

Rapid Watershed Assessment Chaco Watershed



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Overview

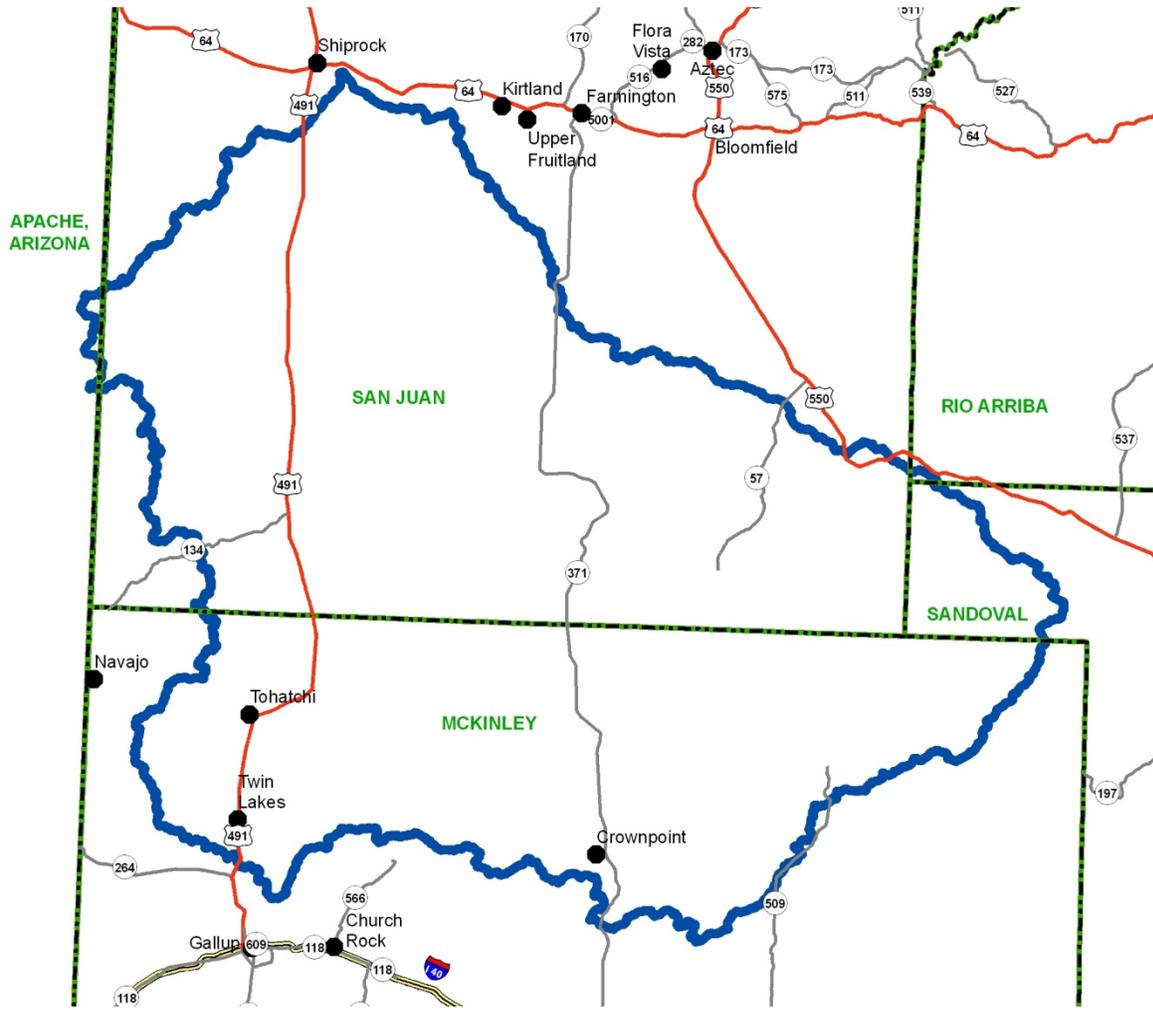


Figure 1. Chaco Watershed Overview



Overview

The Chaco Watershed is located in northwestern New Mexico, and northeastern Arizona, just south of the Four Corners area. It covers 2,931,265 total acres (11,862 sq. km). The counties it covers are Apache county in Arizona, and San Juan, McKinley, Sandoval, and Rio Arriba counties in New Mexico. Table 1 summarizes the distribution of the Chaco watershed.

Table 1. Chaco watershed acreage distribution.

	County Acres Total	Acres in HUC	% of HUC in County	% of County in HUC
Apache - AZ	7,118,652	5,821	<1	<1
McKinley	3,496,292	1,152,915	39	33
Rio Arriba	3,772,816	1,468	<1	<1
Sandoval	2,377,011	101,802	3	4
San Juan	3,549,586	1,669,286	57	47
Sum (Σ)	--	2,931,265	100	--



Physical Setting

Geology:

The watershed originates in the Chuska Mountains and proceeds East southeastwards and also originates on the western side of the Continental Divides and proceeds West northwestwards to its confluence with the San Juan River just east of Shiprock. The San Juan Basin lies on the Colorado Plateau. Several formations of Tertiary and Cretaceous age compose the consolidated geology of the San Juan River basin. The predominant geologic formation in New Mexico is the Nacimiento Formation of Tertiary age which underlies the soils and crops out along nearly all of the reach of the San Juan River valley east of Farmington. The Cretaceous Kirtland and Fruitland Formation and the Mancos Shale layers underlie the soils and crop out west of the Hogback. These two formations underlie tile soils and compose the outcrop in most of the upland area south of the San Juan River. Near Farmington, Cretaceous rocks rise sharply in some areas, forming hogback ridges. All of the shales of Cretaceous age consist at least in part of gray arid black shale. The San Juan River valley is composed in part of Quaternary unconsolidated sand, gravel, silt, clay, and terrace gravel and boulder deposits. Valley soils typically are derived from sandstone, shale, siltstone, and mudstone and range in permeability from moderately rapid to moderately slow.

Resource concerns are high sediment erosion and water runoff. In addition the lowering of valleys by river incision is a continuing process. Many valleys are flanked by terraces. Rivers respond by aggrading during climates that promote large sediment yield and large, stable discharges; and incise during climates that produce flashy flows and reduce the sediment supply. This can be exasperated by the mining of sand and gravel from the river channels.

Groundwater quality and quantity is a concern. Groundwater occurs to a greater or lesser extent in all of these geologic units. Depth to groundwater is a concern if the shallow unconfined aquifer does not produce enough water for the resource or increased population demands are 'mining' the water. Groundwater in the igneous rocks and volcanics is usually along fracture zones which are hard to intercept with water wells. Groundwater quality ranges from good to poor for livestock or crops.



Soils:

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The soils in the Chaco are assigned to four groups (A, B, C, and D).



Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.



Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.



Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.



Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.



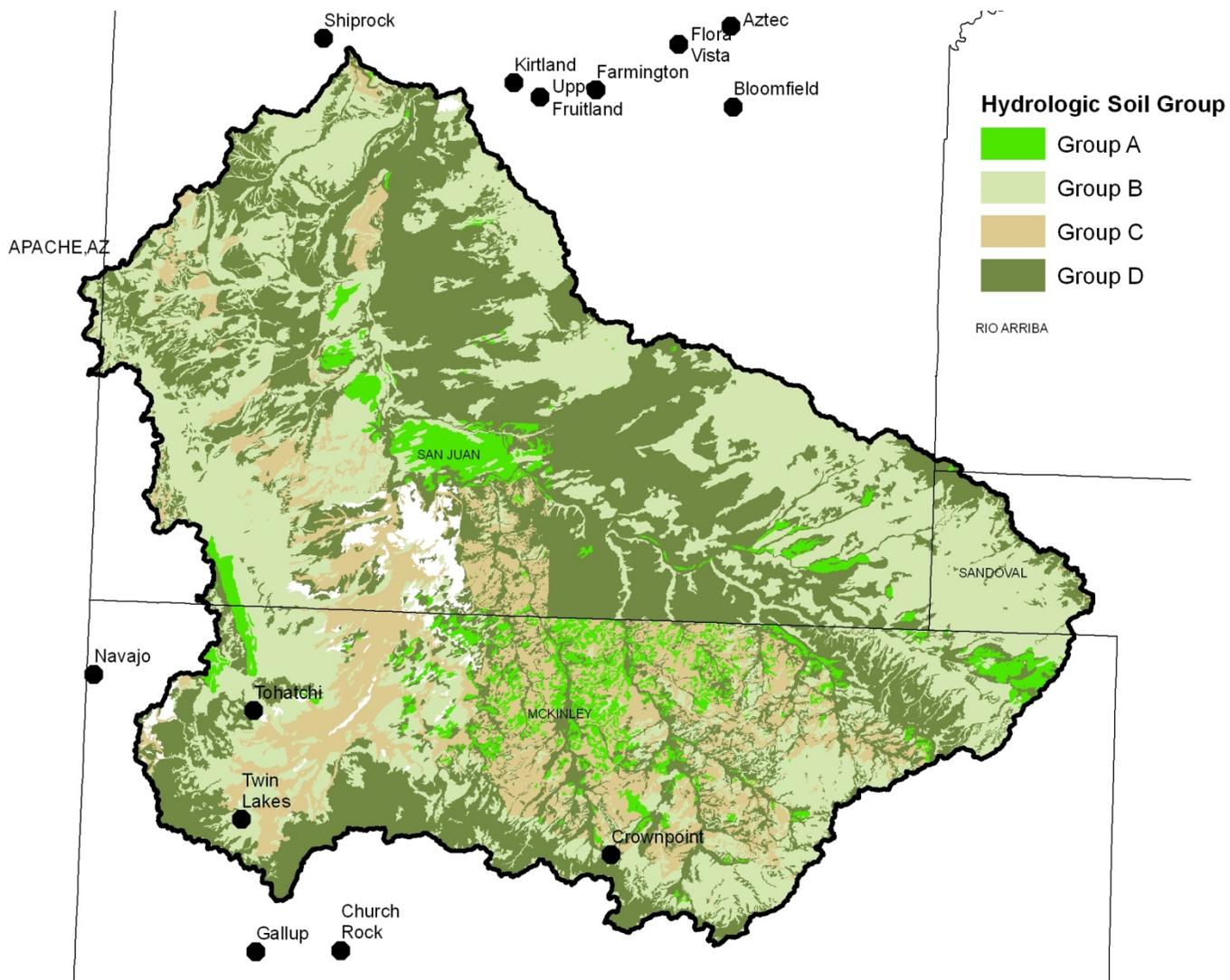
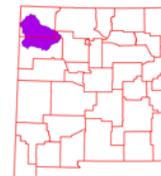


Figure 2. Hydrologic Soil Groups



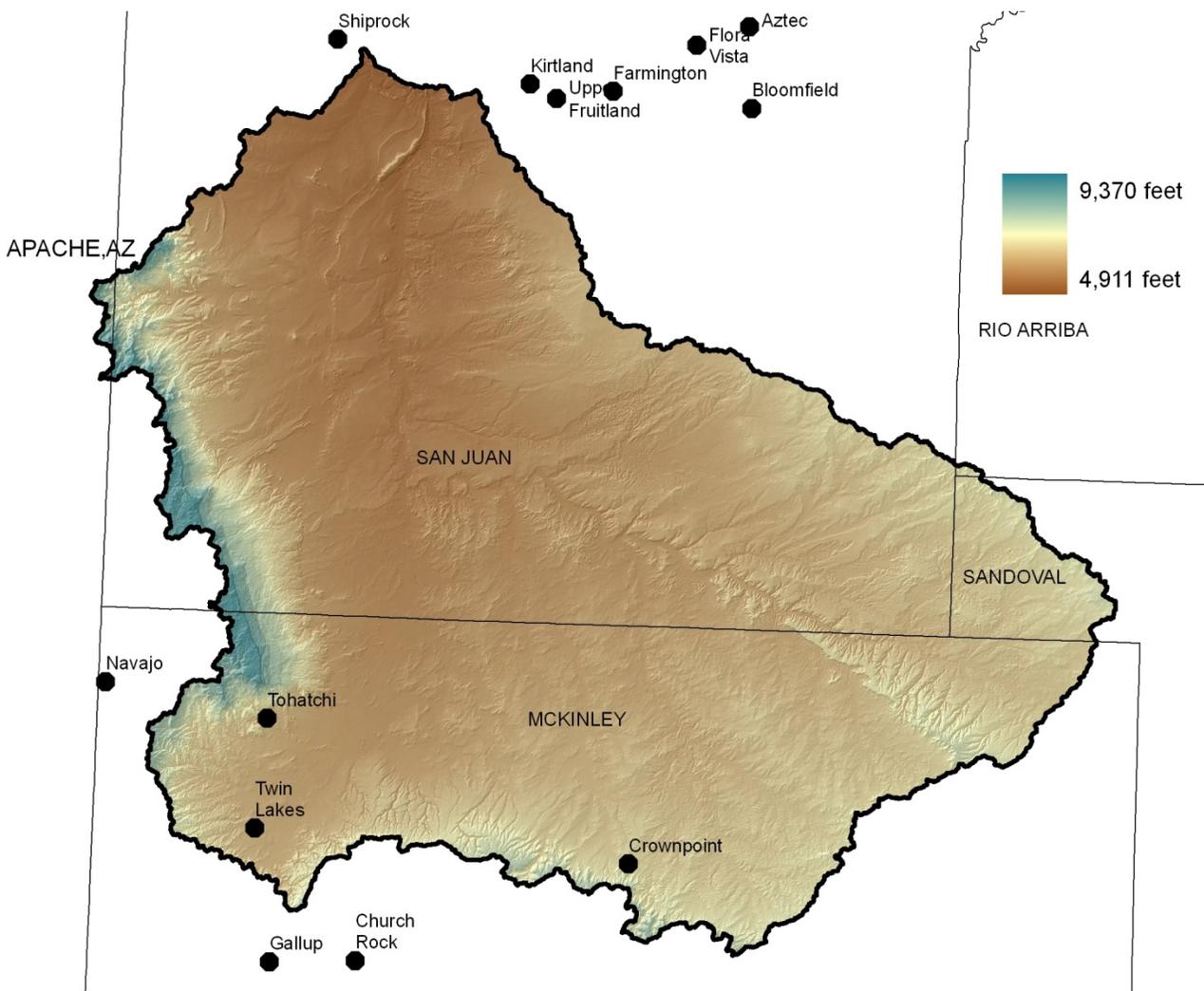
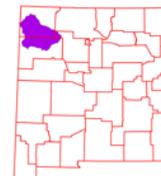


Figure 3. Chaco Watershed Shaded Relief



Precipitation

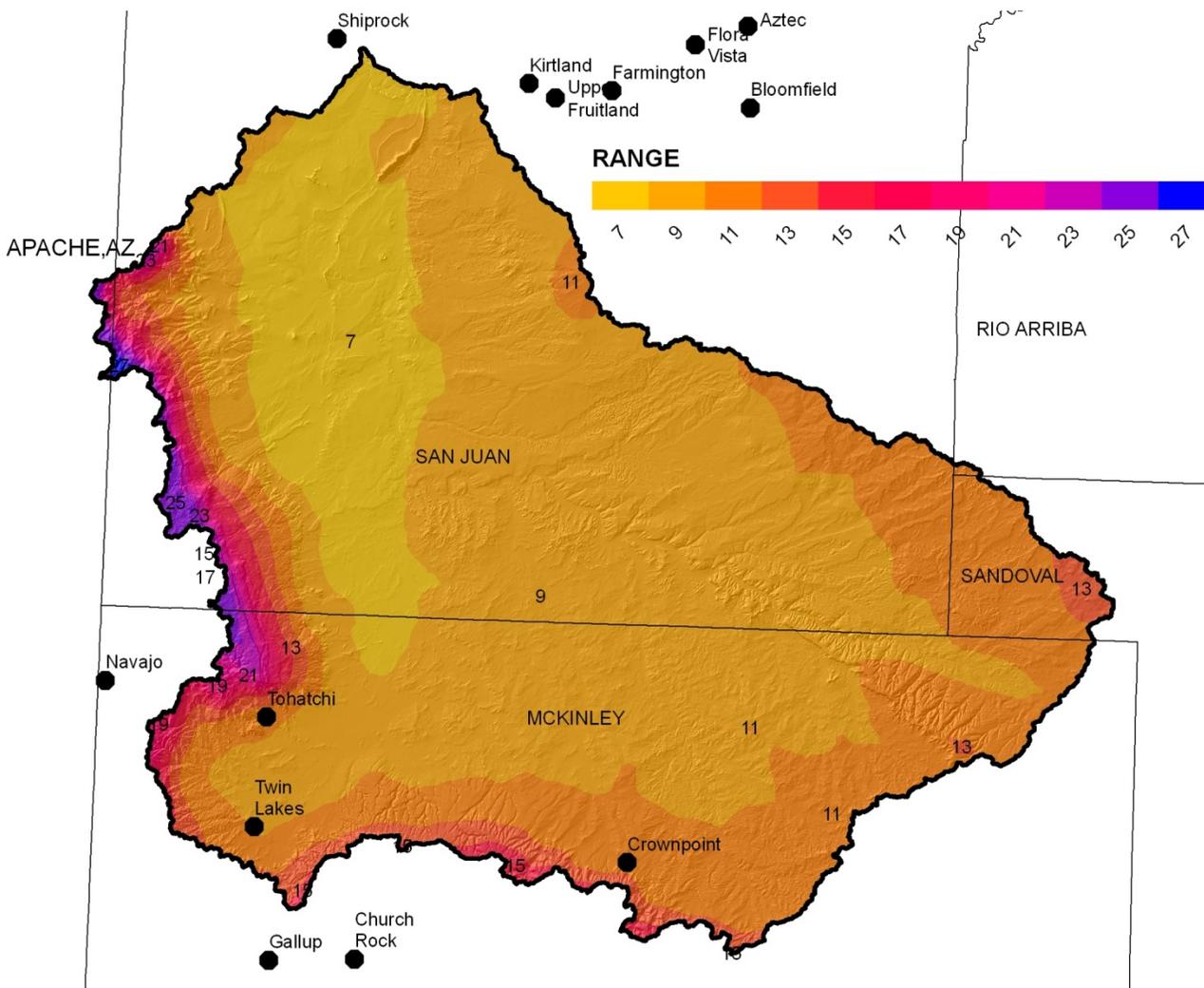


Figure 4. Chaco Watershed Annual Precipitation.



Land Ownership ³

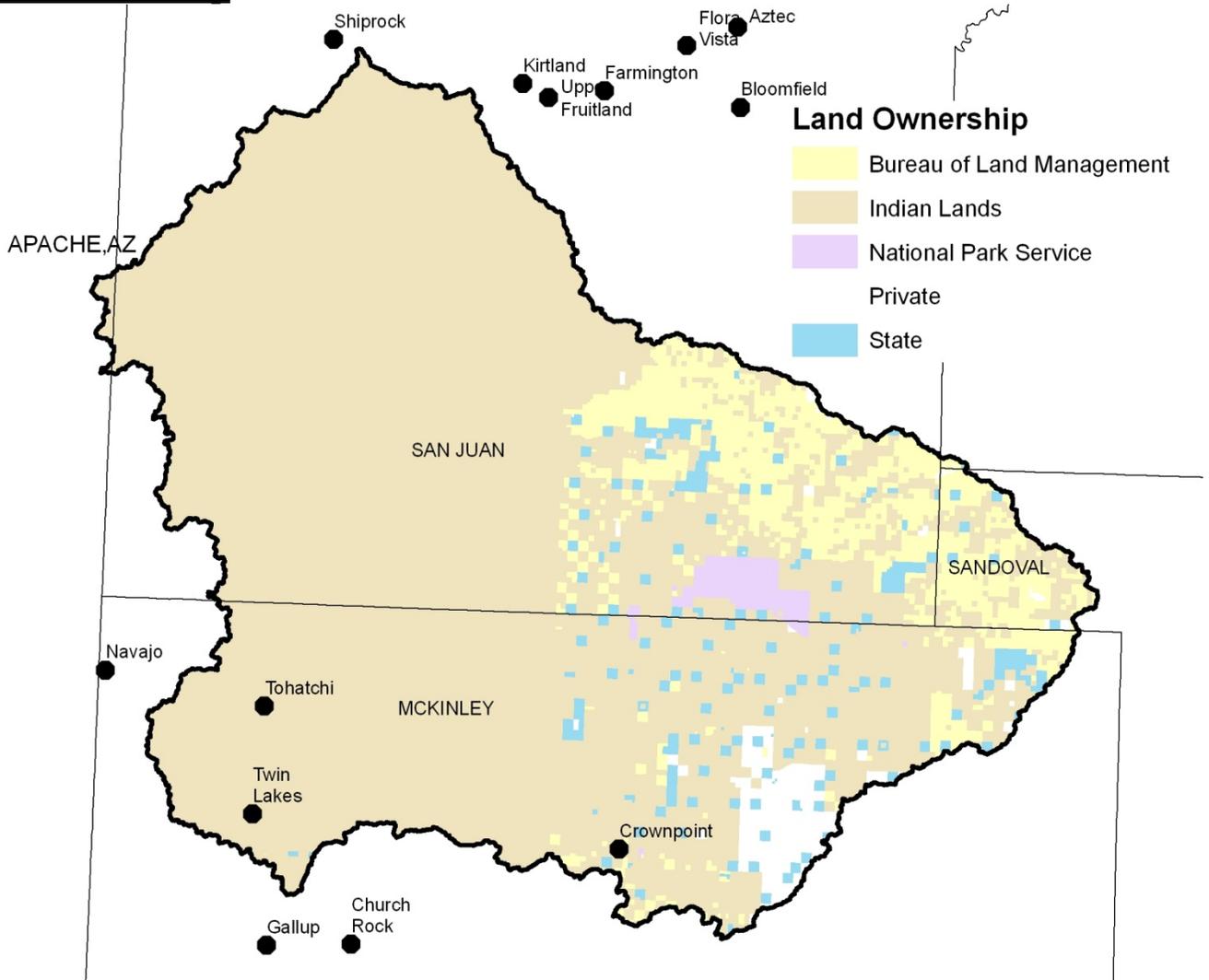


Figure 5. Chaco Watershed Land Ownership



Land Ownership

<u>COUNTY</u>	<u>BLM</u>	<u>Indian Lands</u>	<u>NPS</u>	<u>Private</u>	<u>State</u>
Apache - AZ		5,821			
McKinley	44,294	978,278	2,863	68,989	58,491
Rio Arriba	1186			88	193
Sandoval	58,684	37,228		1,964	3,925
San Juan	208,011	1,384,531	31,412	4,060	41,263
Watershed (Σ)	312,175	2,405,858	34,275	75,101	103,872
% Watershed	11	82	1	3	4

Table 2. Land ownership in the Chaco watershed.



Land Use / Land Cover ^{4.5}

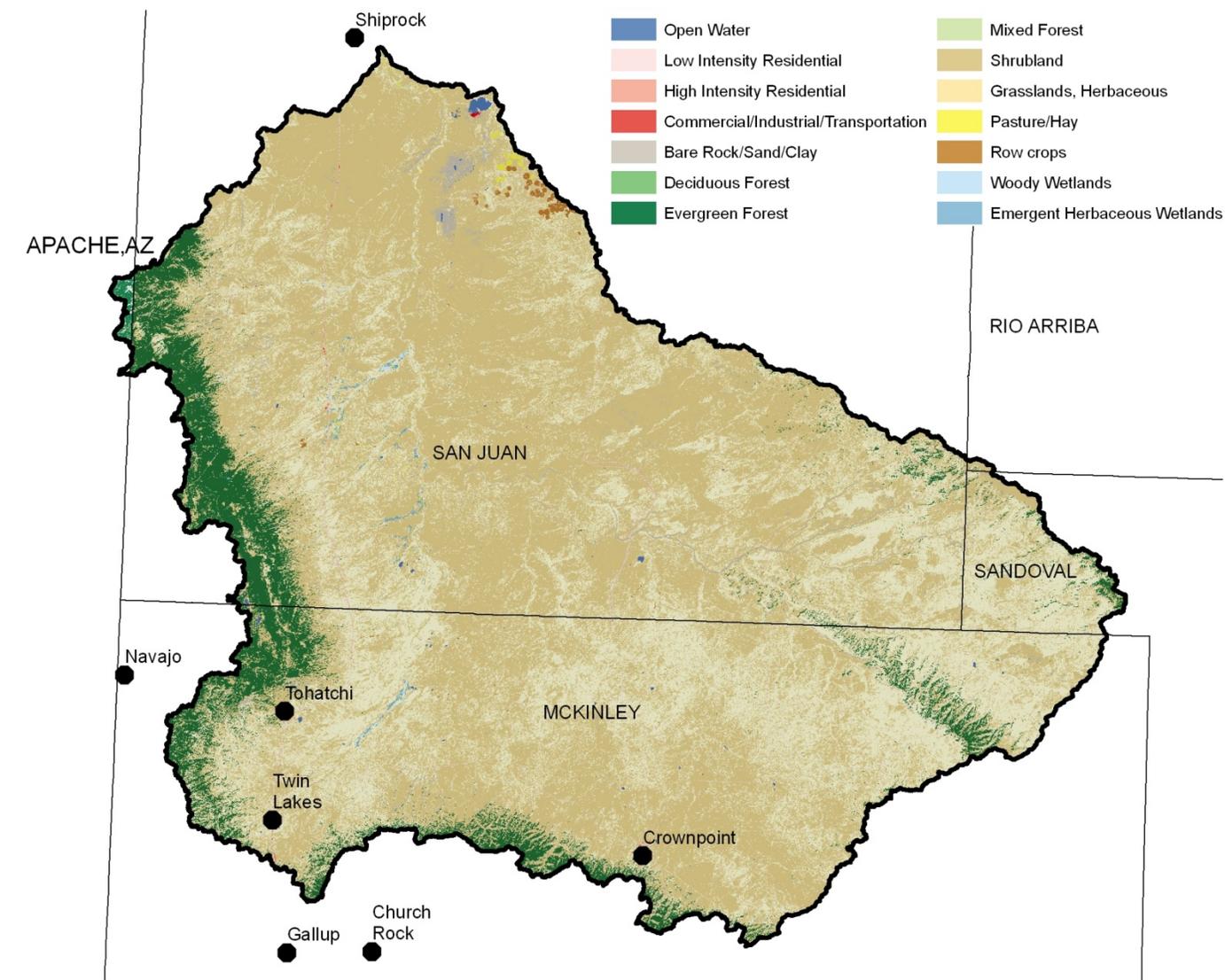


Figure 6. Subset of the National Land Cover Dataset in the Chaco Watershed.



Land Use / Land Cover

The U.S. Geological Survey (USGS) produced the National Land Cover Dataset (NLCD) as part of a cooperative project between the USGS and the U.S. Environmental Protection Agency (USEPA). The goal of this project was to produce a consistent land cover data layer for the conterminous United States. The Multiresolution Land Characterization (MRLC) Consortium collected the data used to compile the NLCD. The MRLC Consortium is a partnership of Federal agencies that produce or use land cover data; partners include the UNITED STATES GEOLOGICAL SURVEY (National Mapping, Biological Resources, and Water Resources Divisions), USEPA, the U.S. Forest Service, and the National Oceanic and Atmospheric Administration.

<u>Land use / Land cover</u>	<u>Acres</u>	<u>% of Watershed</u>
Shrubland	1,715,527	59
Grasslands, Herbaceous	936,128	32
Evergreen Forest	213,513	7
Bare Rock/Sand/Clay	34,653	1
Low Intensity Residential	11,358	< 1%
Emergent Herbaceous Wetlands	4,724	< 1%
Row crops	4,638	< 1%
Open Water	3,728	< 1%
Pasture/Hay	3,126	< 1%
High Intensity Residential	1,855	< 1%
Woody Wetlands	1,397	< 1%
Deciduous Forest	737	< 1%

Table 3. Extent of NLCD classes in the Chaco watershed.



Land Use / Land Cover

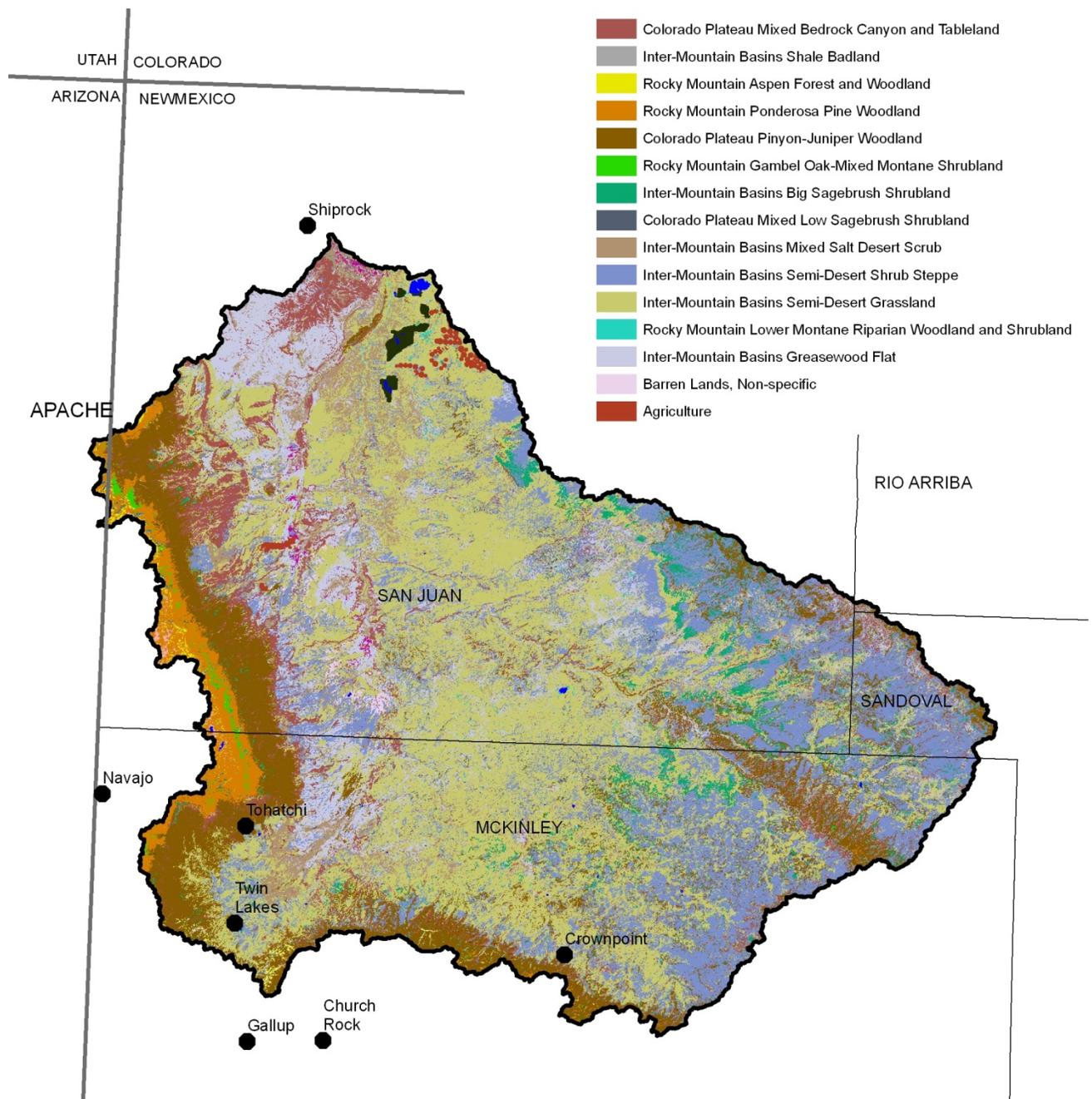


Figure 7. Subset of the SWREGAP over the Chaco Watershed. The 15 dominant ecosystems are displayed in the legend.



Land Use / Land Cover

The landcover mapping effort for the Southwest Region Gap Analysis Project was a coordinated multi-institution endeavor. This dataset was created for regional terrestrial biodiversity assessment. Additional objectives were to establish a coordinated mapping approach to create detailed, seamless maps of land cover, all native terrestrial vertebrate species, land stewardship, and management status, and to analyze this information to identify those biotic elements that are underrepresented on lands managed for their long term conservation.

<u>Ecosystem</u>	<u>Acres</u>	<u>% of Watershed</u>
Inter-Mountain Basins Semi-Desert Grassland	1,033,261	35
Inter-Mountain Basins Semi-Desert Shrub Steppe	616,817	21
Colorado Plateau Pinyon-Juniper Woodland	377,813	13
Inter-Mountain Basins Greasewood Flat	265,382	9
Colorado Plateau Mixed Bedrock Canyon and Tableland	192,546	7
Inter-Mountain Basins Mixed Salt Desert Scrub	155,478	5
Rocky Mountain Ponderosa Pine Woodland	86,317	3
Inter-Mountain Basins Big Sagebrush Shrubland	74,359	3
Inter-Mountain Basins Shale Badland	45,158	2
Agriculture	10,721	<1
Barren Lands, Non-specific	10,433	<1
Colorado Plateau Mixed Low Sagebrush Shrubland	10,086	<1
Rocky Mountain Aspen Forest and Woodland	6,538	<1
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	5,620	<1
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	5,612	<1

Table 4. SW Region Gap analysis ecosystem acreages.



Hydrology 6, 7, 8, 9, 10

The National Hydrography Dataset (NHD) is a comprehensive set of data that encodes information about naturally occurring and constructed bodies of water, paths through which water flows, and related entities. The NHD identifies 10,757 miles (17,311 km) of water courses in the Chaco River Watershed. The majority of these courses typically flow intermittently in summer months during periods associated with high intensity convective thunderstorms.

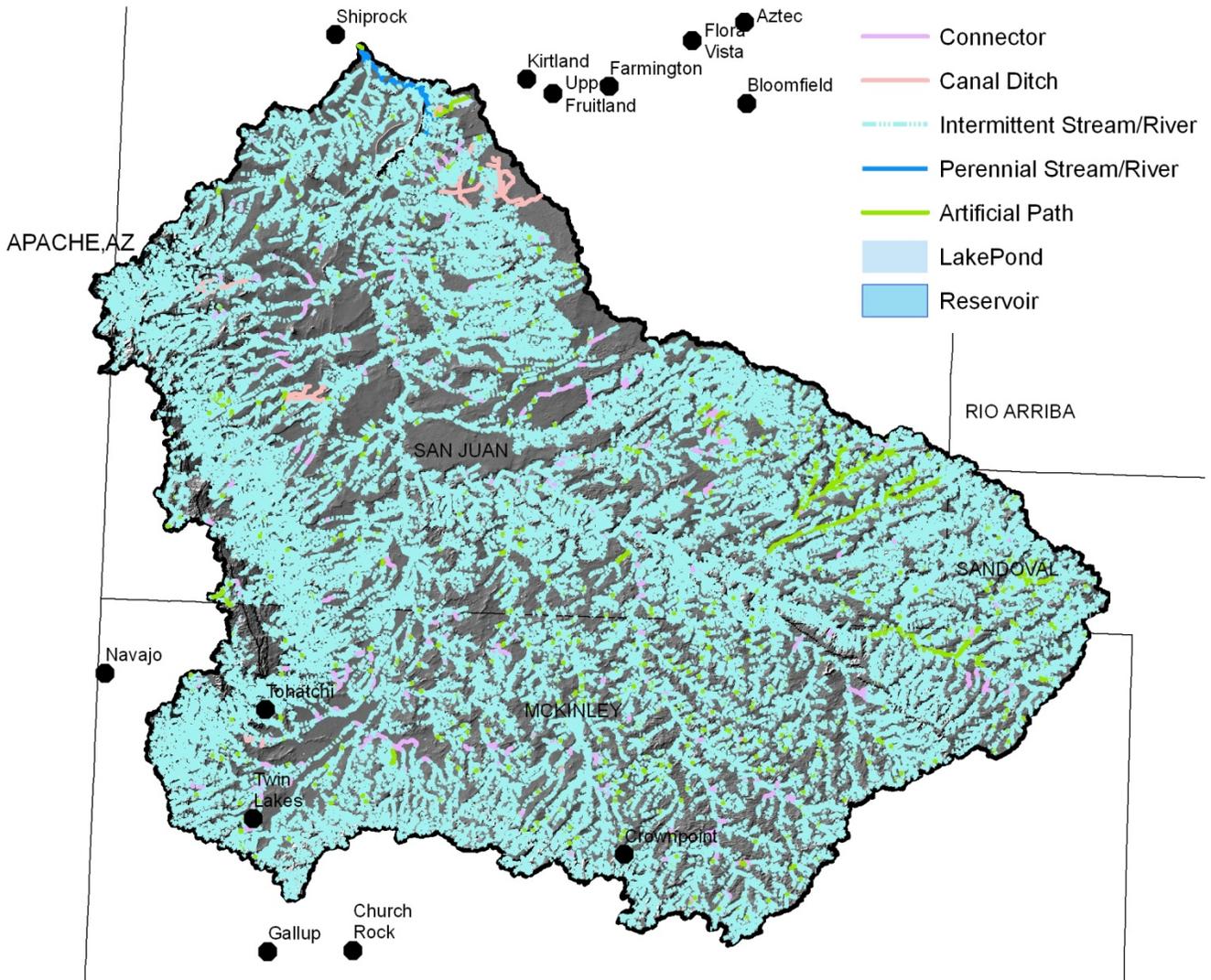


Figure 8. National Hydrologic Dataset (NHD) of the Chaco.



Water Course Type	Miles
Artificial path	159
Connector	50
Canal / Ditch	136
Intermittent Stream / River	10,392
Perennial Stream / River	19
Sum (Σ)	10,757

Table 5. NHD Water Course Type and Extents



There are 16 water gauging stations in the watershed. USGS Site 09367950 is near the north end of the watershed on the Chaco River near Waterflow, NM. During the period 1977 – 1994, this site has had mean annual discharge of 47.9 cubic feet per second ranging from 20.8 (1981) to 97.5(1988) cubic feet per second.

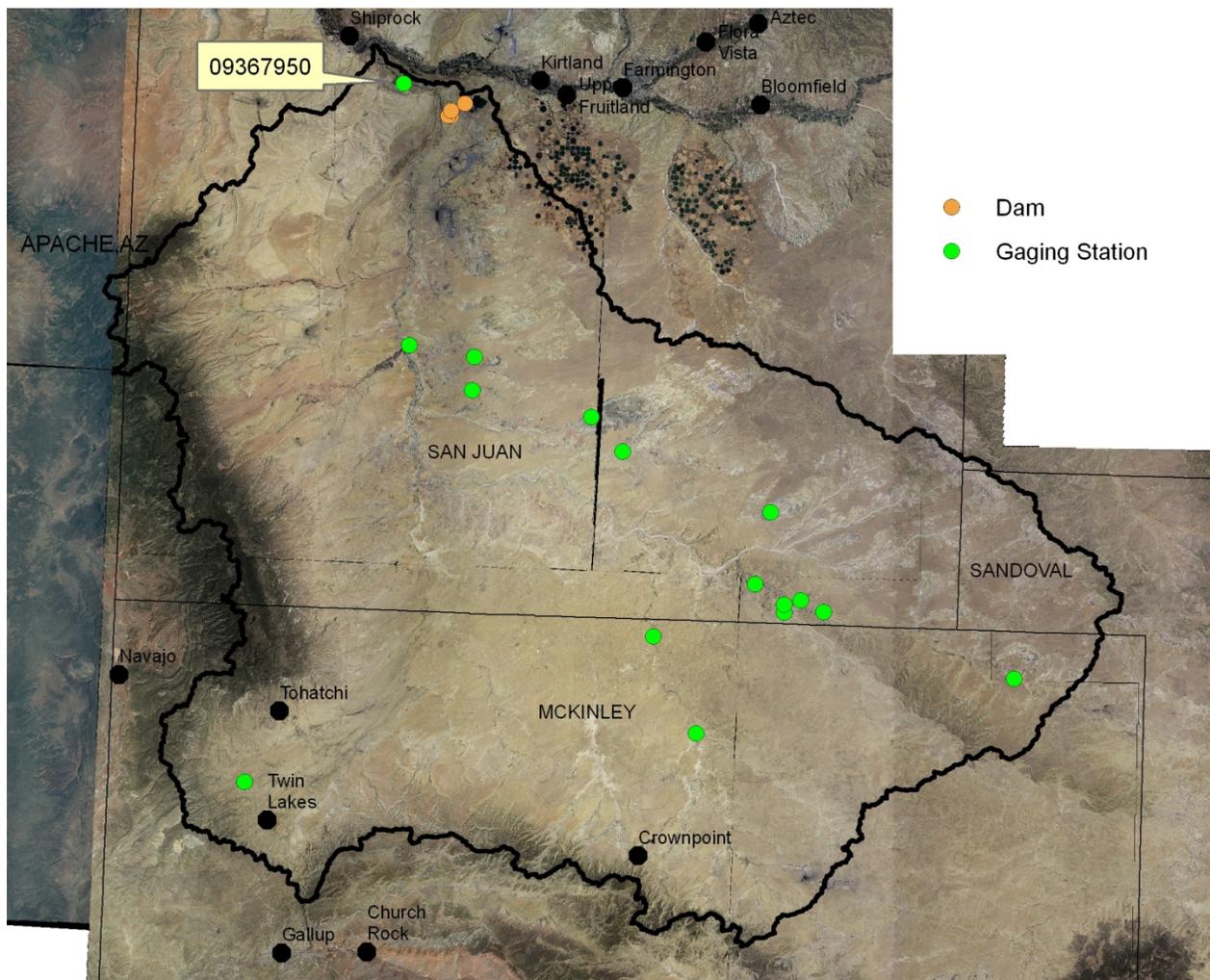


Figure 9. Gauging Stations in the Chaco Watershed



Hydrology

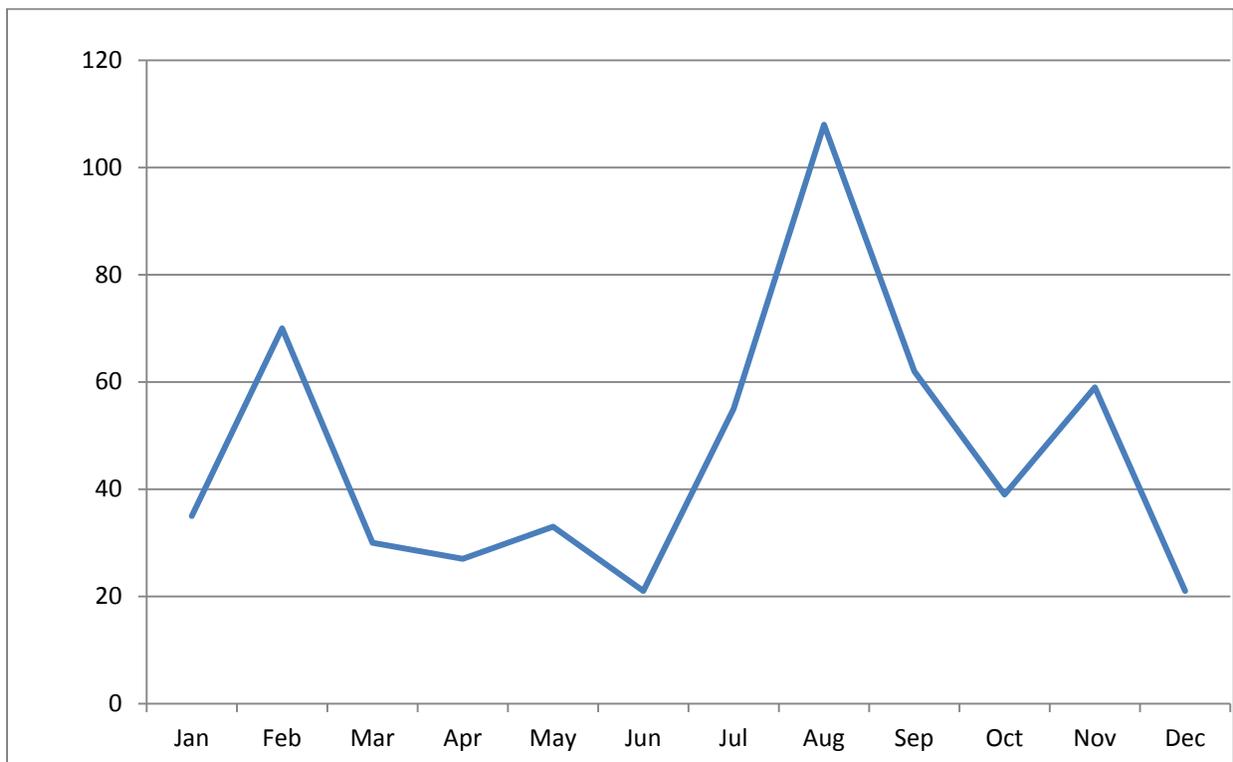


Figure 10. Monthly Average of Mean Daily Flow on the Chaco River near Waterflow, NM. Period of observation: 1975-1994.



Hydrology

The New Mexico Water Quality Control Commission (NMWQCC) is the issuing agency of water quality standards for interstate and intrastate waters in New Mexico. The NMWQCC has defined the Chaco watershed as part of the San Juan River Basin.

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes, are required to develop lists of impaired waters. These are waters for which technology-based regulations and other required controls are not stringent enough to meet the water quality standards set by states. The law requires that states establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDLs), for these waters. A TMDL is a calculation of the maximum amount of a pollutant a water body can receive and still safely meet water quality standards.

The Chaco watershed has no reaches listed as 303 (d) Impaired Surface Waters.



Hydrology

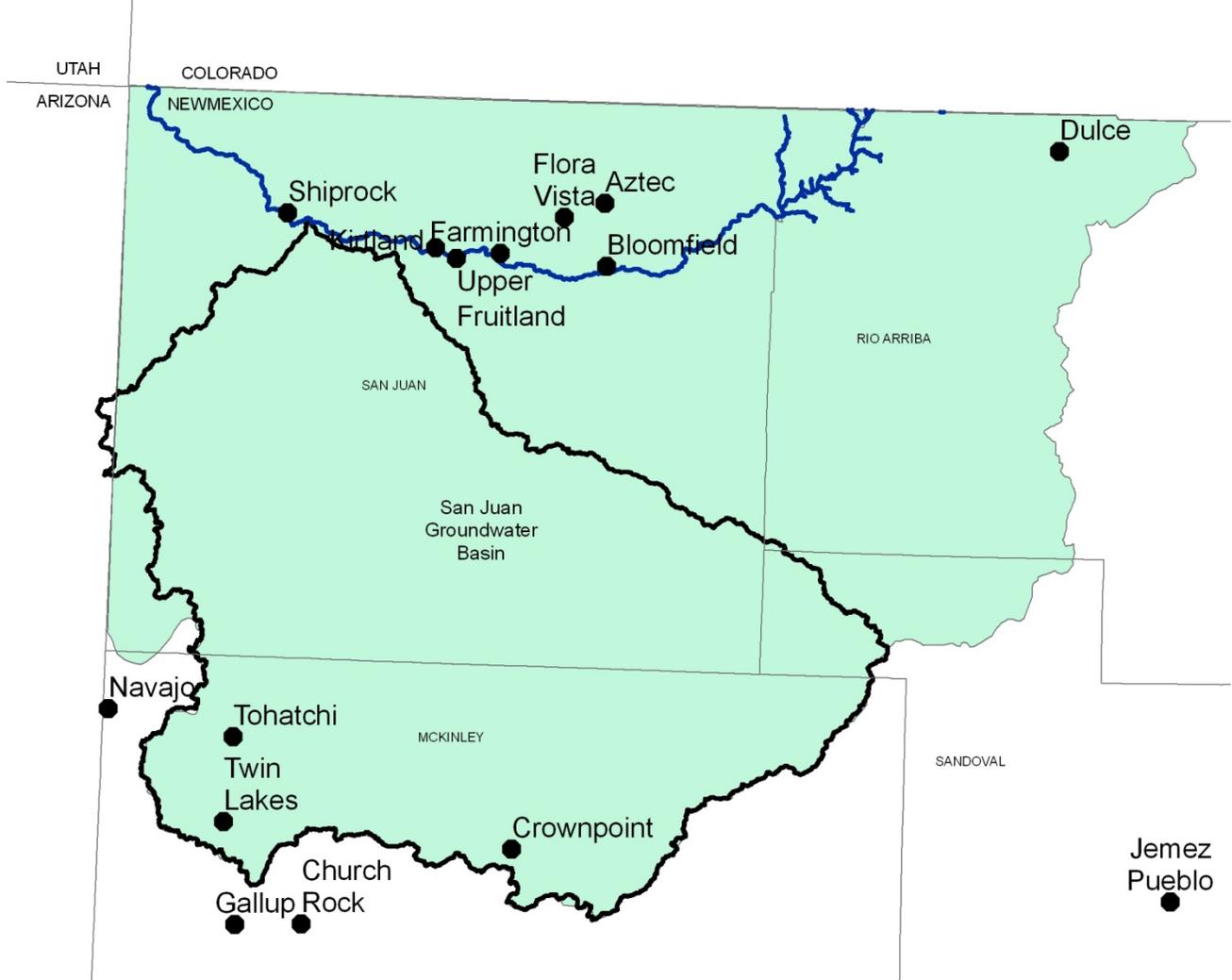
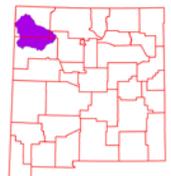


Figure 11. Declared Groundwater Basins of the Chaco.

A declared groundwater basin is an area of the state proclaimed by the State Engineer to be underlain by a groundwater source having reasonably ascertainable boundaries. By such proclamation the State Engineer assumes jurisdiction over the appropriation and use of groundwater from the source. The New Mexico portion of the Chaco watershed is completely within the San Juan Underground Water Basin.



Threatened and Endangered Species ¹¹

Endangered species are those that are at risk of extinction throughout all or a significant portion of its native range. A threatened species is one that is likely to become endangered in the foreseeable future. The New Mexico Natural Heritage program tracks the status of threatened and endangered species which are listed on both federal and state lists. Table 7 lists those species which are currently listed and tracked in the Chaco River Watershed.

<u>Common Name</u>	<u>Scientific Name</u>	<u>Tax.Class</u>	<u>Family</u>	<u>Fed Status</u>	<u>State Status</u>
<u>Brown Pelican</u>	<u><i>Pelecanus occidentalis</i></u>	Aves	Pelecanidae		E
<u>Gray Vireo</u>	<u><i>Vireo vicinior</i></u>	Aves	Vireonidae		T
<u>Rhizome Fleabane</u>	<u><i>Erigeron rhizomatus</i></u>	Dicotyledoneae	Asteraceae	LT	E
<u>Mesa Verde Cactus</u>	<u><i>Sclerocactus mesae-verdae</i></u>	Dicotyledoneae	Cactaceae	LT	E
<u>Mancos Milk-vetch</u>	<u><i>Astragalus humillimus</i></u>	Dicotyledoneae	Fabaceae	LE	E

Table 6. Threatened and Endangered Plant and Animal Species.

Invasive Species ¹²

Invasive species are those which have been introduced into a region or ecosystem and have the ability to out-compete native species for resources (i.e. water, nutrients, sunlight, etc.) The Southwest Exotic Plant Mapping Program (SWEMP) is a collaborative effort between the United States Geological Survey and federal, tribal, state, county and non-government organization partners in the southwest which maintains ongoing efforts to compile and distribute regional data on the occurrence of non-native invasive plants in the southwestern United States. Within the Chaco watershed, the SWEMP has identified 7 species of invasive plants (Table 8). Each of these species is defined as non-native by the USDA PLANTS database.

<u>Scientific Name</u>	<u>Common Name</u>
<i>Zygophyllaceae</i> (Caltrop Family)	African Rue
<i>Brassicaceae</i> (Mustard Family)	Hoary Cress (Whitetop)
<i>Euphorbiaceae</i> (Spurge Family)	Leafy Spurge
<i>Asteraceae</i> (Sunflower Family)	Musk Thistle
<i>Asteraceae</i> (Sunflower Family)	Russian Knapweed
<i>Asteraceae</i> (Sunflower Family)	Spotted Knapweed
<i>Asteraceae</i> (Sunflower Family)	Yellow Starthistle

Table 7. Invasive Species Recognized by the SWEMP.



Common Resource Areas¹³

A Common Resource Area (CRA) is defined as a geographical area where resource concerns, problems, or treatment needs are similar. It is considered a subdivision of an existing Major Land Resource Area (MLRA) designation. Landscape conditions, soil, climate, human considerations, and other natural resource information are used to determine the geographic boundaries of a Common Resource Area.

Each Common Resource Area will have multiple Conservation System Guides associated with it. A Conservation System Guide associates, for a given CRA and land use, different components of Resource Management Systems and their individual effect on conserving soil and water resources.

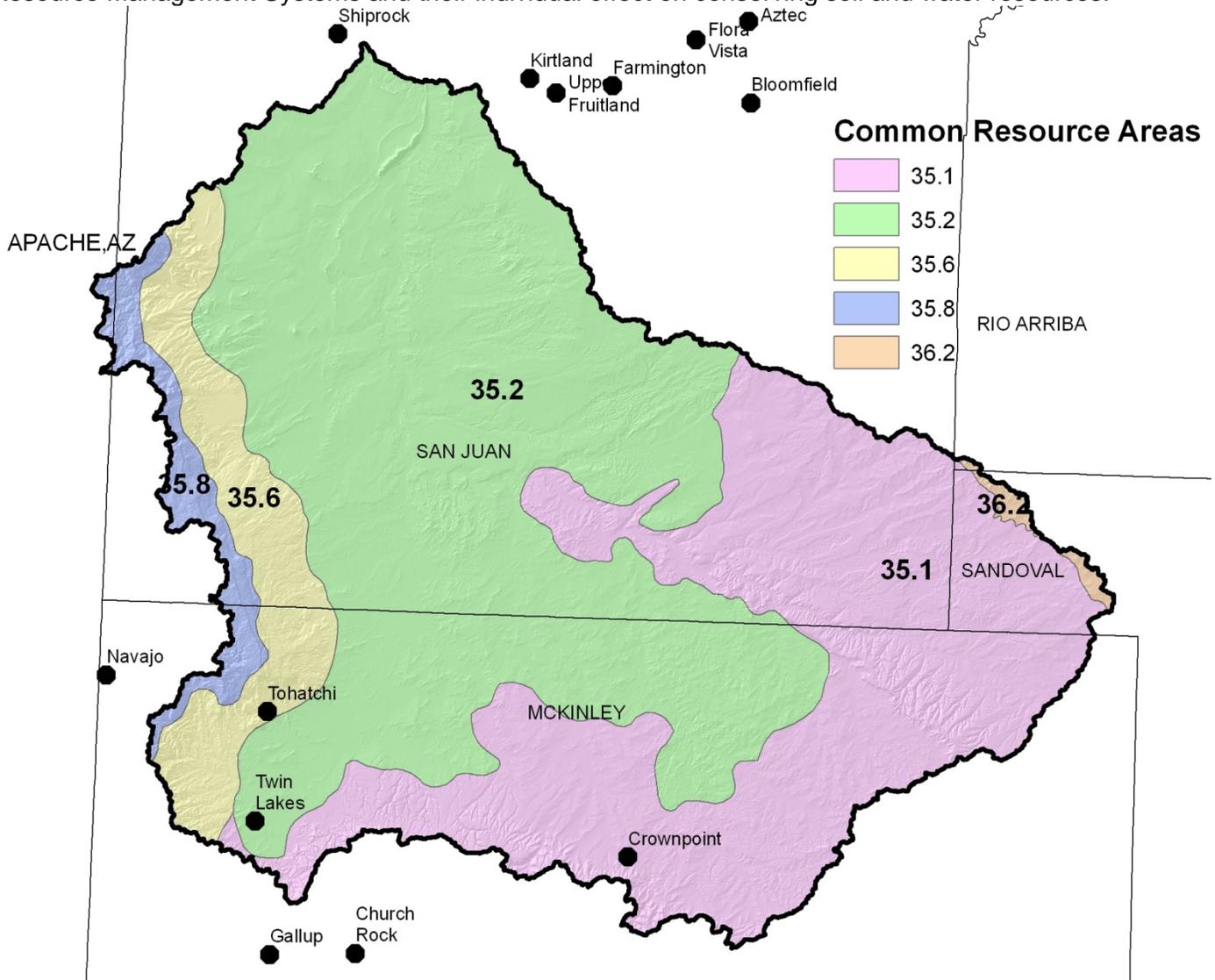


Figure 12. Common Resource Areas of the Chaco..



Common Resource Areas

35.1 - Colorado Plateau Mixed Grass Plains

This unit occurs within the Colorado Plateau Physiographic Province and is characterized by flat to gently dipping sedimentary rocks eroded into plateaus, valleys and deep canyons. Volcanic fields occur in places. Elevations range from 5100 to 6000 feet. Precipitation averages 10 to 14 inches per year. The soil temperature regime is mesic. The soil moisture regime is ustic aridic. Vegetation includes Stipa, Indian ricegrass, galleta, blue grama, fourwing saltbush, and scattered juniper.

35.2 - Colorado Plateau Shrub – Grasslands

This unit occurs within the Colorado Plateau Physiographic Province and is characterized by gently dipping sedimentary rocks eroded into plateaus, valleys and deep canyons. Volcanic fields occur in places. Elevations range from 3500 to 5500 feet. Precipitation averages 6 to 10 inches per year. The soil temperature regime is mesic and the soil moisture regime is typic aridic. Vegetation includes shadscale, fourwing saltbush, mormon tea, Indian ricegrass, galleta, and blue and black grama.

35.6 - Colorado Plateau Pinyon-Juniper-Sagebrush

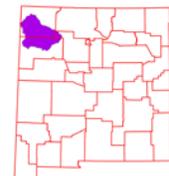
This unit occurs within the Colorado Plateau Physiographic Province and is characterized by gently dipping sedimentary rocks eroded into plateaus, valleys and deep canyons. Volcanic fields occur in places. Elevations range from 5500 to 7000 feet. Precipitation averages 13 to 17 inches per year. The soil temperature regime is mesic. The soil moisture regime is aridic ustic. Vegetation includes pinyon, juniper, big sagebrush, muttongrass, prairie junegrass, western wheatgrass, and blue grama.

35.8 - Colorado Plateau Ponderosa Pine Forests

This unit occurs within the Colorado Plateau Physiographic Province and is characterized by gently dipping sedimentary rocks eroded into plateaus, valleys and deep canyons. Volcanic fields occur in places. Elevations range from 6800 to 8500 feet. Precipitation averages 17 to 25 inches per year. The soil temperature regime ranges from mesic to frigid. The soil moisture regime is typic ustic. Vegetation includes ponderosa pine, white fir, aspen, pinyon, juniper, Gambel oak, and big sagebrush.

36.2 – Southwest Plateaus, Mesas, and Foothills – Warm Semiarid Mesas and Plateaus

This area encompasses the lower elevation mesas and plateaus. The temperature regime is mesic and the moisture regime is transitional from ustic to aridic. Vegetation is typically twoneedle pinyon, Utah juniper, and big sagebrush. Cropland is a significant land use in parts of this area, particularly on soils formed in thick deposits of eolian material. Precipitation ranges from 10 to about 16 inches. Elevations range from about 6,000 to 7,000 feet.



Conservation ¹⁴

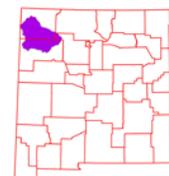
The USDA-Natural Resources Conservation Service (NRCS) focuses on the development and delivery of high quality products and services that enable people to be good stewards of our Nation's soil, water, and related natural related resources on non-Federal lands. The Natural Resources Conservation Service's conservation programs aid agricultural producers in their efforts to reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Public benefits include enhanced natural resources that help sustain agricultural productivity and environmental quality while supporting continued economic development, recreation, and scenic beauty. These figures cover only New Mexico, not Arizona.

Conservation Practice	2007		2008		2009		2010		2011		TOTAL	
	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres
Access Control	9	388									9	388
Brush Management	7	1317			2	297					9	1614
Forage and Biomass Planting	9	388									9	388
Integrated Pest Management					2	214					2	214
Irrigation System, Sprinkler			8	8							8	8
Irrigation Water Management	17	2050									17	2050
Prescribed Grazing	3	5256	10	24093	3	6469	9	17234	4	8076	29	61128
Upland Wildlife Habitat Management			3	5297	1	2061	3	3619			7	10977
SUM (Σ)	45	9399	21	29398	8	9041	12	20853	4	8076	90	76767

Table 8. 5 year Trends in Applied Conservation Practices. Reported in Acres.

Conservation Practice	2007		2008		2009		2010		2011		TOTAL	
	#	Feet	#	Feet	#	Feet	#	Feet	#	Feet	#	Feet
Fence	1	5397	7	61339	2	15776	6	45841	15	71520	31	199873
Pipeline							2	14336	2	8718	4	23054
Pond									2		2	
Pumping Plant							1		2		3	
Water Well			1						2		3	
Watering Facility							5		4		9	
SUM (Σ)	1		8		2		14		27		52	

Table 9. 5 Year Trends in Location Specific Applied Conservation Practices. Reported in Feet if Linear (i.e. Fence).



Soil Resource Inventory ¹⁵

The Chaco Watershed has a number of certified National Cooperative Soil Survey (NCSS) inventories. Soils data is available from the NRCS Soil Data Mart at <http://soildatamart.nrcs.usda.gov/> and/or the NRCS Geospatial Data Gateway at <http://datagateway.nrcs.usda.gov/>.

National Cooperative Soil Survey

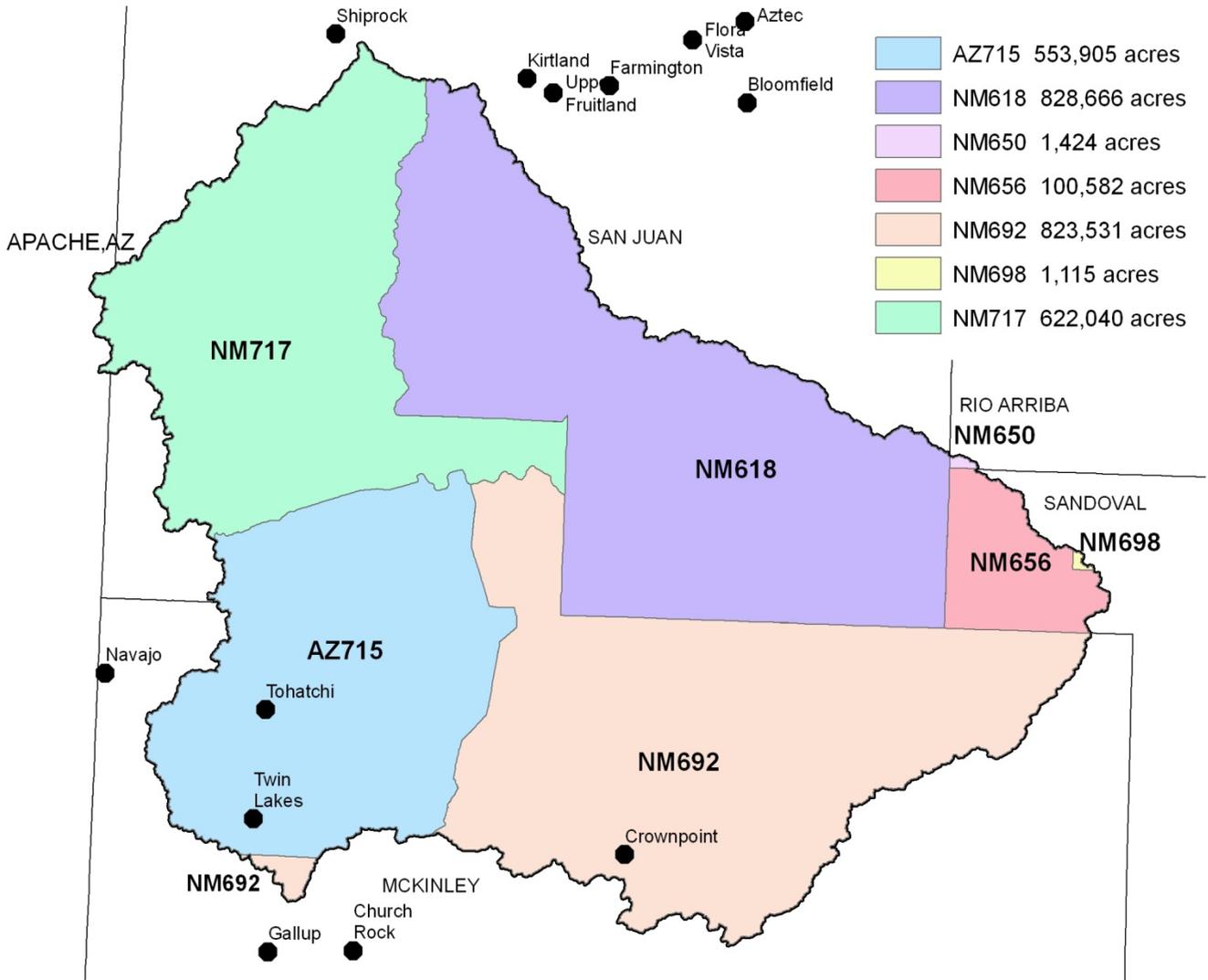


Figure 13. National Cooperative Soil Survey coverage of the Chaco Watershed.

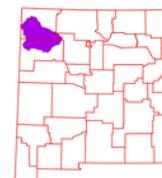


Soil Resource Inventory

In order to evaluate the susceptibility of erosion within the Chaco watershed, a model was developed using Soil Survey Geographic Database (SSURGO) information. The soil properties saturated hydraulic conductivity, soil loss tolerance, and wind erodibility group were used in conjunction with slope to assess soil mapunit potential for erosion. Saturated hydraulic conductivity and slope are reported in SSURGO databases as interval/ratio data whereas wind erodibility and soil loss tolerance are ordinal data. Data transformations for the model are listed -

<u>SSURGO Value</u>	<u>Nominal Description</u>	<u>Model Rank</u>
Saturated Hydraulic Conductivity		
µm / s		
705.0 - 100.0	Very High	0
100.0 - 10.0	High	1
10.0 - 1.0	Moderately High	2
1.0 - 0.1	Moderately Low	3
0.1 - 0.01	Low	4
Slope %		
0 - 5		0
6 - 10		1
11 - 15		2
16 - 25		3
> 25		4
Soil Loss Tolerance		
5	High Tolerance For loss	0
4	↓	1
3	↓	2
2	↓	3
1	Low Tolerance For Loss	4
Wind Erodibility Group		
1	Very High	4
2	Very High	4
3	High	3
4	High	3
4L	High	3
5	Moderate	2
6	Moderate	2
7	Moderate	1
8	Slight	0

Table 10. Criteria Used for Soil Erosion Susceptibility Model.



Soil Resource Inventory

For each soil map unit (discrete delineation), the soil properties (named above) of the dominant soil type was used as the condition to be evaluated in the susceptibility to erosion model. Miscellaneous areas such as gravel pits, water, riverwash, etc. were excluded from evaluation. Possible range of values for each map unit are 0 – 16. Increasing values represent a higher susceptibility to soil erosion.

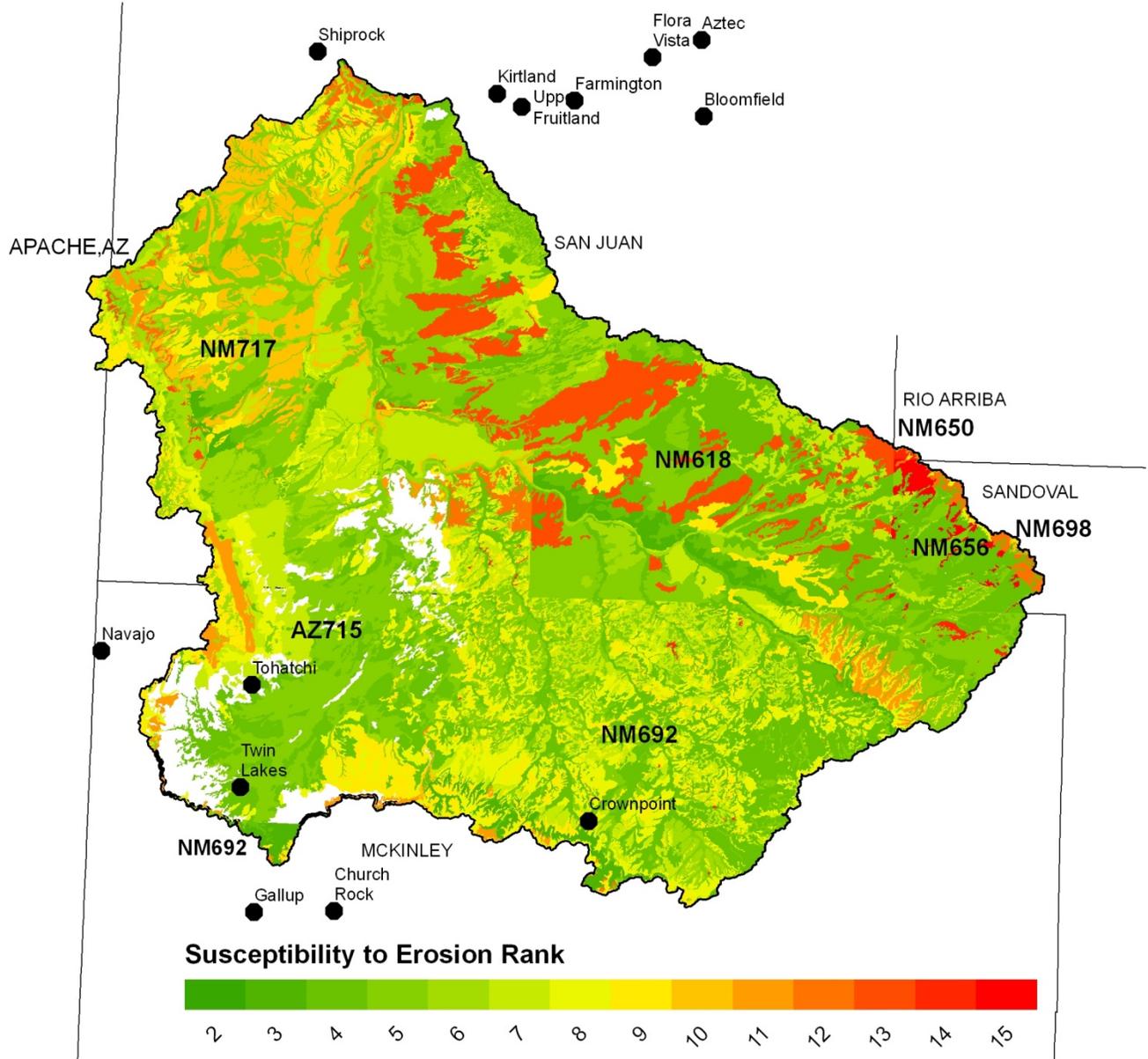


Figure 14. Chaco Watershed Erosion Potential.



Soil Resource Inventory

Rank	Acres
2	286
3	70,189
4	648,996
5	699,662
6	202,222
7	356,325
8	218,623
9	223,578
10	125,360
11	45,944
12	38,473
13	176,334
14	4,837
15	11,500
Sum(Σ)	2,822,330

Table 11. Soil Erosion Potential Model Results. A greater rank indicates greater potential for erosion.



Socioeconomic Data ¹⁶

COUNTY	Total population: Total	Total population: Hispanic or Latino	Total population: White alone	Total population: Black or African American alone	Total population: American Indian and Alaska Native alone	Total population: Asian alone	Total population: Native Hawaiian and Other Pacific Islander alone	Total population: Some other race alone	Total population: Two or more races	Families: Median family income 2010
Apache (AZ)	71,518	4,113	16,634	175	52,154	203	26	904	1,422	N/A
McKinley (NM)	71,492	9,473	10,834	360	53,988	568	23	3,522	2,197	\$29,369
Rio Arriba (NM)	40,246	28,703	38,900	204	6,447	170	13	11,288	1,346	N/A
Sandoval (NM)	131,561	46,129	89,482	2,800	16,945	1,922	169	15,139	5,104	\$51,959
San Juan (NM)	130,044	24,776	67,048	756	47,640	484	74	9,501	4,541	\$52,039

Table 12. Socioeconomic Data of the Counties in the Watershed (2010).



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