decimated Puebloan populations: at Zuni, the six or more villages inhabited at contact dwindled to three by 1680, and only one village, the present pueblo of Zuni, was reoccupied after the reconquest (Mills, 2002a). To the east, Acoma remained the only village along the Rio San Jose until 1697, when the pueblo of Laguna was established by a group of Acoma dissidents and refugees from other villages after the Spanish reconquest (Ellis, 1979).

More benign aspects of colonialism included new economic opportunities afforded by the food crops and domesticated animals brought by the Spanish. Sheepherding, in particular, began at both Zuni and Acoma as early as the mid-17th century, and by the mid-18th century, the Zunis grazed more than 15,000 sheep across an area extending as far as 112 km [70 mi] from the central pueblo itself (Ferguson and Hart, 1985; Schutt and Chapman, 1997). Small, temporary campsites associated with sheepherding and agriculture are among the most common historic period Puebloan archaeological sites from the 1600s into the 20th century (Ferguson, 1996; Schutt and Chapman, 1997).

Navajo (ca. 1700 to present)

With the exception of the areas just discussed, much of the northern Southwest, including northwestern New Mexico, was abandoned by Ancestral Puebloan groups during the

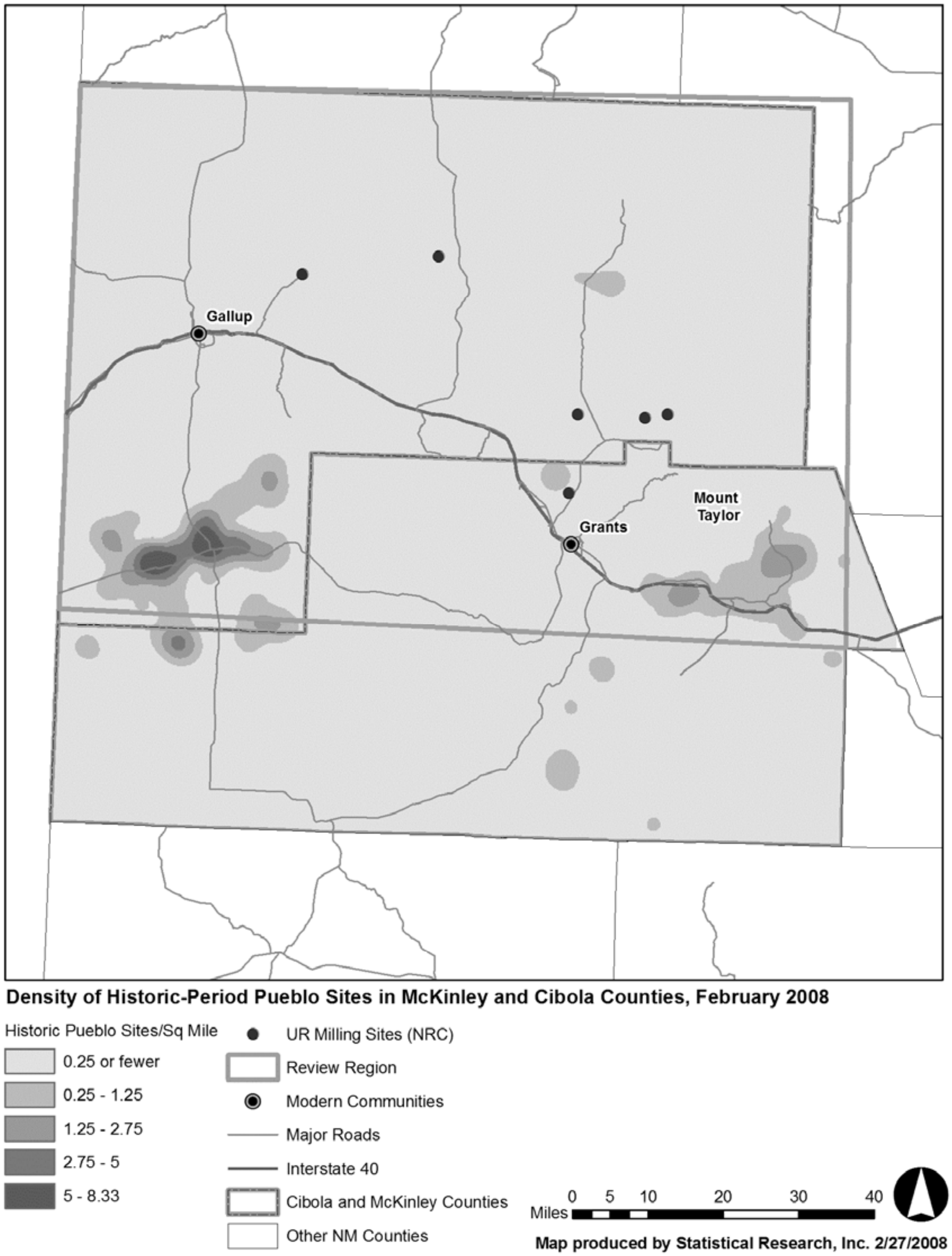


Figure 3.5-18. Distribution of Historic Pueblo Sites

14th century, followed by the expansion of Athabaskan hunter-gatherers into these vacated areas, perhaps as early as the late 15th century (Dean, et al., 1994; Towner, 1996). The Athabaskan-speaking groups are believed to have been the ancestors of today's Navajo and Apachean groups in the Southwest. The ancestral Navajo groups subsequently adopted maize cultivation and later moved south into the southern San Juan Basin by the 1700s (Figure 3.5-19). The 18th century Navajo migration southward was due to several factors including conflict with the Comanches and Utes, drought, and disease outbreaks. Records of Navajo baptisms at the Cebolleta Mission occur after 1749, with Navajo raids on local settlers and Laguna Pueblo Indians being reported in the late 1700s (Brugge, 1968; Correll, 1976; Reeve, 1959). This conflict continued through the 1800s, although the Navajos in the Mount Taylor (Tsoodzil) area were also involved in trade relations with both local Spanish and Pueblo Indians. Nonetheless, in 1864 all the Navajos residing in the region were forcibly moved to Fort Sumner in eastern New Mexico. By 1868 the Navajos were allowed to return to their lands within a newly designated reservation. The arrival of the railroad during the 1880s provided them with a market for wool blankets and jewelry. However, this was a mixed blessing, with pressures on the Navajo households to produce market items, versus subsistence self-sufficiency. Ultimately, Navajos expanded into more marginal areas that could not sustain the growing economic markets, with the long-term result being the partitioning of landholdings into smaller family-owned tracts, the overgrazing of these tracts, and a shift toward wage-earning jobs (Kelley, 1986).

3.5.8.2 National Register of Historic Properties and State Registers

Table 3.5-12 includes a summary of sites in the Northwestern New Mexico Uranium Milling Region that are listed on the New Mexico State and/or NRHP. Most of the sites are located in McKinley County, and the locations of many of the archaeological sites are not identified to reduce the likelihood of vandalism. Historic sites are located in the communities of Grants, Gallup, and Crownpoint, all of which are close to potential uranium ISL milling locations.

3.5.8.3 New Mexico Tribal Consultation

There are 22 Native American Pueblos and tribes located within the state of New Mexico. Most of these groups are situated along the Rio Grande valley corridor from Albuquerque to Taos, with several additional groups being represented in the northwest and southern parts of the state. Five tribes have reservation lands within McKinley and Cibola Counties, consisting of Acoma Pueblo, Laguna Pueblo, Zuni Pueblo, the Navajo Nation and the Ramah Navajo Tribe. These counties lie in the northwestern section of the state, along the southern periphery of the San Juan Basin. The region is characterized by mesas and open grasslands, which are bounded by the Chuska Mountains, Zuni Mountains, and Mount Taylor rising to heights of over 2,950 m [9,700 ft]. The Continental Divide bisects the area with drainages flowing toward the north, west, and east. Silko provides an insight into the Pueblo perspective of this environment when she states that "there is no high mesa edge or mountain peak where one can stand and not immediately be part of all that surrounds. Human identity is linked with all the elements of Creation" (Silko, 1990, pp. 884–885).

Traditional cultural properties are places of special heritage value to contemporary communities because of their association with cultural practices and beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (Parker and King, 1998; King, 2003). Religious places are often associated with prominent topographic features like mountains, peaks, mesas, springs and lakes (Silko, 1990). In addition,

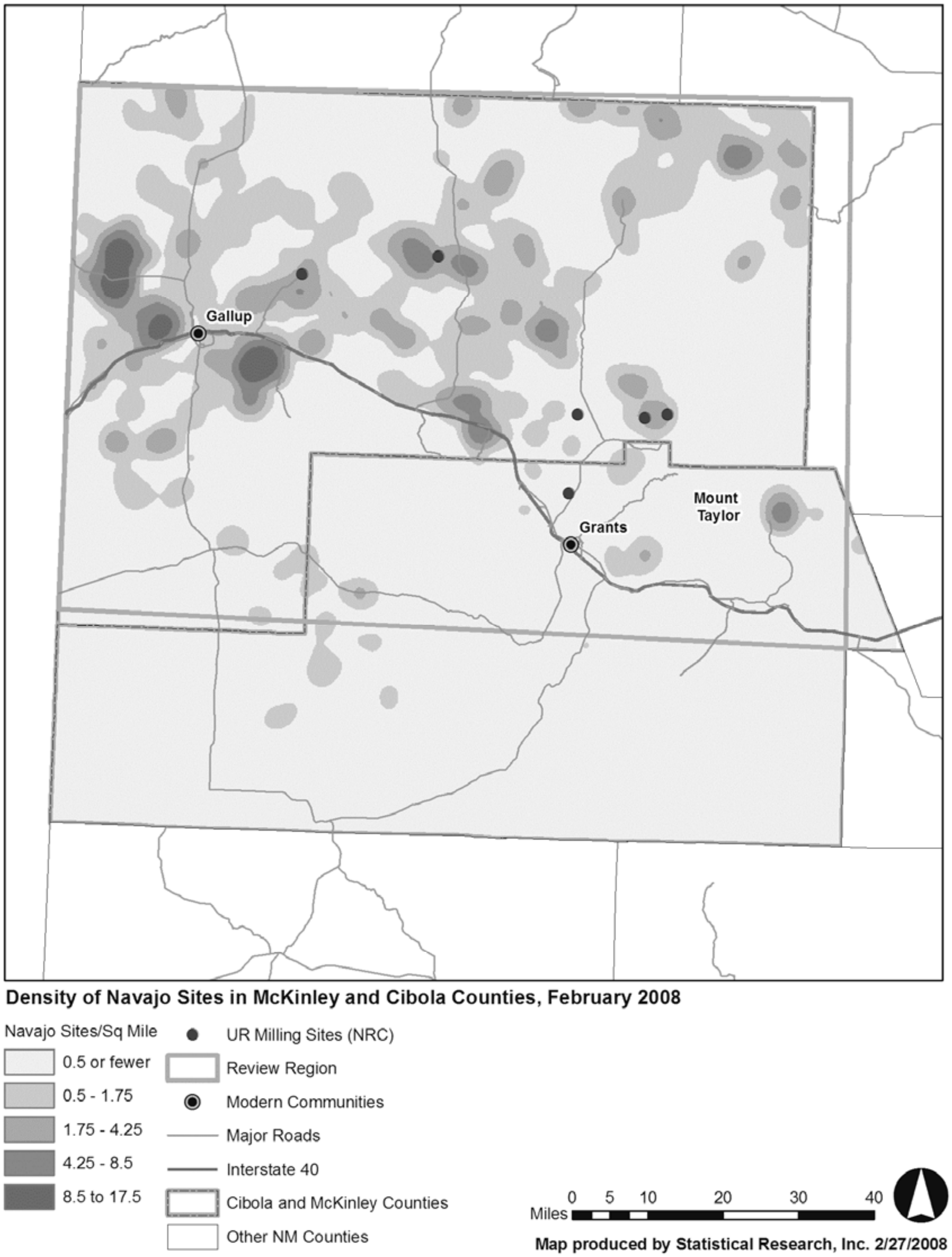


Figure 3.5-19. Distribution of Navajo Archaeological Sites

Table 3.5-12. National Register Listed Properties in Counties Included in the Northwestern New Mexico Uranium Milling Region

County	Resource Name	City	Date Listed YYYY-MM-DD
Cibola	Bowlin's Old Crater Trading Post	Bluewater	2006-03-21
Cibola	Candelaria Pueblo	Grants	1983-03-10
Cibola	Route 66 Rural Historic District: Laguna to McCarty's	Cubero	1994-01-13
Cibola	Route 66, State Maintained from McCarty's to Grants	Grants	1997-11-19
Cibola	Route 66, State Maintained from Milan to Continental Divide	Continental Divide	1997-11-19
McKinley	Andrews Archeological District	Prewitt	1979-05-17
McKinley	Archaeological Site # LA 15278 (Reservoir Site; CM 100)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,780	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,781	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,782	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,784	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,785	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,786	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 45,789	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,000	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,001	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,013 (CM101)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,014 (CM 102)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,015 (CM 102A)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,016 (CM 103)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,017 (CM 104)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,018	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,019 (CM 105)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,020 (CM 106)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,021	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,022 (CM 107)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,023 (CM 118)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,024 (CM 108)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,025 (CM 109)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,026 (CM 108)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,027 (CM 111)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,028 (CM 112)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,030 (CM 114)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,031 (CM 115)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,033 (CM 117)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,034	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,036	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,037	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,038	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,044	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,071 (CM 148)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,072 (CM 94)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,074 (CM 181)	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,077	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,080	Pueblo Pintado	1985-08-02
McKinley	Archaeological Site # LA 50,035	Pueblo Pintado	1985-10-09

Table 3.5-12. National Register Listed Properties in Counties Included in the Northwestern New Mexico Uranium Milling Region (continued)			
County	**Resource Name**	**City**	**Date Listed YYYY-MM-DD**
McKinley	Ashcroft—Merrill Historic District	Ramah	1990-07-27
McKinley	Bee Burrow Archeological District	Seven Lakes	1984-12-10
McKinley	Casa de Estrella Archeological Site	Crownpoint	1980-10-10
McKinley	Chaco Culture National Historical Park	Thoreau	1966-10-15
McKinley	Chief Theater	Gallup	1988-05-16
McKinley	Cotton, C.N., Warehouse	Gallup	1988-01-14
McKinley	Cousins Bros. Trading Post	Chi Chil Tah	2006-03-22
McKinley	Dalton Pass Archeological Site	Crownpoint	1980-10-10
McKinley	Drake Hotel	Gallup	1988-01-14
McKinley	El Morro Theater	Gallup	1988-05-16
McKinley	El Rancho Hotel	Gallup	1988-01-14
McKinley	Fort Wingate Archeological Site	Fort Wingate	1980-10-10
McKinley	Fort Wingate Historic District	Fort Wingate	1978-05-26
McKinley	Grand Hotel	Gallup	1988-05-25
McKinley	Greenlee Archeological Site	Crownpoint	1980-10-10
McKinley	Halona Pueblo	Gallup	1975-02-10
McKinley	Harvey Hotel	Gallup	1988-05-25
McKinley	Haystack Archeological District	Crownpoint	1980-10-10
McKinley	Herman’s, Roy T., Garage and Service Station	Thoreau	1993-11-22
McKinley	Lebanon Lodge No. 22	Gallup	1989-02-14
McKinley	Log Cabin Motel	Gallup	1993-11-22
McKinley	Manuelito Complex	Manuelito	1966-10-15
McKinley	McKinley County Courthouse	Gallup	1989-02-15
McKinley	Palace Hotel	Gallup	1988-05-16
McKinley	Peggy's Pueblo	Zuni	1994-08-16
McKinley	Redwood Lodge	Gallup	1998-02-13
McKinley	Rex Hotel	Gallup	1988-01-14
McKinley	Route 66, State Maintained from Iyanbito to Rehobeth	Rehobeth	1997-11-19
McKinley	Southwestern Range and Sheep Breeding Laboratory Historic District	Fort Wingate	2003-05-30
McKinley	State Maintained Route 66—Manuelito to the Arizona Border	Mentmore	1993-11-22
McKinley	Upper Kin Klizhin Archeological Site	Crownpoint	1980-10-10
McKinley	U.S. Post Office	Gallup	1988-05-25
McKinley	Vogt, Evon Zartman, Ranch House	Ramah	1993-02-04
McKinley	White Cafe	Gallup	1988-01-14

shrines are present across the landscape to denote specific culturally significant locations where an individual can place offerings (Ellis, 1974a,b; Perlman, 1997; Rands, 1974a,b). Ancestral villages also represent culturally significant places where the ancestors of these contemporary communities once resided in the distant past, and these villages are sometimes linked to Pueblo migration stories (Ellis, 1974a,b). In addition, specific resource collecting areas may have significance for maintaining traditional lifeways (Ferguson and Hart, 1985; Perlman, 1997; Rands 1974a,b). Lastly, pilgrimage trails with trail markers provide a link to all these areas across the broad ethnic landscape (Ferguson and Hart, 1985; Fox, 1994; Parsons, 1918; Sedgwick, 1926).

The area of McKinley and Cibola Counties only composes a small portion of the lands considered to be affiliated with traditional land-use activities. For example, the Navajo Nation bounds their traditional lands by the four culturally significant mountains: Hesperus Peak, Blanca Peak, Mount Taylor, and the San Francisco Peaks, which are located in Colorado, New Mexico, and Arizona, respectively (Linford, 2000). Zuni Pueblo recognizes a shrine that is situated more than 240 km [150 mi] away at Bandelier National Monument near Los Alamos, New Mexico (Ferguson and Hart, 1985). On the other hand, Mount Taylor is significant to nearby Acoma and Laguna Pueblos for its role in their traditional origin myth where the Gambler held captive the Rainclouds until released by Sun Youth and Old Grandmother Spider (Sterling, 1942; Silko, 1990).

Information on traditional land use and the location of culturally significant places is often protected information within the community (e.g., King, 2003). Therefore, the information presented on religious places is limited to those that are identified in the published literature and is therefore restricted to a few highly recognized places on the landscape within McKinley and Cibola counties. Various documents pertaining to the Indian land claims also provide background information on local history and traditional land use (Ellis, 1974a,b; Minge, 1974; Rands, 1974a,b; Jenkins, 1974).

Linford's (2000) statement on the relation between mythology and place names is relevant to all traditional communities when he states that "a location's religious significance is more obscure, usually ascribed through it's [sic] association with, or mention in, one or more of the stories that are the foundation of Navajo ceremonies" (Kelley and Francis, 1994; Holt, 1981; Ortiz, 1992; Silko, 1990). The list of religious places provided in Table 3.5-13 is most often associated with traditional stories that recount the community's heritage through oral traditions. Ellis (1974a,b) and Rand (1974a,b) do, however, provide a list of shrines that are associated with Laguna and Acoma Pueblos, and Ferguson and Hart (1985) list religious sites associated with Zuni Pueblo.

On June 14, 2008, the New Mexico Cultural Properties Review Committee accepted an emergency listing of the Mount Taylor traditional cultural property to the State Register of Cultural Properties (Los Angeles Times, 2008). The nomination was submitted by Acoma Pueblo, Hopi Tribe, Laguna Pueblo, the Navajo Nation, and Zuni Pueblo. The boundaries of the traditional cultural property have been tentatively set to include the summit and surrounding mesas above 2,440 m [8,000 ft], with the boundary dropping down to 2,224 m [7,300 ft] in the area of Horace Mesa. This application was specifically initiated to protect culturally sensitive sites that may be impacted by proposed uranium mining activities. The nominating group has 1 year to complete the final nomination to the state register; however, during this time, the traditional property is given the full status of being listed. Also in 2008, the USFS has determined that Mount Taylor is eligible for listing in the NRHP as a traditional cultural property.

If the listing of Mount Taylor is approved and NRC receives a license application for the Mount Taylor area, NRC regulations require that the application be reviewed. Under applicable NRC regulations, if an ISL license application is received, consultation and site-specific review of the application will be undertaken according to NEPA, NHPA, and NRC regulations. Appendix D summarizes the NHPA process that would occur should a license application be received.

The New Mexico Historic Preservation website suggests that the following Pueblo and tribal groups should be contacted for consultation associated with activities in McKinley and Cibola Counties: Acoma Pueblo, Hopi Tribe, Isleta Pueblo, Laguna Pueblo, Mescalero Apache Tribe, Navajo Nation, Sandia Pueblo, White Mountain Apache Tribe and Zuni Pueblo. This list was generated from the Pueblo and American land claims, Historic Preservation Division ethnographic study, the National Park Service's Native American Consultation database and groups that directly contacted Historic Preservation Division requesting to be notified of potential

Table 3.5-13. Known Culturally Significant Places in McKinley and Cibola Counties

Place	Affiliated Tribe	Reference
Bandera Crater	Zuni	Ferguson and Hart (p. 127)*
Cerro del Oro	Laguna	Parsons†, Rands (p. 68)‡
Chuska Mountains (various locations)	Navajo	Linford (p. 194)§
Correo Snake Pit	Acoma and Laguna	Ellis (p. 92) ‖, Parsons†, Rands (p. 8)¶
Dowa Yalanne	Zuni	Ferguson and Hart (p. 124)*
El Malpais	Navajo	Linford (p. 204)§
El Morro	Zuni	Ferguson and Hart (p. 127)*
Hosta Butte	Navajo	Linford (p. 218)§
Ice Caves	Zuni	Ferguson and Hart (p. 125)*
Mount Taylor Shrines	Acoma Laguna Zuni	Parsons (p. 185) #, Rands (p. 97)¶, Ellis (p. 92)‖, Ferguson and Hart (p. 126)*
Mount Taylor: Kaweshtima Tsiipiya T'se pina Tsoodzil Dewankwi Kyabachu Yalanne	 Acoma Hopi Laguna Navajo Zuni	Application for Register. New Mexico State Register of Cultural Properties, June 14, 2008 (Los Angeles Times**). New Mexico State Historic Preservation Office.
Pueblo Pintado	Navajo	Linford (p. 247)§
Red Lake	Navajo	Linford (p. 250)§
Springs	Acoma Laguna Zuni	Rands (p. 97)¶, White (pp. 45–47)††, Ellis (p. 92)‖, Ferguson and Hart (pp. 125–132)*
Zuni Salt Lake	Laguna Zuni Navajo	Rands (p. 68)‡, Ferguson and Hart (p. 126)*, Linford (p. 284)§
Zuni Mountains (various locations)	Zuni	Ferguson and Hart (pp. 125, 132)*

*Ferguson, T.J. and E. Hart. *A Zuni Atlas*. Norman, Oklahoma: University of Oklahoma Press. 1985.
†Parsons, E.C. "War God Shrines of Laguna and Zuni." *American Anthropologist*. Vol. 20. pp. 381–405. 1918.
‡Rands, R. *Laguna Land Utilization: Pueblo Indians IV*. New York City, New York: Garland Publishing. 1974.
§Linford, L. *Navajo Places: History, Legend and Landscape*. Salt Lake City, Utah: University of Utah Press. 2000.
‖Ellis, F.H. *Archaeologic and Ethnologic Data: Acoma-Laguna Land Claims*. New York City, New York: Garland Publishing, Inc. 1974.
¶Rands, R. *Acoma Land Utilization: Pueblo Indians III*. New York City, New York: Garland Publishing. 1974.
#Parsons, E.C. "Notes on Acoma and Laguna." *American Anthropologist.* pp. 162–186. 1918.
**Los Angeles Times. "Tribes Get Mt. Taylor Listed as Protected." Los Angeles Times, June 15, 2008. <http://articles.latimes.com/2008/jun/15/nation/na-mountain 15>
††White, L.A. *The Acoma Indians*. Forty-Seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. Washington, DC: Smithsonian Institution. 1932.

activities in these areas. The Pueblo and tribal contact information provided in Table 3.5-14 was obtained from the State of New Mexico, Indian Affairs Department website at <http://www.iad.state.nm.us/ pueblogovandtribaloff.html>.

Table 3.5-14. 2008 Pueblo and Tribal Government Contacts for McKinley and Cibola Counties, New Mexico

Affiliated Tribe	Contact	Address
Acoma Pueblo	Governor Chandler Sanchez	Pueblo of Acoma P.O. Box 309 Acoma, NM 87034 (505) 552-6604/6605
Acoma Pueblo	Director Teresa Pasqual,	Pueblo of Acoma Historic Preservation Office PO Box 309 Acoma, NM 87034 (505) 552-5170
Hopi Tribe	Chairman Benjamin Nuvamsa	Hopi Tribe P.O. Box 123 Kykotsmovi, AZ 86039 (928) 734-3000
Hopi Tribe	Leigh Kuwanwisiwma	Hopi Cultural Preservation Office The Hopi Tribe P.O. Box 123 Kykotsmovi, AZ 86039 (928) 734-6636 P (928) 734-3613 EX611 Leigh (928) 734-3629 Fax
Jemez Pueblo	Governor Paul Chinana	Jemez Pueblo P.O. Box 100 Jemez Pueblo, NM 87024 (505) 834-7359
Jicarilla Apache Nation	President Levi Pesata	Jicarilla Apache Nation P.O. Box 507 Dulce, NM 507 (505) 759-3242
Isleta Pueblo	Governor Robert Benavides	Pueblo of Isleta P.O. Box 1270 Isleta Pueblo, NM 87022 (505) 869-3111/6333
Laguna Pueblo	Governor John Antonio, Sr.	Pueblo of Laguna P.O. Box 194 Laguna Pueblo, NM 87026 (505) 552-6654/6655/6598
Mescalero Apache Tribe	President Carleton Naiche-Palmer	Mescalero Apache Tribe P.O. Box 227 Mescalero, NM 88340 (505) 464-4494
Navajo Nation	President Joe Shirley, Jr.	Navajo Nation P.O. Box 9000 Window Rock, AZ 86515 (928) 871-6352/6357

Table 3.5-14. 2008 Pueblo and Tribal Government Contacts for McKinley and Cibola Counties, New Mexico (continued)		
Affiliated Tribe	**Affiliated Tribe**	**Affiliated Tribe**
Navajo Nation	Alan Downer	Tribal Preservation Officer Navajo Nation Historic Preservation Department P.O. Box 4950 Window Rock, AZ 86515 (928) 871-6437
Sandia Pueblo	Governor Robert Montoya	Pueblo of Sandia 481 Sandia Loop Bernalillo, NM 87004 (505) 867-3317
White Mountain Apache	Mr. Ramon Riley	White Mountain Apache Tribe P.O. Box 507 Fort Apache, AZ 85926
Zuni Pueblo	Governor Norman Cooeyate	Pueblo of Zuni P.O. Box 339 Zuni, NM 87327 (505) 782-7022
Zuni Pueblo	Kurt Dongoske	Office of Heritage and Historic Preservation Pueblo of Zuni P.O. Box 339 Zuni, New Mexico 87327-0339 (928) 782-4814 P (928) 782-2393 F

3.5.8.4 Traditional Cultural Landscapes

Although archaeology and cultural resources management have historically focused on archaeological sites and artifact finds, past and present human interactions with their natural surroundings extend beyond the material traces of past human behavior. As a result, archaeologists and resource managers alike are increasingly focusing on the concept of traditional *cultural landscapes* as a broader, more accurate perspective on the way humans conceive of and use their environments. A cultural landscape is not the same as a natural “environmen”; rather, it is produced by a cultural group’s interaction with their environment. In simple terms, a cultural landscape is what results as members of a particular human group “project culture onto nature” (Crumley and Marquardt, 1990) by interacting with, modifying, and conceptualizing their natural surroundings over time (Anschuetz, et al., 2001).

The notion of a cultural landscape includes the physical evidence of a group’s interactions with the natural world, but is not limited to quantifiable material resources or patterns. A landscape perspective also incorporates the significance of particular places or landmarks for a group’s histories, traditional stories, or religious beliefs (Anschuetz, 2007; Anschuetz, et al., 2001; Basso, 1996). Particular locations may serve as reminders of traditional beliefs or ways of life, or be venerated as supernatural beings in their own right. To quote a recent summary, a landscape perspective encompasses a “community’s intimate relationships with the land and its resources in every aspect of its material life, including economy, society, polity, and recreation” (Anschuetz, 2007).

Understanding the importance of traditional cultural landscapes, then, means being aware of many overlapping dynamics of a culture's relationships with its environment. A landscape perspective must also take into account the overlapping, diverse cultural landscapes of many different cultures. In west-central New Mexico, for instance, a survey of cultural landscapes would include the distinct, extensive territories formerly used by the Zunis for economic activities ranging from farming and herding to gathering medicinal plants or collecting raw materials for stone tools (Ferguson and Hart, 1985). It would also recognize the culturally significant springs, caves, and shrines dotting the world as conceived by the Keres people of Laguna and Acoma, or the culturally significant peaks at the four cardinal directions delineating this world's boundaries (Snead and Preucel, 1999; White, 1932). Similar culturally significant landmarks recognized by the Navajo form part of yet another traditional landscape perspective, as described previously. Finally, the roads and ruins of the ancient inhabitants of Chaco Canyon figure in the traditional histories of Zuni, Acoma, and Navajo alike, but also serve as clues to illuminate the traditional landscapes of the Chacoans themselves. Like their modern descendents, the ancient Chacoans seem to have placed importance on astronomical alignments, the cardinal directions, and prominent peaks, mesas, and other landmarks (Van Dyke, 2004).

In summary, then, the distribution of archaeological sites, artifacts, and other physical markers of human activity are only one dimension of the processes in which past human groups used and conceptualized their surroundings. The traditional cultural landscapes of west-central New Mexico's indigenous groups include a wide variety of landmarks, traditional use areas, and other important features, many of which retain importance for contemporary groups. These traditional landscapes are increasingly recognized by agencies and archaeologists alike and play an expanding role in historic preservation and cultural resource management decision making.

3.5.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook (BLM, 2007a–c), the Grants Uranium District in the Northwestern New Mexico Uranium Milling Region is located in the Colorado Plateau physiographic province (BLM, 2007a). The Farmington and Albuquerque field offices of the BLM have classified most of the region as VRM Class III and IV (BLM, 2003, 2000). There are no VRM Class I VRM areas, and most of the Class II areas are located just north of Interstate 40. As described in NRC (1997), the primary viewers in the San Juan Basin and Grants Uranium District are likely to be Native American residents living on and near a proposed ISL facility (see Section 3.5.8). For this reason, their aesthetic sense at the landscape scale is important. In general, Native American thought is "integrative and comprehensive. It does not separate intellectual, moral, emotional, aesthetic, economic, and other activities, motivations, and functions" (Norwood and Monk, 1987). For both the Navajo and Zuni, moral good tends to be equated with aesthetic good: that which promotes or represents human survival and human happiness tends to be experienced as "beautiful." The landscape is beautiful by definition because the Holy People designed it to be a beautiful, harmonious, happy, and healthy place (Norwood and Monk, 1987). Native Americans have not created an abstract category for unspecified vistas; the emphasis is on specific mountains, specific trees, and specific colors of the soil (Norwood and Monk, 1987). References to the visual quality of a given area may be more meaningful when linked to an identifiable place and not to more generalized landscapes.

Natural and scenic attractions within the Grants Uranium District in the Northwestern New Mexico Uranium Milling Region are minimal. Regionally, the Chaco Culture National Historic Park, El Malpais National Monument (BLM, 2000), El Morro National Monument, and the Red

Rock State Park, among other features, attract tourists for scenic, historic, and cultural features (see Section 3.5.1). Near Gallup and south of Interstate 40, the USFS categorizes the visual quality objectives within the Cibola National Forest as predominantly (about 75 percent) in the Modification and Maximum Modification class (USFS, 1985), with some areas such as the Mount Taylor district in the San Mateo Mountains having high scenic integrity (USFS, 2007). In addition, in June 2008 (Los Angeles Times, 2008), the New Mexico Cultural Properties Review Committee approved listing the Mount Taylor traditional cultural property in the State Register of Cultural Properties (see Section 3.5.8.3). With the exception of major highways such as Interstate 40 and U.S. Highway 491, area roads are used mostly for local travel. The urban areas such as Gallup, Crownpoint, and Grants tend to dominate visual resources near these cities and towns (NRC, 1997).

The resource management plan for the Farmington field office of the BLM provides a VRM classification for the public lands in the Northwestern New Mexico Uranium Milling Region (BLM, 2003) (Figure 3.5-20). The visual context is also an important component of the cultural resource values of the Chacoan Outliers, Native American Use and Sacred Areas of Critical Environmental Concern, and additional traditional cultural properties (BLM, 2003). The approximately 2 million ha [5 million acres] of regional public lands and subsurface mineral resources BLM administers in the Farmington field office have a relatively small amount (about 13 percent) of VRM Classes I and II viewsheds associated with wilderness areas, wilderness study areas, specially designated areas, and special management areas. As categorized by BLM, the visual landscape in northwestern New Mexico is dominated by VRM Class IV (55 percent) and Class III (32 percent). The natural state has been considerably modified by human activities and structures associated with oil and gas development, including gas wells, pipelines, and the accompanying access roads. There are no Class I areas within the Northwestern New Mexico Uranium Milling Region. Areas categorized as Class II include locations where scenic vistas (from major highways), riverfronts, and high places are important because of associated sightseeing and recreational value (BLM, 2003).

Specific VRM Class II locations identified by BLM within and near the region include the Cabezon Peak, Cañon Jarido, Elk Springs, Ignacio Chavez, Jones Canyon, and La Lena special management areas and the Empedrado wilderness study areas (BLM 2003) at the eastern edge of the Northwestern New Mexico Uranium Milling Region. The USFS also identifies Corral Canyon and the western edge of the San Pedro Mountains in the La Jara area of the Santa Fe National Forest just to the east of the Northwestern New Mexico Uranium Milling Region as areas where recreation and timber are to be managed to preserve visual resource value (USFS, 2007). These Class II resource areas are adjacent to the Grants Uranium District, but the closest potential uranium ISL facility to these resource areas is about 16 km [10 mi]. A Class II area associated with the Chaco Culture National Historic Park is north of the Northwestern New Mexico Uranium Milling Region and extends into the region about 50 km [30 mi] north of the nearest potential uranium recovery facility (Figure 3.5-20). BLM National Conservation Areas, adjacent to the El Malpais National Monument and about 3 km [2 mi] south of Grants, are also identified as Class II. Two potential facilities are located near San Mateo Mesa about 16 km [10 mi] northwest of Mount Taylor. In addition, two of the proposed facilities are located within about 3–8 km [2–5 mi] of the borders of the Navajo Nation (Figure 3.5-20). Current indications from industry are that these would be developed as conventional milling operations (NRC, 2008).

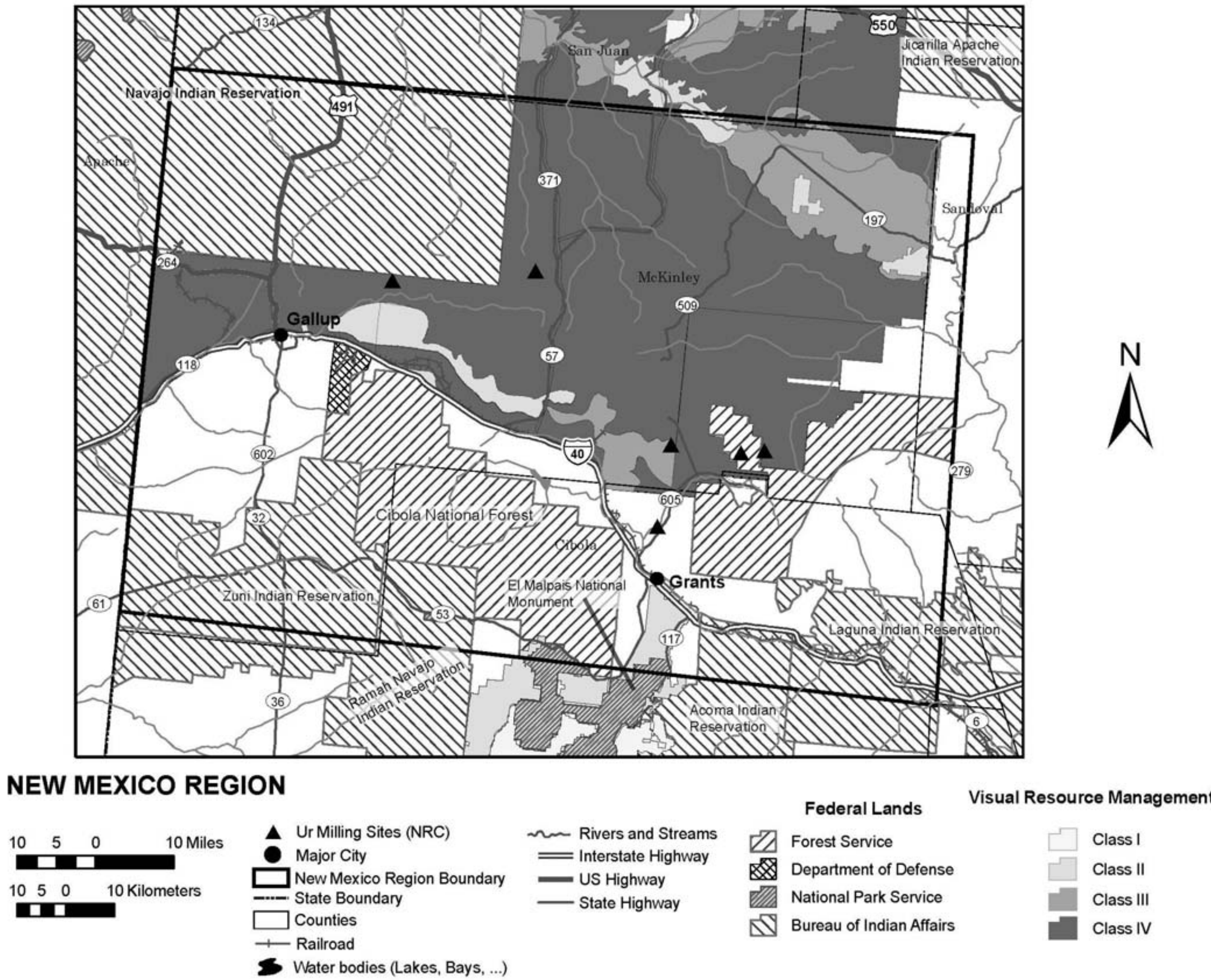


Figure 3.5-20. BLM Visual Resource Classifications for the Northwestern New Mexico Uranium Milling Region (BLM, 2003, 2000)

3.5.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Northwestern New Mexico Uranium Milling Region includes communities within the region of influence for potential ISL facilities in the Grants Uranium District. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined by (1) proximity to an ISL facility {generally within about 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment consists of counties, towns, CBSAs, and Native American communities (reservation land) (Table 3.5-15). A CBSA, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000 (U.S. Census Bureau, 2008). The following subsections describe areas most likely to have implications with regard to socioeconomics. In some subsections, Metropolitan Areas are also discussed. A Metropolitan Area is greater than 50,000 and a town has less than 10,000 in population (U.S. Census Bureau, 2008).

3.5.10.1 Demographics

Demographics are based on 2000 U.S. Census data on population and racial characteristics of the affected environment (Table 3.5-16). Figure 3.5-21 illustrates the populations of communities within the Northwestern New Mexico Uranium Milling Region. Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic area of interest.

Based on review of Table 3.5-16, the most populated county is Sandoval County and the most sparsely populated county is Cibola County. The largest populated town/CBSAs in the Northwestern New Mexico Uranuim Milling Region is Gallup. The county with the largest percentage of non-minorities is Sandoval County with a white population of 65.1 percent. The town/CBSAs with the largest percentage of non-minorities is Grants with a white population of 56.2 percent. The largest minority-based county is McKinley County with a white population of

<table>
<tr><th colspan="4">Table 3.5-15. Summary of Affected Environment Within the Northwestern New Mexico Uranium Milling Region</th></tr>
<tr><th>Counties Within New Mexico</th><th>Towns Within New Mexico</th><th>CBSAs Within New Mexico</th><th>Native American Communities Within New Mexico</th></tr>
<tr><td>Cibola</td><td rowspan="6">Grants</td><td rowspan="6">Gallup</td><td>Acoma Indian Reservation</td></tr>
<tr><td>McKinley</td><td>Tohajiilee Indian Reservation</td></tr>
<tr><td rowspan="4">Sandoval</td><td>Laguna Indian Reservation</td></tr>
<tr><td>Navajo Nation Indian Reservation</td></tr>
<tr><td>Ramah Navajo Indian Reservation</td></tr>
<tr><td>Zuni Indian Reservation</td></tr>
</table>

Table 3.5-16. 2000 U.S. Bureau of Census Population and Race Categories of the Northwestern New Mexico Uranium Milling Region*

Affected Environment	Total Population	White	African American	Native American	Some Other Race	Two or More Races	Asian	Hispanic Origin†	Native Hawaiian and Other Pacific Islander
New Mexico	1,819,046	1,214,253	34,343	173,483	309,882	66,327	19,255	765,386	1,503
Percent of total		66.8%	1.9%	9.5%	3.6%	3.6%	1.1%	42.1%	0.1%
Cibola County	25,595	10,138	246	10,319	3,952	828	98	8,555	14
Percent of total		39.6%	1.0%	40.3%	15.4%	3.2%	0.4%	33.4%	0.1%
McKinley County	74,798	12,257	296	55,892	4,095	1,882	344	9,276	32
Percent of total		16.4%	0.4%	74.7%	5.5%	2.5%	0.5%	12.4%	0.0%
Sandoval County	89,908	58,512	1,535	14,634	11,118	3,117	894	26,437	98
Percent of total		65.1%	1.7%	16.3%	12.4%	3.5%	1.0%	29.4%	0.1%
Gallup	20,274	8,106	219	7,404	2,985	1,187	289	6,699	19
Percent of total		40.1%	1.1%	36.6%	14.8%	5.9%	1.4%	33.1%	0.1%
Grants	8,806	4,947	143	1,054	2,184	386	81	4,611	11
Percent of total		56.2%	1.6%	12.0%	24.8%	4.4%	0.9%	52.4%	0.1%

*U.S. Census Bureau. “American FactFinder.” <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100 percent).

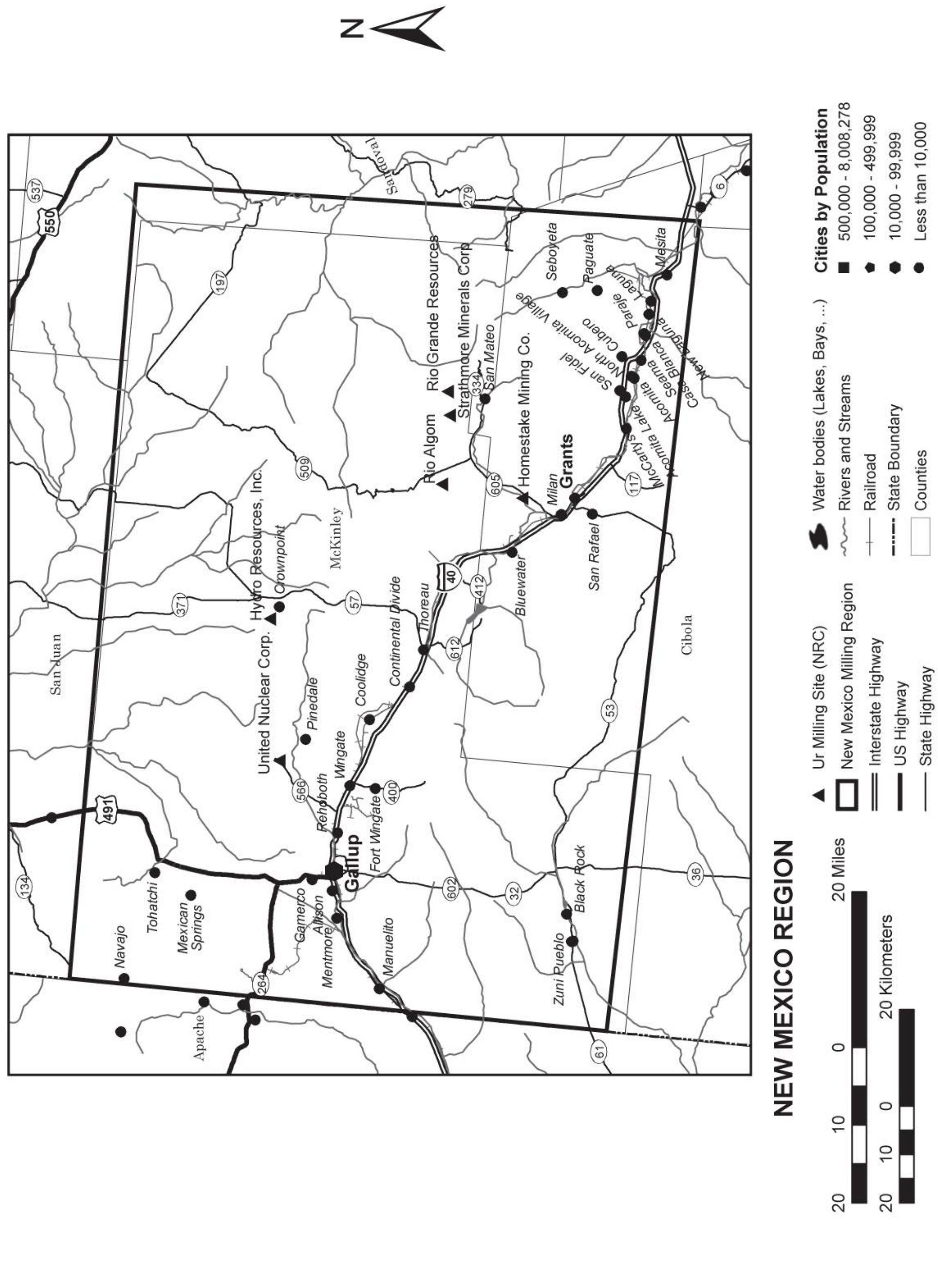


Figure 3.5-21. Northwestern New Mexico Uranium Milling Region With Population

only 16.4 percent. The largest minority-based town is Gallup with a white population of 40.1 percent.

Although not listed in Table 3.5-16, total population counts based on 2000 U.S. Census Bureau data (U.S. Census Bureau, 2008) for the Native American communities (reservation land) that would be affected are

- Acoma Indian Reservation: 2,802
- Tohajiilee Indian Reservation: 1,649
- Laguna Indian Reservation: not available
- Navajo Nation Indian Reservation: 173,987 [Includes Arizona, Utah, and New Mexico (131,166 were reported as living in Arizona]
- Ramah Navajo Indian Reservation: 2,167
- Zuni Indian Reservation: 7,758

3.5.10.2 Income

Income information from 2000 U.S. Census data including labor force, income, and poverty levels for the affected environment is collected at the state and county levels. Data collected from a state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or unspecialized). Data collected from a county level is generally the same affected environment discussed previously in Table 3.5-15 and also includes information on Native American communities in the Northwestern New Mexico Uranium Milling Region. State-level information is provided in Table 3.5-17, and county data is listed in Table 3.5-18.

For the region surrounding the Northwestern New Mexico Uranium Milling Region, the state with the largest labor force population is Arizona. The community with the largest labor force is Albuquerque, New Mexico {144 km [90 mi] from the nearest potential ISL facility}, and the smallest community labor force is Grants, New Mexico {8 km [5 mi] from the nearest potential ISL facility}. The community with the highest per capita income is Santa Fe, New Mexico {96 km [60 mi] from the nearest potential ISL facility} and the lowest per capita income population is Silver City, New Mexico {161 km [100 mi] from the nearest potential ISL facility}. Outside of tribal lands, the community with the highest percentage of individuals and families below poverty levels is Grants, New Mexico.

The county with the largest labor force population in the Northwestern New Mexico Uranium Milling Region is Sandoval County, and the county with the smallest labor force population is Cibola County. The county with the highest per capita income is Sandoval County, and the lowest per capita income county is McKinley County. The county with the highest percentage of individuals and families below the poverty level is McKinley County (Table 3.5-18).

3.5.10.3 Housing

Housing information from the 2000 U.S. Census data is provided in Table 3.5-19.

The availability of housing within the immediate vicinity of the proposed ISL facilities is somewhat limited. The majority of housing is available in larger populated areas such as Gallup

Table 3.5-17. U.S. Bureau of Census State Income Information for the Northwestern New Mexico Uranium Milling Region*						
Affected Environment	**2000 Labor Force Population (16 years and over)**	**Median Household Income In 1999**	**Median Family Income In 1999**	**Per Capita Income In 1999**	**Families Below Poverty Level In 2000**	**Individuals Below Poverty Level In 2000**
Arizona	2,387,139	$40,558	$46,723	$20,275	128,318	698,669
New Mexico	834,632	$34,133	$39,425	$17,261	68,178	328,933
Albuquerque, New Mexico	232,320	$38,272	$46,979	$20,884	11,285	59,641
Percent of total†	66.2%	NA‡	NA	NA	10.0%	13.5%
Farmington, New Mexico	18,204	$37,663	$42,605	$18,167	1,328	5,910
Percent of total	65.0%	NA	NA	NA	12.9%	16.0%
Flagstaff, Arizona	30,822	$37,146	$48,427	$18,637	1,255	8,751
Percent of total	73.7%	NA	NA	NA	10.6%	17.4%
Gallup, New Mexico	8,941	$34,868	$39,197	$15,789	804	4,079
Percent of total	61.9%	NA	NA	NA	16.6%	20.8%
Grants, New Mexico	3,801	$30,652	$33,464	$14,053	446	1,810
Percent of total	58.3%	NA	NA	NA	19.4%	21.9%
Rio Rancho, New Mexico	25,964	$47,169	$52,233	$20,322	521	2,619
Percent of total	67.9%	NA	NA	NA	3.7%	5.1%

Table 3.5-17. U.S. Bureau of Census State Income Information for the Northwestern New Mexico Uranium Milling Region* (continued)

Affected Environment	2000 Labor Force Population (16 years and over)	Median Household Income In 1999	Median Family Income In 1999	Per Capita Income In 1999	Families Below Poverty Level In 2000	Individuals Below Poverty Level In 2000
Santa Fe, New Mexico	34,033	$40,392	$49,705	$25,454	1,425	7,439
Percent of total	66.8%	NA	NA	NA	9.5%	12.3%
Silver City, New Mexico	4,249	$25,881	$31,374	$13,813	483	2,237
Percent of total	52.5%	NA	NA	NA	17.7%	21.9%

*Source: U.S. Census Bureau. “American FactFinder.” <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 15 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA—not applicable.

Table 3.5-18. U.S. Bureau of Census County Income Information for the Northwestern New Mexico Uranium Milling Region*						
Affected Environment	**2000 Labor Force Population (16 years and over)**	**Median Household Income In 1999**	**Median Family Income In 1999**	**Per Capita Income In 1999**	**Families Below Poverty Level In 2000**	**Individuals Below Poverty Level In 2000**
Cibola County, New Mexico	9,848	$27,774	$30,714	$11,731	1,365	6,054
Percent of total	53.0%	NA	NA	NA	21.5%	24.8%
McKinley County, New Mexico	26,498	$25,005	$26,806	$9,872	5,303	26,664
Percent of total	53.4%	NA	NA	NA	31.9%	36.1%
Sandoval County, New Mexico	41,599	$44,949	$48,984	$19,174	2,130	10,847
Percent of total	63.0%	NA	NA	NA	9.0%	12.1%

*Source: U.S. Census Bureau. “American FactFinder.” <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Percent of total based on a population of 16 years and over.
‡NA—not applicable.

Table 3.5-19. U.S. Bureau of Census Housing Information for the Northwestern New Mexico Uranium Milling Region*						
Affected Environment	Single Family Owner-Occupied Homes	Median Value in Dollars	Median Monthly Costs With a Mortgage	Median Monthly Costs Without a Mortgage	Occupied Housing Units	Renter-Occupied Units
New Mexico	339,888	$108,100	$929	$228	677,971	200,908
Cibola County	3,742	$62,600	$654	$179	8,327	1,873
McKinley County	10,235	$57,000	$841	$140	21,476	5,840
Sandoval County	21,873	$115,400	$979	$233	31,411	5,097
Gallup	2,922	$97,000	$933	$4,245	6,807	2,682
Grants	1,634	$64,700	$697	$210	3,160	1,024
* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).						

{24 km [15 mi] to the nearest potential ISL facility}, Grants {8 km [5 mi] to nearest potential ISL facility}, Albuquerque {144 km [90 mi] to the nearest potential ISL facility}, and Rio Rancho {161 km [100 mi] to the nearest potential ISL facility}. There are approximately 20 housing units, including manufactured housing parks or residential neighborhoods in this region (MapQuest, 2008).

Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the Grants Uranium District ISL facilities is not as limited. The majority of apartments is available in larger populated areas such as Gallup, Grants, Belen, Los Lunas, and Albuquerque with approximately 75 apartment complexes (MapQuest, 2008). There are 19 hotels/motels along major highways or towns near the ISL facilities. In addition to apartments and lodging, there are three trailer camps also located near potential ISL facilities (along major roads or near towns) (MapQuest, 2008).

3.5.10.4 Employment Structure

Employment structure from the 2000 U.S. Census data including employment rate and type is based on data collected at the state and county levels. Data collected at the state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than [48 km [30 mi]} for employment opportunities or may be a workforce needed to fulfill specialized positions (if local workforce is unavailable or unspecialized). Data collected from a county level are generally the same affected environment previously discussed in Table 3.5-15 and also include information on Native American communities.

Based on review of state information, the state in the vicinity of the Northwestern New Mexico Uranium Milling Region with the highest percentage of employment is Arizona.

The county with the highest percentage of employment is Sandoval County, and the county with the highest unemployment rate is McKinley County. Native American communities (Navajo Nation, Zuni, and Laguna Reservations) report unemployment rates of 60 percent or more, much greater than the state unemployment levels of 3.4 percent (Arizona) to 4.4 percent (New Mexico) Table 3.5-20.

3.5.10.4.1 State Data

3.5.10.4.1.1 Arizona

The state of Arizona has an employment rate of 57.2 percent and unemployment rate of 3.4 percent. The largest sector of employment is management, professional, and related occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

<u>Flagstaff</u>

Flagstaff has an employment rate of 69.8 percent and an unemployment rate slightly higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 30.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.5.10.4.1.2 New Mexico

The State of New Mexico has an employment rate of 55.7 percent and unemployment rate of 4.4 percent. The largest sector of employment is management, professional, and related occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Albuquerque

Albuquerque has an employment rate of 61.8 percent and an unemployment rate lower than that of the state at 3.8 percent. The largest sector of employment is management, professional, and related occupations at 38.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Gallup

Gallup has an employment rate of 57.1 percent and an unemployment rate slightly higher than that of the state at 4.8 percent. The largest sector of employment is management, professional, and related occupations at 38.9 percent. The largest type of industry is educational, health, and social services at 31.5 percent. The largest class of worker is private wage and salary workers at 65.2 percent (U.S. Census Bureau, 2008).

Grants

Grants has an employment rate of 51.9 percent and an unemployment rate higher than that of the state at 6.2 percent. The largest sector of employment is management, professional, and related occupations at 30.0 percent. The largest type of industry is educational, health, and social services at 23.6 percent. The largest class of worker is private wage and salary workers at 61.3 percent (U.S. Census Bureau, 2008).

Farmington

Farmington has an employment rate of 60.4 percent and an unemployment rate slightly higher than that of the state at 4.5 percent. The largest sector of employment is management, professional, and related occupations at 30.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Rio Rancho

Rio Rancho has an employment rate of 64.3 percent and an unemployment rate slightly higher than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 34.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Santa Fe

Santa Fe has an employment rate of 63.7 percent and an unemployment rate much lower than that of the state at 3.0 percent. The largest sector of employment is management, professional, and related occupations at 43.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.5.10.4.2 County Data

Cibola County, New Mexico

Cibola County has an employment rate of 46.8 percent and an unemployment rate relatively higher than that of the state at 6.1 percent. The largest sector of employment is management, professional, and related occupations at 29.6 percent. The largest type of industry is educational, health, and social services at 27.4 percent. The largest class of worker is private wage and salary workers at 58.4 percent (U.S. Census Bureau, 2008).

McKinley County, New Mexico

McKinley County has an employment rate of 44.2 percent and an unemployment rate relatively higher than that of the state at 9.2 percent. The largest sector of employment is management, professional, and related occupations at 32.4 percent. The largest type of industry is educational, health, and social services at 32.4 percent. The largest class of worker is private wage and salary workers at 55.9 percent (U.S. Census Bureau, 2008).

Sandoval County, New Mexico

Sandoval County has an employment rate of 58.8 percent and an unemployment rate lower than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 36.0 percent. The largest type of industry is educational, health, and social services at 17.4 percent. The largest class of worker is private wage and salary workers at 73.6 percent (U.S. Census Bureau, 2008).

Native American Communities

Information on labor force and poverty levels for the affected Native American communities within the Northwestern New Mexico Uranium Milling Region is based on 2003 Bureau of Indian Affairs data and is provided in Table 3.5-20 (U.S. Department of the Interior, 2003).

3.5.10.5 Local Finance

Local finance such as revenue and tax information for the affected environment is provided next and in Tables 3.5-21 to 3.5-23.

New Mexico

Sources of revenue for the State of New Mexico come from income, mineral extraction, and property taxes. Personal income tax rates for New Mexico range from 1.7 percent to 5.3 percent. New Mexico does not have a sales tax and instead has a 5 percent gross receipts tax. Combined gross receipts tax rates throughout the state range from 5.125 to 7.8125 percent. Net taxable values for affected counties in New Mexico are presented in Table 3.5-21 (New Mexico Taxation and Revenue Department, 2008).

Table 3.5-20. Employment Structure of Native American Communities Within the Affected Environment of the Northwestern New Mexico Uranium Milling Region*				
Affected Areas	**2003 Labor Force Population**	**Unemployed as Percent of Labor Force**	**Employed Below Poverty Guidelines**	
Acoma Indian Reservation	NR†	NR	NR	NR
Canoncito Indian Reservation	NA‡	NA	NA	NA
Laguna Indian Reservation	828	81%	NR	NR
Navajo Nation Indian Reservation (Eastern Navajo Agency)	2,664	74%	62	2%
Ramah Navajo Indian Reservation	NR	NR	NR	NR
Zuni Indian Reservation	1,591	64%	110	7%

* U.S. Department of the Interior. "Affairs American Indian Population and Labor Force Report 2003." <http://www.doi.gov/bia/labor.html>. Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs, Office of Tribal Affairs. 2003.
†NR—Not reported by tribes.
‡NA—not available.

Table 3.5-21. Net Taxable Values for Affected Counties Within New Mexico for 2006*			
Affected Counties	**Residential**	**Nonresidential**	**Total**
Cibola County	$88,563,082	$145,457,203	$234,020,285
McKinley County	$219,073,850	$410,061,159	$629,311,981
Sandoval County	$1,631,727,293	$449,148,142	$6,755,265

*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department. (18 October 2007 and 25 February 2008).

Table 3.5-22. Percent Change in Tax Values From 2005 to 2006 for the Affected Counties Within New Mexico*			
Affected Counties	**Residential**	**Nonresidential**	**Total**
Cibola County	3.0 percent	3.6 percent	3.4 percent
McKinley County	4.1 percent	4.0 percent	4.0 percent
Sandoval County	18.8 percent	8.7 percent	16.5 percent

*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department. (18 October 2007 and 25 February 2008).

Table 3.5-23. Percent Distribution of New Mexico Property Tax Obligations Within Affected Counties for 2006*					
Affected Counties	**State**	**County**	**Municipal**	**School District**	**Other**
Cibola County	4.4 percent	34.4 percent	9.8 percent	34.4 percent	17 percent
McKinley County	3.9 percent	32.3 percent	10.9 percent	31.6 percent	21.1 percent
Sandoval County	4.8 percent	26.6 percent	19.7 percent	39.7 percent	9.1 percent
*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department (18 October 2007 and 25 February 2008).					

Percentages and sources of revenue for 2006 were counties at 32.3 percent, municipalities at 14.3 percent, school districts at 30.0 percent, conservancy districts at 0.1 percent, state debt service at 4.8 percent, health facilities at 8.8 percent, and higher education at 9.7 percent. Total tax values for the affected counties within New Mexico follow. Percentage change in net taxable values from 2005 to 2006 for the affected counties is provided in Table 3.5-22 (New Mexico Taxation and Revenue Department, 2008).

New Mexico imposes ad valorem production and ad valorem production equipment taxes in lieu of property taxes on mineral extraction properties. Taxes are levied monthly on all owners and are imposed on products below the wellhead, such as oil and gas (New Mexico Taxation and Revenue Department, 2000.) Equipment is also levied against the operator of the property. In 2000, ad valorem production and production equipment taxes totaled approximately $43.4 million. Of this total, 83 percent came from the oil and gas production tax. How revenues are distributed in a particular county is determined by property tax rates imposed at the county level.

Percentage distribution of New Mexico property tax obligations for 2006 within the affected counties is listed in Table 3.5-23. Information on local finance for the CBSAs of Gallup and town of Grants is presented next.

<u>Gallup</u>

Sources of revenue for Gallup consist of gross receipts taxes, compensating taxes, corporate income taxes, franchise taxes, property taxes, severance taxes, and workers' compensation taxes. The largest tax revenues are gross receipts at a rate of 7.6 percent and property tax ranging from 4.7 percent to 7.4 percent. Revenue from gross receipts totaled $115,031,909 as of 2004 (City of Gallup Economic Development Center, 2007).

<u>Grants</u>

Sources of revenue for Grants consist of gross receipts taxes and property taxes (New Mexico Economic Development, 2008).

Native American Communities

The Acoma Indian Reservation's largest sources of revenue come from the Sky City Casino and big game hunting. Specific financial information including tax revenue is not available (Acoma New Mexico, 2007).

The Tohajiilee Indian Reservation receives revenue from local retail and gaming. Specific financial information including tax revenue is not available (Division of Economic Development of the Navajo Nation, 2006).

The Laguna Indian Reservation receives revenue from local retail and gaming. Specific financial information including tax revenue is not available (New Mexico Tourism Department, 2008).

The largest source of revenue for the Navajo Nation Indian Reservation comes from internal and external revenue. Internal revenue is referred to as General Fund revenues and consists of mining and taxes. Mining is the largest source of internal revenue. Taxes are the second largest sources of internal revenue and in 2005 accounted for $75.0 million (Division of Economic Development of the Navajo Nation, 2006). Taxes include business gross receipts. This tax could be levied on uranium production within the Navajo Reservation if production is determined to occur on the reservation (NRC, 1997). External sources of revenue consist of Federal, State, Private and other funds, and are mostly in the form of grants (Division of Economic Development of the Navajo Nation, 2006).

The Ramah Navajo Indian Reservation is one of 110 chapters that make up the larger Navajo Nation. The Ramah Navajo take no assistance from the Navajo Nation. The majority of revenue comes from federal funding because this group does not have a single, sustainable economic development program that generates significant income (Ramah Navajo Chapter, 2003).

The majority of revenue for the Zuni Indian Reservation comes from federal grants, such as the Community Services Block Grant. Other sources of income include local taxes such as sales tax from gross receipts (Pueblo of Zuni, 2008).

3.5.10.6 Education

Based on review of the affected environment, the county with the largest number of schools is McKinley County and the county with the smallest number of schools is Cibola County. The town/CBSA with the largest number of schools is Gallup, and the town/ CBSA with the smallest number of schools is Grants. The Native American community with the largest number of schools is the Navajo Nation, and the Native American community with the smallest number of schools is the Tohajiilee Indian Reservation.

Grants

Grants has 2 elementary schools, 1 middle school, 1 high school, 3 private academies, and 1 public school, with a total of approximately 2,414 students (Localschooldirectory.com, 2008).

Gallup

Gallup has 33 public schools and 2 parochial schools, with a total of approximately 8,013 students. (City of Gallup Economic Development Center, 2007).

Cibola County

Public education in Cibola County is operated by Grants/Cibola County Schools, which is based in Grants, New Mexico. There are 7 elementary schools, 1 middle school, 1 middle-high school, and 1 high school, with a total of approximately 3,698 students. The majority of schools provide bus services (Grants-Cibola County Schools, 2007).

McKinley County

Public education in the McKinley County education system is operated by the Gallup-McKinley County School District, which serves students from Gallup and surrounding areas of McKinley County. There are 36 public and private elementary, middle, and high schools within the county, with a total of approximately 13,840 students. The majority of schools provides bus services (Greatschools, 2007).

Sandoval County

Sandoval County has a total of 11 elementary schools, 6 middle schools, and 5 high schools, with a total of approximately 8,580 students. The majority of schools provides bus services (Publicschoolreview.com, 2008).

Native American Communities

The Acoma Indian Reservation has the Sky City Community School located at Acoma Pueblo. The total number of students is approximately 275. Information as to whether this school provides bus services is not available (Public Schools Report, 2007).

The Tohajiilee Indian Reservation has one school that is located within the Tohajiilee Indian Reservation. Specific information pertaining to school population or bus services is not available (Tohajiilee Chapter, 2008).

The Laguna Indian Reservation has one elementary school, one middle school, one high school, and one academy. Specific information pertaining to school population or bus services is not available (Lat-Long.com, 2008).

The Navajo Nation Indian Reservation has over 150 public, private, and Bureau of Indian Affairs schools serving students from kindergarten through high school. There are over 10,000 students. Information as to whether these schools provide bus services is not available (Division of Economic Development of the Navajo Nation, 2008).

The Ramah Navajo Indian Reservation school system is operated by the Ramah Navajo School Board and the Ramah Navajo Chapter. It has an Indian-controlled contract school located in Pine Hill, New Mexico. It accommodates almost 600 students from elementary through 12th grade. Information as to whether this school provides bus services is not available (Ramah Navajo Chapter, 2003).

The Zuni Indian Reservation has 2 elementary schools, 1 middle school, and 2 high schools, with a total of approximately 2,000 students. Information as to whether these schools provide bus services is not available (Zuni Pueblo Public School District, 2008).

3.5.10.7 Health and Social Services

Health Care Facilities

The majority of health care facilities is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the ISL facilities are located in Gallup, Zuni, Rio Rancho, and Albuquerque and total approximately 50 facilities (MapQuest, 2008). These consist of hospitals, clinics, emergency centers, and medical services. There are 13 hospitals located within or proximate of this region: Gallup (1), Zuni (1), Rio Rancho (1), and Albuquerque (greater than10).

Local Emergency

Local police within the affected environment are within the jurisdiction of each county. There are 12 police, sheriff, or marshal's offices within the region: Cibola County (3), McKinley County (3), and Sandoval County (6) (Usacops, 2008).

Fire departments within the affected area are comprised at the town, CBSA, or city level. There are 24 fire departments within the milling region: Grants (4), Gallup (13), and Albuquerque (7) (50states, 2008).

3.5.11 Public and Occupational Health

3.5.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council of Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels that those with other types of soils/bedrock (EPA, 2006).

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

For the Northwestern New Mexico Uranium Milling Region, the average background rate including natural and man-made sources for the state of New Mexico is used, which is 3.15 mSv/yr [315 mrem/yr] (EPA, 2006). This average background rate in New Mexico is lower than the U.S. average rate of 3.6 mSv/yr [360 mrem/yr] primarily because average annual radon dose is less for New Mexico {1.32 mSv/yr [132 mrem/yr] versus the national average of 2 mSv/yr [200 mrem/yr]}. The background contribution from cosmic radiation is slightly higher for New Mexico versus the U.S. average {0.47 mSv/yr [47 mrem/yr] versus the national average of 0.27 mSv/yr [27 mrem/yr]}. The remaining contributors to background dose (terrestrial radiation, internal radiation, and man-made) are similar for New Mexico {1.36 mSv [136 mrem/yr]} and the U.S. average {1.33 mSv/yr [133 mrem/yr]}. The combination of these differences results in a decrease from the national average of about 0.45 mSv [45 mrem/yr].

3.5.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. Therefore, see Section 3.2.11.2 for further discussion of these public health and safety standards.

3.5.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. Therefore, see Section 3.2.11.3 for further discussion of these occupational health and safety standards.

3.5.12 References

50states.com. "New Mexico." 2008. <http://50states.com> (15 April 2008).

Acoma, New Mexico. "Sky City." 2007. <www.skycity.com> (13 October 2007).

Adams, E.C. and A.I. Duff, eds. *The Protohistoric Pueblo World, A.D. 1275–1600*. Tucson, Arizona: University of Arizona Press. 2004.

Adams, S.S. and A.E. Saucier. "Geology and Recognition Criteria for Uraniferous Humate Deposits, Grants Uranium Region, New Mexico—Final Report." Open-File Report GJBX. Vol. 2, No. 81. Washington, DC: DOE. 1981

Allen, C. and B. Nelson. *Anasazi and Navajo Land Use in the McKinley Mine Area Near Gallup, New Mexico: Archaeology (Vol. 1)*. Albuquerque, New Mexico: University of New Mexico, Office of Contract Archaeology. 1982.

Amick, D. "Folsom Diet Breadth and Land Use in the American Southwest." Ph.D. dissertation. University of New Mexico, Department of Anthropology. Albuquerque, New Mexico. 1994.

Anschuetz, K.F. "Introducing a Landscape Approach for Evaluating Traditional Senses of Time and Place." *More Than a Scenic Mountain Landscape: Valles Caldera National Preserve Land Use History*. K.F. Anscheutz and T. Merlan, eds. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. pp. 249–262. 2007.

Anschuetz, K.L., R.H. Wilshusen, and C. Schick. "An Archaeology of Landscape: Perspectives and Directions." *Journal of Archaeological Research.* Vol. 9, No. 2. pp. 157–211. 2001.

Atomic Safety and Licensing Board. "Atomic Safety and Licensing Board Transcript in the Matter of Hydro Resources Inc." Docket No. 40–8968–ML. Washington, DC: Atomic Safety and Licensing Board. May 16, 2006.

Audubon Society. "2007 Watchlist." 2007. <http://www.audubon2.org/watchlist> (12 February 2008).

Basso, K.H. *Wisdom Sits in Places: Landscape and Language Among the Western Apache*. Albuquerque, New Mexico: University of New Mexico. 1996.

Biota Information System of New Mexico. "Species Booklets and Reports." Santa Fe, New Mexico: New Mexico Department of Game and Fish. 2007. <http://www.bison-m.org> (5 October 2007).

BLM. "Visual Resource Management." Manual 8400. Washington, DC: BLM. 2007a. <http://www.blm.gov/nstc/VRM/8400.html> (17 October 2007).

BLM. "Visual Resource Inventory." Manual H–8410–1. Washington, DC: BLM. 2007b. <http://www.blm.gov/nstc/VRM/8410.html> (17 October 2007).

BLM. "Visual Resource Contrast Rating." Manual 8431. Washington, DC: BLM. 2007c. <http://www.blm.gov/nstc/VRM/8431.html> (17 October 2007).

BLM. "Farmington Proposed Resource Management Plan and Final Environmental Impact Statement." BLM–NM–PL–03–014–1610. Farmington, New Mexico: BLM, Farmington Field Office. 2003. <http://www.blm.gov/pgdata/etc/medialib/blm/nm/field_offices/farmington/farmington_planning/ffo_rmp_docs.Par.32114.File.dat/Final%20RMP%20with%20ROD.pdf?bcsi_scan_B6C3A1920618BACA=0&bcsi_scan_filename=Final%20RMP%20with%20ROD.pdf> (17 October 2007).

BLM. "Proposed El Malpais Plan and Final Environmental Impact Statement." Albuquerque, New Mexico: BLM, Albuquerque Field Office. 2000.

Broster, J. and B. Harrill. *A Cultural Resource Management Plan for Timber Sale and Forest Development Area on the Pueblo of Acoma (Vol. 1 and 2)*. Albuquerque, New Mexico: Bureau of Indian Affairs. 1982.

Brugge, D. "Navajos in the Catholic Church Records of New Mexico 1694–1875." Research Report No. 1. Window Rock, New Mexico: Parks and Recreation Department, Navajo Nation. 1968.

Center for Plant Conservation. "National Protection Plant Profile, Recovering Americas Vanishing Flora." 2008 <http://www.centerforplantconservation.org/ASP/CPC_ViewProfile.asp?CPCNum=3241> (15 February 2008).

Chenoweth, W.L. "Geology and Production History of Uranium Deposits in the Dakota Sandstone, McKinley County, New Mexico." *New Mexico Geology*. Vol. 11. pp. 21–29. 1989.

Chenoweth, W.L. and E.A. Learned. "Stratigraphic Section, Church Rock Area, McKinley County, New Mexico." Geology and Mineral Technology of the Grants Uranium Region 1979.

C.A. Rautman, ed. New Mexico Bureau of Mines and Mineral Resources Memoir 38. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. 1980.

City of Gallup Economic Development Center. "City of Gallup Departments." 2007. <www.ci.gallup.nm.us/dept.htm> (18 October 2007).

Cordell, L.S. "Chaco's Corn: Where Was It Grown?" *Search of Chaco: New Approaches to an Archaeological Enigma.* D.G. Noble, ed. Santa Fe, New Mexico: School of American Research Press. 2004.

Cordell, L.S. "Cultural Resources Overview: Middle Rio Grande Valley, New Mexico." Albuquerque, New Mexico: U.S. Department of Agriculture, Forest Service, Southwestern Region, and Santa Fe, New Mexico: Bureau of Land Management, New Mexico State Office. 1979.

Cornell Laboratory of Ornithology. "All About Birds: Baird's Sparrow." 2003. <http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Bairds_Sparrow_dtl.htm> (20 February 2009).

Correll, J. "Through the White Man's Eyes: A Contribution to Navajo History. A Chronological Record of the Navajo People From Earliest Times to the Treaty of June 1, 1868." Publication No. 1. Window Rock, New Mexico: Navajo Heritage Center. 1976.

Crumley, C. and W.H. Marquardt. "Landscape: A Unifying Concept in Regional Analysis." *Interpreting Space: GIS and Archaeology.* K.M.S. Allen, S.W. Green, and E.B W. Zubrow, eds. London, England: Taylor and Francis. pp. 49–54. 1990.

Damp, J.E., S.A. Hall, and S.J. Smith. "Early Irrigation on the Colorado Plateau Near Zuni Pueblo, New Mexico." *American Antiquity.* Vol. 67, No. 4. pp. 665–676. 2002.

Dean, J.S., W.H. Doelle, and J.D. Orcutt. "Adaptive Stress: Environment and Demography." *Themes in Southwest Prehistory.* G.J. Gumerman, ed. Santa Fe, New Mexico: School of American Research Press. pp. 53–86. 1994.

Division of Economic Development of the Navajo Nation. "Educational Facilities on the Navajo Nation." Window Rock, Arizona: Division of Economic Development of the Navajo Nation. 2008. <www.navajobusiness.com/infrastructure/Education%20Facilities.htm> (23 February 2008).

Division of Economic Development of the Navajo Nation. "2005–2006 Comprehensive Economic Development Strategy of Navajo Nation." Window Rock, New Mexico: Division of Economic Development of the Navajo Nation. 2006.

Driscoll, F.G. "Groundwater and Wells." 2nd Edition. St. Paul, Minnesota: Johnson Filtration Systems Inc. 1986.

Dulaney, A. and S. Dosh. "A Class II Cultural Resources Inventory of the Southern Portion of the Chaco Planning Unit, McKinley and Sandoval Counties, New Mexico." Albuquerque, New Mexico: Bureau of Land Management. 1981.

Ellis, F.H. “Laguna Pueblo.” *Handbook of North American Indians: Southwest.* A. Ortiz, ed. Vol. 9. Washington, DC: Smithsonian Institution. 1979.

Ellis, F.H. *Archaeologic and Ethnologic Data: Acoma-Laguna Land Claims: Pueblo Indians II.* New York City, New York: Garland Publishing. 1974a.

Ellis, F.H. *Anthropology of Laguna Pueblo Land Claims: Pueblo Indians III*. New York City, New York: Garland Publishing. 1974b.

EPA. “National Assessment Database.” 2008. <http://www.epa.gov/waters/305b/index.html> (28 February 2008).

EPA. “Counties Designate Nonattainment or Maintenance for Clean Air Act’s National Ambient Air Quality Standards (NAAQS).” 2007a. <http://www.epa.gov/oar/oaqps/greenbk/mapnmpoll.html> (29 September 2007).

EPA. “Prevention of Significant Deterioration (PSD) Permit Program Status: May 2007.” 2007b. <http://www.epa.gov/nsr/where.html> (26 September 2007).

EPA. “Assessment of Variations in Radiation Exposure in the United Sates (Revision 1).” Contract Number EP–D–05–02. Washington, DC: EPA. 2006.

Federal Highway Administration. “Synthesis of Noise Effects on Wildlife Populations.” FHWA–HEP–06–016. Washington, DC: Federal Highway Administration, Department of Transportation. 2004.

Ferguson, T.J. *Historic Zuni Architecture and Society: An Archaeological Application of Space Syntax: Anthropological Papers of the University of Arizona 60*. Tucson, Arizona: University of Arizona Press. 1996.

Ferguson, T.J. and E. Hart. *A Zuni Atlas*. Norman, Oklahoma: University of Oklahoma Press. 1985.

Flint, R. and S.C. Flint. *Documents of the Coronado Expedition, 1539-1542*. Dallas, Texas: Southern Methodist University Press. 2005.

Fox, S. “Sacred Pedestrians: The Many Faces of Southwest Pilgrimage.” *Journal of the Southwest.* Vol. 36. pp. 33–53. 1994.

Gilpin, D. “Social Transformations and Community Organization in the Southwest San Juan Basin, New Mexico: Archaeological Investigations Along Navajo Route 9, Twin Lakes to Standing Rock.” Flagstaff, Arizona: SWCA Environmental Consultants. 2007.

Grants-Cibola County Schools. “Grants-Cibola County Schools.” Grants, New Mexico: Grants-Cibola County School District. 2007. <www.gccs.cc> (15 October 2007).

Greatschools. “McKinley County.” 2007. <www.greatschools.net> (15 October 2007).

Green, W.G. and C.T. Pierson. “A Summary of the Stratigraphy and Depositional Environments of Jurassic and Related Rocks in the San Juan Basin.” San Juan Basin III, New Mexico Geological Society Guidebook, 28th Field Conference. J.E. Fassat, ed. pp. 147–152. 1977.

Griffith, G.E., J.M. Omernik, M.M. McGraw, G.Z. Jacobi, C.M. Canavan, T.S. Schrader, D. Mercer, R. Hill, and B.C. Moran. "Ecoregions of New Mexico." U.S. Geological Survey Map. Scale 1:1,400,000. Reston, Virginia: U.S. Geological Survey. 2006.

Hilpert, L.S. "Uranium Resources of Northwestern New Mexico." U.S. Geological Survey Professional Paper 603. 1969.

Hilpert, L.S. "Regional and Local Stratigraphy of Uranium-Bearing Rocks." Geology and Technology of the Grants Uranium Region. V.C. Kelley, ed. New Mexico Bureau of Mines and Mineral Resources Memoir 15. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. pp. 6–18. 1963.

Holen, H.K. and W.O. Hatchell. "Geological Characterization of New Mexico Uranium Deposits for Extraction by In-Situ Leach Recovery." New Mexico Bureau of Mines and Mineral Resources Open-File Report 251. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. 1986.

Holt, B. "Navajo Sacred Areas: Guide for Management." *Contract Abstracts and CRM Archaeology.* Vol. 2, No. 2. pp. 45–53. Albuquerque, New Mexico: Atechiston, Inc. 1981.

Huber, E.K. and C.R. Van West. "Synthetic Studies. Archaeological Data Recovery at the New Mexico Transportation Corridor and First Five-Year Permit Area, Fence Lake Coal Mine Project, Catron County, New Mexico." Vol. 3. Technical Series 84. Tucson, Arizona: Statistical Research. 2005.

Hunt, C.B. "Natural Regions of the United States and Canada." San Francisco, California: W.H. Freeman and Company. 1974.

Huntley, D.L. and K.W. Kintigh. "Archaeological Patterning and Organizational Scale of Late Prehistoric Settlement Clusters in the Zuni Region of New Mexico." *The Protohistoric Pueblo World, A.D. 1275–1600.* E.C. Adams and A.I. Duff, eds. Tucson, Arizona: University of Arizona. 2004.

Hydro Resources, Inc. "Clarification and Additional Information Request—Hydro Resources, Inc. *In-Situ* Leach Mine, Crownpoint,New Mexico." Crownpoint, New Mexico: Hydro Resources, Inc. 1996.

Jenkins, M.E. *History of Laguna Pueblo Land Claims. Pueblo Indians IV*. New York City, New York: Garland Press. 1974.

Judge, J.W. "Chaco's Golden Century." *Search of Chaco: New Approaches to an Archaeological Enigma.* D.G. Noble, ed. Santa Fe, New Mexico: School of American Research Press. pp. 1–6. 2004.

Kantner, J. *Ancient Puebloan Southwest*. Cambridge, Massachusetts: Cambridge University Press. 2004.

Kantner, J. "Ancient Roads, Modern Mapping." *Expedition.* Vol. 39, No. 3. 1997.

Kantner, J. and N.M. Mahoney, eds. *Great House Communities Across the Chacoan Landscape: Anthropological Papers of the University of Arizona No. 64*. Tucson, Arizona: University of Arizona Press. 2000.

Kearns, T., C. Kugler, and P. Simmon. "The Dog Leg Site (LA 6448): A Basketmaker II Cache Local in the Southern Chuska Valley, New Mexico." *Pipeline Archaeology 1990–1993: The El Paso Natural Gas North System Expansion Project, New Mexico and Arizona (Vol. II).* T. Kearns and J. McVickar, eds. Farmington, New Mexico: Western Cultural Resource Management. pp. 301–476. 1998.

Kelley, K. *Navajo Land Use: An Ethnoarchaeological Study*. New York City, New York: Academic Press. 1986.

Kelley, K. "Anasazi and Navajo Land Use in the McKinley Mine Area Near Gallup, New Mexico (Ethnohistory, Vol. 2)." Albuquerque, New Mexico: University of New Mexico, Office of Contract Archeology. 1982.

Kelley, K. and H. Francis. *Navajo Sacred Places*. Bloomington, Indiana: University of Indiana Press. 1994.

Kidder, A.V. "Southwestern Archaeological Conference." *Science.* Vol. 66. pp. 489–491. 1927.

King, T. *Places That Count: Traditional Cultural Properties in Cultural Resources Management*. Walnut Creek, California: Altamira Press. 2003.

Kintigh, K.W. "The Cibola Region in the Post-Chacoan Era." *The Prehistoric Pueblo World, A.D. 1150–1350.* M.A. Adler, ed. Tucson, Arizona: University of Arizona Press. pp. 131–144. 1996.

Lat-Long.com. "Laguna Indian Reservation." 2008. <www.lat-long.com> (28 February 2008).

Linford, L. *Navajo Places: History, Legend and Landscape*. Salt Lake City, Utah: University of Utah Press. 2000.

Localschooldirectory.com. "Grants Schools in New Mexico." 2008. <www.localschooldirectory.com> (28 February 2008).

Los Angeles Times. "Tribes Get Mt. Taylor Listed as Protected." Los Angeles Times, June 15, 2008. <http://articles.latimes.com/2008/jun/15/nation/na-mountain 15> (29 February 2009).

Mahoney, N.M. and J. Kantner. "Chacoan Archaeology and Great House Communities." *Great House Communities Across the Chacoan Landscape, Anthropological Papers of the University of Arizona No. 64*. J. Kartner and N.M. Mahoney, eds. Tucson, Arizona: University of Arizona Press. pp. 1–15. 2000.

Mapquest. "New Mexico." <http://www.mapquest.com> (15 April 2008).

Marshall, M., J. Stein, R. Loose, and J. Novotny. *Anasazi Communities of the San Juan Basin*. Public Service Company of New Mexico. Santa Fe, New Mexico: New Mexico Historic Preservation Division. 1979.

McLemore, V.T. "Uranium Resources in New Mexico." Proceedings of the 2007 Annual Meeting and Exhibit Society for Mining, Metallurgy, and Exploration, Denver, Colorado, February 25–28, 2007. Littleton, Colorado: Society for Mining, Metallurgy, and Exploration. 2007.

McLemore, V.T. and W.L. Chenoweth. "Uranium Resources in New Mexico." New Mexico Bureau of Mines and Mineral Resources Map 18. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. 1989.

Mills, B.J. "Acts of Resistance: Zuni Ceramics, Social Identity, and the Pueblo Revolt." *Archaeologies of the Pueblo Revolt.* R.W. Preucel, ed. Albuquerque, New Mexico: University of New Mexico Press. pp. 85–98. 2002a.

Mills, B.J. "Recent Research on Chaco: Changing Views on Economy, Ritual and Society." *Journal of Archaeological Research.* Vol. 10, No. 1. pp. 65–117. 2002b.

Minge, W. *Defense of the Pueblo of Acoma Land Claims: Pueblo Indians III*. New York City, New York: Garland Publishing. 1974.

Murphy, D., G. Huey, and W. Clay. "El Morro National Monument." Globe, Arizona: Southwestern Parks and Monuments. 2003.

National Climatic Data Center. "NCDC U.S. Storm Events Database." 2007. <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms> (14 April 2008).

National Climatic Data Center. "Climates of the States, Climatology of the United States No. 60 (New Mexico, Nebraska, South Dakota, and Wyoming)." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2005. <http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM60&subrnum=> (30 January 2005).

National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971-2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

National Council on Radiation Protection and Measurements. "Report No. 094—Exposure of the Population in the United States and Canada From Natural Background Radiation." Bethesda, Maryland: National Council on Radiation Protection & Measurements. 1987.

National Weather Service. "NOAA Technical Report NWS 33: Evaporation Atlas for the Contiguous 48 United States." Washington, DC: National Oceanic and Atmospheric Administration. 1982.

NatureServe. "NatureServe Explorer: An Online Encyclopedia of Life (Web Application)." Version 7.0. 2008. Arlington, Virginia: NatureServe. <http://www.natureserve.org/explorer> (14 April 2008).

Navajo Nation. <www.navajolorg/govt.htm> (25 February 2008).

New Mexico Department of Game and Fish. "Wildlife Notes." Albuquerque, New Mexico: New Mexico Department of Game and Fish. 2008. <http://www.wildlife.state.nm.us/education/wildlife_notes/WildlifeNotes.htm> (15 February 2008).

New Mexico Department of Game and Fish. "Oil and Gas Development Guidelines, Conserving New Mexico's Wildlife Habitat and Wildlife." Santa Fe, New Mexico: New Mexico Department of Game and Fish. August 2007.

New Mexico Department of Game and Fish. "Comprehensive Wildlife Conservation Strategy for New Mexico." Santa Fe, New Mexico: New Mexico Department of Game and Fish. 2006.

New Mexico Department of Game and Fish. "Zuni Bluehead Sucker Recovery Plan." 2004. <http://www.wildlife.state.nm.us/conservation/threatened_endangered_species/documents/ZuniBlueheadSuckerRecoveryPlan.pdf> (14 February 2008).

New Mexico Department of Transportation. "New Mexico 2006 Traffic Survey." Albuquerque, New Mexico: New Mexico Department of Transportation. 2007. <http://nmshtd.state.nm.us/main.asp?secid=15370> (26 February 2008).

New Mexico Economic Development. "Grants." 2008. <www1.edd.statenm.us/datacenter/moredata/index.html> (27 February 2008).

New Mexico Environmental Department, Air Quality Bureau. "Dispersion Modeling—Meteorological Data." 2007. <http://www.nmenv.state.nm.us/aqb/modeling/metfiles/ISCST3/SCRAM_GALLUP_91.pdf> (13 September 2007).

New Mexico Environment Department. "Air Quality Regulations." 2002. <http://www.nmenv.state.nm.us/aqb/> (23 October 2007).

New Mexico State University. "Southwest Regional Gap Analysis Project." Las Cruces, New Mexico: New Mexico State University. 2007. <http://fws-nmcfwru.nmsu.edu/swregap/> (29 November 2007).

New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." Albuquerque, New Mexico: New Mexico Taxation and Revenue Department. 2008.

New Mexico Taxation and Revenue Department. "New Mexico Oil and Gas Ad Valorem Production and Production Equipment Taxes—Description and Summary of Statistical Reports." Albuquerque, New Mexico: New Mexico Taxation and Revenue Department. 2000.

New Mexico Tourism Department. "New Mexico: The Land of Enchantment Tourism Department." 2008. <www.newmexico.org/place/loc/cities/page/DB-place/place/1200.html> (25 February 2008).

Noble, D.G., ed. *Search of Chaco: New Approaches to an Archaeological Enigma*. Santa Fe, New Mexico: School of American Research Press. 2004.

Norwood, V. and J. Monk, eds. *The Desert Is No Lady: Southwestern Landscapes in Women's Writing and Art*. New Haven, Connecticut: Yale University Press. 1987.

NRC. "Expected New Uranium Recovery Facility Applications/Restarts/Expansions: Updated 1/24/2008." 2008. <http://www.nrc.gov/info-finder/materials/uranium/2008-ur-projects-list-public-012408.pdf> (08 February 2008).

NRC. NUREG–1508, "Final Environmental Impact Statement To Construct and Operate the Crownpoint Uranium Solution Mining Project, Crown Point, New Mexico." Washington, DC: NRC. February 1997.

NRCS, United States Department of Agriculture. "Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties. Albuquerque, New Mexico: New Mexico NRCS State Office. 2001.

Orcutt, J.D., J.L. McVickar, and J.D. Kilby. "Environmental and Cultural Background*." The El Malpais Archeological Survey, Phase I.* R.P. Powers and J.D. Orcutt, eds. Intermountain Cultural Resources Management Professional Paper Vol. 70. Santa Fe, New Mexico: National Park Service. pp. 31–44. 2005.

Ortiz, J. *Woven Stone*. Tucson, Arizona: University of Arizona Press. 1992.

Owen, D.E. "The Jackpile Sandstone Member of the Morrison Formation in West-Central New Mexico—A Formal Definition." *New Mexico Geology*. Vol. 6, No. 3. pp. 45–52. 1984.

Parker, P. and T. King. "Guidelines for Evaluating and Documenting Traditional Cultural Properties." National Register Bulletin 38. Washington, DC: National Park Service. 1998.

Parsons, E.C. "Notes on Acoma and Laguna." *American Anthropologist.* pp. 162–186. 1918.

Perlman, S. "Fort Wingate Depot Activity Ethnographic Study." Albuquerque, New Mexico: University of New Mexico, Office of Contract Archaeology. 1997.

Peterson, R.J. "Geology of Pre-Dakota Uranium Geochemical Cell, Section 13, T.16. N, R.17. W., Church Rock Area, McKinley County." Geology and Mineral Technology of the Grants Uranium District. New Mexico Bureau of Mines and Mineral Resources, Memoir 38. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. pp. 131–134. 1980.

Plog, F. and W. Wait. "The San Juan Basin Tomorrow: Planning for the Conservation of Cultural Resources in the San Juan Basin." Santa Fe, New Mexico: National Park Service. 1979.

Powers, R. and J. Orcutt. "The El Malpais Archaeological Survey." Professional Report No. 70. Santa Fe, New Mexico: Intermountain Cultural Resources Management. 2005a.

Powers, R. and J. Orcutt, eds. "Site Typology, Architecture, Population and Settlement Patterns." *The El Malpais Archeological Survey, Phase I.* Professional Paper. Vol. 80. Santa Fe, New Mexico: Intermountain Cultural Resources Management. pp. 71–97. 2005b.

Powers, R., B. Gillespie, and S. Lekson. "The Outlier Survey: A Regional View of Settlement in the San Juan Basin." Reports of the Chaco Center No. 3. Albuquerque, New Mexico: National Park Service. 1983.

Public Employees for Environmental Responsibility. "Common Black Hawk." 2008. <http://www.txpeer.org/limpia/CommonBlackHawk.html> (14 February 2008).

Public Schools Report. "Public School Information and Data—Acoma Indian Reservation." 2007. <http//schools.publicschoolsreport.com> (15 October 2007).
Publicschoolreview.com. "Sandoval County." 2008 <www.publicschoolreview.com> (28 February 2008).

Pueblo of Zuni. "Pueblo Indians." 2008 <www.ashiwi.org/> (25 February 2008).
Ramah Navajo Chapter. "A History of the Ramah Navajo Community." Ramah, New Mexico: Tohajiilee Navajo Chapter. 2008. <www.tohajiilee.nndes.org> (28 February 2008).

Rands, R. *Acoma Land Utilization: Pueblo Indians III*. New York City, New York: Garland Publishing. 1974a.

Rands, R. *Laguna Land Utilization: Pueblo Indians IV*. New York City, New York: Garland Publishing. 1974b.

Reed, P.F., ed. *Foundations of Anasazi Culture: The Basketmaker-Pueblo Transition*. Salt Lake City, Utah: University of Utah Press. 2000a.

Reed, P.F., ed. "Fundamental Issues in Basketmaker Archaeology." *Foundations of Anasazi Culture: The Basketmaker-Pueblo Transition.* Salt Lake City, Utah: University of Utah Press. pp. 3–16. 2000b.

Reeve, F. "The Navajo-Spanish Peace, 1720s–1770s." *New Mexico Historical Review.* Vol. 34. pp. 9–30. 1959.

Riggs, C.R. "Late Ancestral Pueblo or Mogollon Pueblo? An Architectural Perspective on Identity." *Kiva.* Vol. 70, No. 4. pp. 323–348. 2005.

Ristorcelli, S.J. "Geology of Eastern Smith Lake Ore Trend, Grants Mineral Belt." Geology and Mineral Technology of the Grants Uranium Region. New Mexico Bureau of Mines and Mineral Resources Memoir 38. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. pp. 145–152. 1980.

Robson, S.G. and E.R. Banta. "Ground Water Atlas of the United States: Arizona, Colorado, New Mexico, Utah, HA730–C." 1995. <http://pubs.usgs.gov/ha/ha730/ch_c> (29 February 2009).

Roney, J.R. "The Pueblo III Period in the Eastern San Juan Basin and Acoma-Laguna Areas." *The Prehistoric Pueblo World, A.D. 1150–1350.* M.A. Adler, ed. Tucson, Arizona: University of Arizona Press. pp. 145–169. 1996.

Sanford, R.F. "A New Model for Tabular-Type Uranium Deposits." *Economic Geology*. Vol. 87. pp. 2,041–2,055. 1992.

Saucier, A.E. "Tertiary Oxidation in Westwater Canyon Member of the Morrison Formation." Geology and Mineral Technology of the Grants Uranium Region 1979. C.A. Rautman, compiler. New Mexico Bureau of Mines and Mineral Resources Memoir 38. Socorro, New Mexico: New Mexico Bureau of Mines and Mineral Resources. pp. 116–121. 1981.

Schachner, G. and J.D. Kilby. “Archaic and Puebloan Chronology.” *The El Malpais Archeological Survey, Phase I.* R.P. Powers and J.D. Orcutt, eds. Intermountain Cultural Resources Management Professional Paper No. 70. Santa Fe, New Mexico: National Park Service. 2005.

Schutt, J.A. and R.C. Chapman. “Cycles of Closure: A Cultural Resources Inventory of Fort Wingate Depot Activity, New Mexico.” Albuquerque, New Mexico: University of New Mexico, Office of Contract Archaeology. 1997.

Sedgwick, W. *Acoma the Sky City: A Study in Pueblo-Indian History and Civilization*. Cambridge, United Kingdom: Harvard University Press. 1926.

Silko, L. “Landscape, History, and Pueblo Imagination.” *The Norton Book of Nature Writin*g. R. Finch and J. Elder, eds. New York City, New York: W.W. Norton and Company. pp. 882–893. 1990.

Simmons, A. “New Evidence for the Early Use of Cultigens in the American Southwest.” *American Antiquity.* Vol. 51. pp. 73–89. 1986.

Snead, J. and R. Preucel. “The Ideology of Settlement: Ancestral Keres Landscapes in the Northern Rio Grande.” *Archaeologies of Landscape: Contemporary Perspectives.* W. Ashmore and A.B. Knapp, eds. Oxford, United Kingdom: Blackwell. pp. 169–200. 1999.

Spicer, E.H. *Cycles of Conquest: The Impact of Spain, Mexico, and the United States on the Indians of the Southwest, 1533–1960*. Tucson, Arizona: University of Arizona Press. 1962.

Stanford, D. “Paleoindian Archaeology and Late Pleistocene Environments in the Plains and Southwestern United States.” *Ice Age Peoples of North America (Second Edition).* R. Bonnichsen and K. Turnmire, eds. College Station, Texas: Texas A&M University, Center for the Study of the First Americans. pp. 281–339. 2005.

Sterling, M.W. “Origin Myth of Acoma.” Bulletin 135. Washington, DC: Bureau of American Ethnology. 1942.

Tainter, J. and D. Gillio. “Cultural Resources Overview: Mt. Taylor Area, New Mexico.” Albuquerque, New Mexico: USFS. 1980.

Texas Parks and Wildlife Department. “Wildlife Facts Sheets.” 2007. <http://www.tpwd.state.tx.us/huntwild/wild/species/> (15 February 2008).

Thamm, J.K., A.A. Kovschak, and S.S. Adams. “Geology and Recognition Criteria for Sandstone Uranium Deposits of the Salt Wash Type, Colorado Plateau Province—Final Report.” Report GJBX. Vol. 6, No. 81. Washington, DC: DOE. 1981.

Tohajiilee Chapter. <www.tohajiilee.nndes.org> (28 February 2008).

Toll, H.W. “Artifacts in Chaco: Where They Came From and What They Mean*.” In Search of Chaco: New Approaches to an Archaeological Enigma.* D.G. Noble, ed. Santa Fe, New Mexico: School of American Research Press. pp. 32–40. 2004.

Towner, R.H., ed. *The Archaeology of Navaho Origins.* Salt Lake City, Utah: University of Utah Press. 1996.

Udall, S., D. Brugge, T. Benally, and E. Yazzie-Lewis. *The Navajo People and Uranium Mining*. Albuquerque, New Mexico: University of New Mexico Press. 2007.

USACE. “Final Environmental Assessment and Finding of No Significant Impact: The Los Utes Acequia Pipeline Project Sandoval County, New Mexico.” Albuquerque, New Mexico: USACE. 2007.

USACE. “Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region.” Washington, DC: USACE. 2006.

Usacops. New Mexico. <http://www.usacops.com> (15 April 2008).

U.S. Census Bureau. “American FactFinder 2000 Census Data.” <http://factfinder.census.gov> (25 February 2008).

U.S. Department of the Interior, Bureau of Indian Affairs. “2003 Indian Population and Labor Force Report.” 2003. <http://www.doi.gov/bia/laborforce/2003LaborForceReportFinalAll.pdf> (24 October 2007).

U.S. Fish and Wildlife Service. “Ecological Services.” 2008. <http://www.fws.gov/southwest/es/> (12 February 2008).

U.S. Fish and Wildlife Service. “Rio Grande Silvery Minnow Draft Recovery Plan.” 2007. <http://ecos.fws.gov/docs/recovery_plan/070118a.pdf> (12 February 2008).

U.S. Fish and Wildlife Service. “San Juan River Basin Recovery Implementation Program.” 2006. <http://www.fws.gov/southwest/sjrip/pdf/DOC_SJRIP_Final_Program_Document>_9_1_2006.pdf> (14 February 2008).

USFS. “Environmental Assessment for Continental Divide National Scenic Trail Location—Cibola National Forest, Mt. Taylor Ranger District, Cibola and McKinley Counties.” Albuquerque, New Mexico: USFS, Southwestern Region. March 2007. <http://www.fs.fed.us/r3/cibola/projects/nepa_reports/continental_divide_trail_0307.pdf> (17 October 2007).

USFS. “Cibola National Forest General Vicinity Map.” Albuquerque, New Mexico: USFS, Southwestern Region. 2006. <http://www.fs.fed.us/r3/cibola/maps/vicinitysmap.shtml> (29 February 2008).

USFS. “Cibola National Forest Land and Resource Management Plan.” Albuquerque, New Mexico: USFS, Southwestern Region. <http://www.fs.fed.us/r3/cibola/projects/forest_plan/forest_plan.shtml> 1985.

U.S. Geological Survey. “A Tapestry of Time and Terrain.” Denver, Colorado: U.S. Geological Survey. 2004. <http://tapestry.usgs.gov/Default.html> (25 February 2008).

Van Dyke, R.M. “Chaco's Sacred Geography.” *In Search of Chaco: New Approaches to an Archaeological Enigma.* D.G. Noble, ed. Santa Fe, New Mexico: School of American Research Press. pp. 78–85. 2004.

Vierra, B. “Early Agriculture on the Southwestern Periphery of the Colorado Plateau: A Case in Diversity of Tactics.” *Archaeology Without Borders: Contact, Commerce and Change in the U.S. Southwest and Northwestern Mexico.* M. McBrinn and L. Webster, eds. Boulder, Colorado: University of Colorado Press. pp. 71–88. 2008.

Vierra, B. “Aceramic and Archaic Research Questions.” *Across the Colorado Plateau: Anthropological Studies for the Transwestern Pipeline Expansion Project: Excavation and Interpretation of Aceramic and Archaic Sites (Vol. 14).* T. Burchett, B. Vierra, and K. Brown, eds. Albuquerque, New Mexico: University of New Mexico, Office of Contract Archaeology. pp. 375–378. 1994.

Washington State Department of Transportation. “WSDOT's Guidance for Addressing Noise Impacts in Biological Assessments—Noise Impacts.” Seattle, Washington: Washington State Department of Transportation. 2006. <http://www.wsdot.wa.gov/TA/Operations/ Environmental/NoiseChapter011906.pdf> (12 October 2007).

White, L.A. *The Acoma Indians*. Forty-Seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. Washington, DC: Smithsonian Institution. 1932.

Windes, T.C. “The Rise of Early Chacoan Great Houses.” *In Search of Chaco: New Approaches to an Archaeological Enigma.* D.G. Noble, ed. Santa Fe, New Mexico: School of American Research Press. pp. 14–21. 2004.

Winter, J. “Across the Colorado Plateau: Anthropological Studies for the Transwestern Pipeline Expansion Project: Synthesis and Conclusions (Vol. 20).” Albuquerque, New Mexico: University of New Mexico, Office of Contract Archaeology. 1994.

Wyoming Department of Transportation. “WYDOT Traffic Analysis.” Cheyenne, Wyoming: Wyoming Department of Transportation. 2005. <http://www.dot.state.wy.us/ Default.jsp?sCode=hwyta> (25 February 2008).

Zuni Pueblo Public School District. “Zuni Pueblo Official Website of the Zuni People’s Public School District.” 2008. <www.zpsd.org/zuni/index.htm> (28 February 2008).