Riparian/Wetland Vegetation Communities of the Rio Grande: A Classification and Site Evaluation

Final Report

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INTRODUCTION

In New Mexico, as well as in the rest of the country, wetlands and riparian areas along our streams and rivers are very important biological and economic resources. These areas support highly productive ecosystems and a wide variety of plants and animals. The ecosystems are in turn very important for maintaining water quality and quantity, stabilizing streambanks, providing flood protection, as well as enhancing habitat for fish and wildlife (EPA 1988). Additionally, these communities can diminish the magnitude of peak flood flows and increase groundwater recharge within a watershed, thereby having a greater impact on the health of the watershed than their acreage alone might suggest (Elmore and Beschta 1987).

New Mexico riparian/wetland communities are considered highly threatened. Along the Rio Grande, the geographic extent of native riparian/wetland ecosystems, much like other large floodplain rivers in the Southwest, has been dramatically reduced (Fenner, Brady and Patton 1985, Crawford et al. 1993). The rapid decline of these critical ecosystems is due primarily to human impact resulting from agricultural conversion and urbanization of the floodplain, and the development of water storage, diversion and delivery projects. Much of our river system has been modified hydrologically resulting in major changes in ecosystem function and composition, which have been further intensified by the introduction of exotics such as saltcedar, Russian olive and Siberian elm (Campbell and Dick-Peddie 1964, Hink and Ohmart 1984, Brady, Patton and Paxson 1985, Siegel and Brock 1990, Sivinski, Fitch and Cully 1990, Howe and Knopf 1991, Crawford et al. 1993).

In response to this decline in resource value and other state needs, the New Mexico Environment Department (NMED) in cooperation with the Environmental Protection Agency (EPA), has initiated the development of a Wetlands Protection Plan for the state following the guidelines of the National Wetlands Policy Forum. The primary goals of this plan are inventory and assessment of wetland resources, the identification of wetlands protection mechanisms and the development of strategies for implementation of the plan.

To meet the first goal of the planning effort - inventory and assessment - the New Mexico Natural Heritage Program (NMNHP) at the University of New Mexico has joined with NMED and EPA in a cooperative venture to describe and classify riparian vegetation communities of the state, and to initially identify high quality wetland/riparian sites that are fully functional or restorable. In 1993, the venture focused on the Pecos River basin in New Mexico (Durkin et al. 1994). This report expands that work to include the Rio Grande basin from the Colorado border to Elephant Butte Reservoir (future work will include the Gila, San Juan and Canadian River basins).

The first task toward meeting this goal is the development of a comprehensive riparian/wetlands vegetation classification that will allow us to identify specific types of wetland/riparian communities and evaluate their condition. This includes determining species composition of the communities and then relating composition, where possible, to the hydrological regime and soil conditions. In conjunction with biotic/environmental relationships, the dynamics and response of the communities to various disturbances and management practices is also evaluated. The classification will build on previous work, but also expand it with an extensive, detailed sampling effort. Such knowledge of the composition and function of these communities is essential for the identification of high quality sites that merit protection, and in the long-term management and/or restoration of these ecosystems.

The second task is to initially identify significant sites that currently support wetland/riparian communities that are high in quality or restorable to high quality. This task follows directly from the development of the classification system. In building the classification we evaluate a wide spectrum of potential sites for quantitative sampling using aerial photography, air and ground reconnaissance and map references in the literature. From this, potential high quality sites are targeted for sampling (along with low quality ones). In the process of sampling and analysis we are able to assess the quality of the sites and rank them among our sample. This leads to an initial, although not exhaustive, inventory of potentially high quality sites that can provide the foundation for the planning effort.

Below we review the status of knowledge on riparian ecosystems in the Rio Grande watershed with an emphasis on the historical development of the Rio Grande Bosque. We then present a preliminary hierarchical classification system for riparian/wetland community types of the Rio Grande watershed that includes community descriptions and a dichotomous key for identifying communities on the ground. The descriptions characterize the soils, the position of the community within the floodplain, as well as hydrological and stream characteristics, distribution, and additional comments regarding successional trends, adjacent communities and management implications. Finally, we present a preliminary assessment of riparian sites in the Rio Grande watershed with detailed site descriptions of the top eighteen high quality sites.

Riparian/Wetland Ecosystems

The riparian ecosystem encompasses the river and the adjacent floodplain, linking the aquatic ecosystem to the terrestrial ecosystem (Gregory et al. 1991, Crawford et al. 1993). The riparian zone is a flood-driven environment where water is the lifeblood of the ecosystem. Riparian ecosystem composition and structure is dependent on both surface and subsurface streamflows that play an integral role in the dynamics of seed dispersal, plant establishment, species replacement patterns, maintenance of species and "patch" diversity, as well as nutrient cycling and productivity (Leonard et al. 1992, Stromberg et al. 1993). The expression and spatial patterns of riparian vegetation and species distribution is a result of the dynamics and configuration of channels, flooding, geomorphology, soil moisture, and human impact (Hupp and Osterkamp 1985, Hupp 1992, Malanson 1993). They are naturally resilient to flood flows (Stromberg et al. 1993), and they require appropriate seasonal flows of water for plant recruitment, growth and development, maintenance, and restoration (Siegel and Brock 1990, Leonard et al. 1992, Brady, Patton and Paxson 1985, Asplund and Gooch 1988, Muldavin, Wallace and Mehlhop 1993, Stromberg et al. 1993, Crawford et al. 1993, Durkin et al. 1994 and 1995).

In the Southwest, riparian forests and shrublands are considered wetlands along with the inundated marshes that we typically think of as wetlands (Johnson and Lowe 1985, Lowe, Johnson and Bennett 1986). Following Cowardin et al. (1979) and the National Wetlands Inventory (1984) our riparian areas would be classified into forested, shrub or herbaceous-emergent wetlands. The riparian/wetland vegetation communities are uniquely distinct from those found in the adjacent uplands. While the uplands commonly support desert, grassland or woodland vegetation, the riparian zone communities are reminiscent of the winter-deciduous hardwood bottomland and upland forests of the eastern United States (Johnson and Lowe 1985). But unlike their eastern counterparts, the riparian vegetation of the West occurs as narrow, linear strips of vegetation along ephemeral, intermittent, or perennial streams and large floodplain rivers, such as the Rio Grande in New Mexico.

Although the riparian zones occupy only a small portion of a watershed, they are an extremely important ecological component of the landscape (Elmore and Beschta 1987). In the arid and semiarid landscape such that occurs in New Mexico, riparian vegetation on a whole occupies less than one percent of the landscape (Knopf et al. 1988). Yet, in comparison to the surrounding uplands, the greatest diversity of vegetation communities, birds, fish, and terrestrial vertebrates occurs in the riparian zone (Hink and Ohmart 1984, Siegel and Brock 1990, Howe and Knopf 1991, Durkin et al. 1995).

Rio Grande Study Area

Watersheds Studied

The Rio Grande is the fifth largest watershed in North America (Hammond 1993) flowing nearly 2000 miles from its headwaters in the San Juan Mountains of southern Colorado through central New Mexico, then along the international border between the United States (Texas) and the Republic of Mexico, and continuing ultimately to the Gulf of Mexico near Brownsville, Texas (Crawford et al. 1993).

This study centers on what are known in New Mexico as the "upper"and "middle" Rio Grande watersheds (Figure 1). These correspond to 130201 and 130202 hydrologic units of the Hydrologic Unit Map for New Mexico (USGS 1974). Roughly, the upper Rio Grande stretches from the Colorado border to near the upstream end of the gorge of White Rock Canyon (the confluence with Guaje Canyon on San Ildefonso Pueblo south of Espanola). It includes the major tributary watershed of the Chama River, along with several smaller ones such as the Red, Embudo and Nambe. The middle Rio Grande stretches from White Rock Canyon and Cochiti Dam south to Elephant Butte Reservoir. Major tributaries in the middle Rio Grande are the Rio Puerco (including

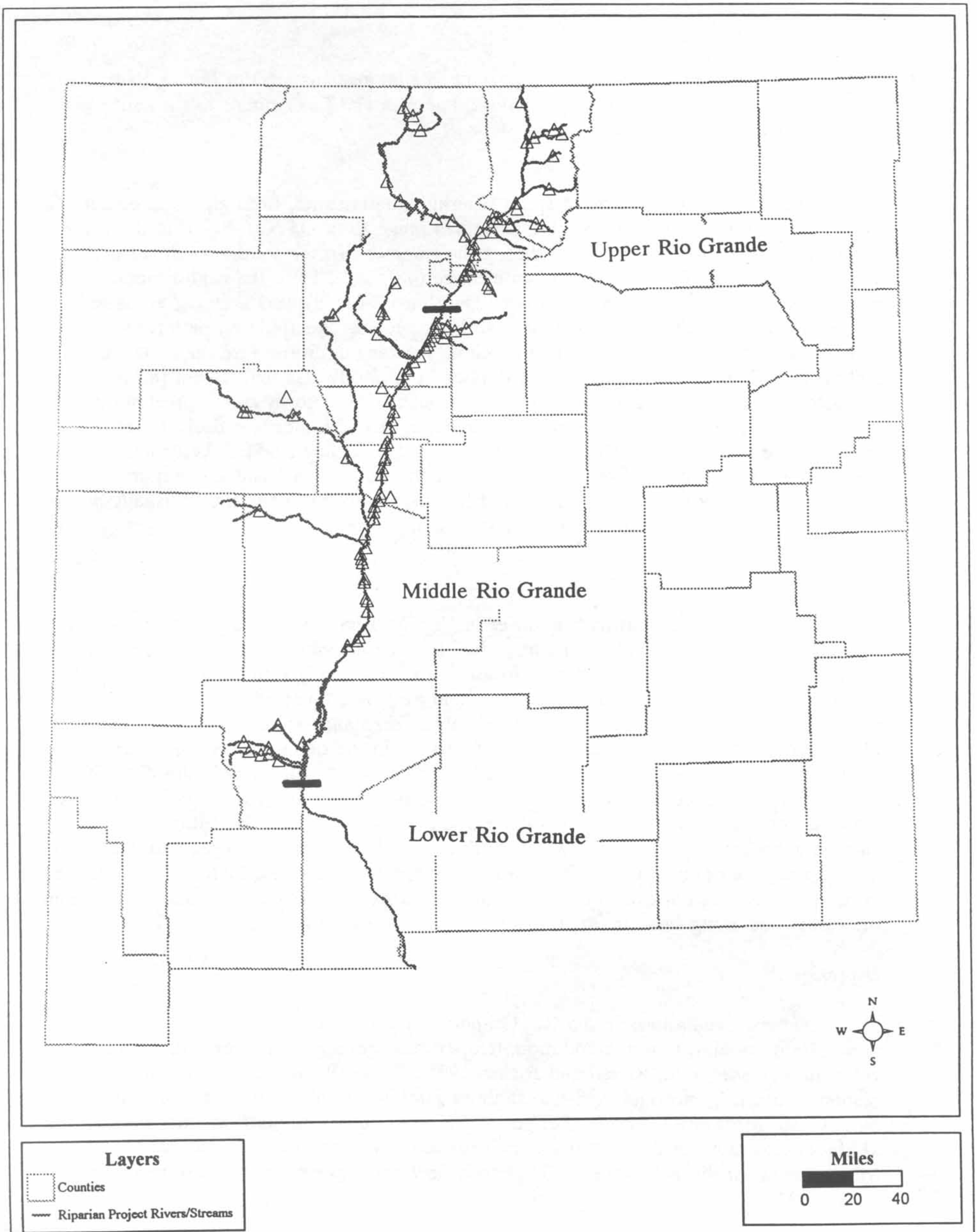


Figure 1. Distribution of riparian/wetland sites assessed in the Rio Grande watershed, New Mexico.

the San Jose) and the Rio Salado. Important smaller streams are the Jemez, Santa Fe and Galisteo to the north, and the Alamosa, Palomas and Las Animas to the south.

Climate

The Rio Grande watershed spans several climatic zones, from alpine to desert. In the northern mountainous regions temperatures range from -34 ^{0}C (-30 ^{0})F in the winter months, to more than 32 ^{0}C (90 ^{0}F) during the summer. In the southern part of the study area, temperatures range from an average of 0 ^{0}C (32^{0}F) in the winter months to more than 37 ^{0}C (100 ^{0}F) in the summer. Over most of study area a frost-free period of 120 days from June through September can be expected. Precipitation patterns vary widely, with extremes in mean annual precipitation ranging from more than 130 cm (50 inches) at high elevations in the headwaters of Colorado to less than 10 cm (8 inches) south of Albuquerque to Elephant Butte Reservoir. The majority of the precipitation, 70-80%, falls in summer as "monsoonal" thunderstorms with moisture derived from the Gulf of Mexico or California (Anderholm, Radell and Richey 1995). The winter precipitation comes in the form of snow and frontal rainstorms. The summer storms can contribute significantly to late summer and fall discharges, but peak runoff usually occurs in late spring (May-June) in response to snowmelt.

Geology

The Rio Grande and its tributaries in New Mexico traverse varying terrains and two major structural alluvial and bedrock basins. The alluvial basin comprises much of the middle Rio Grande area, which is located in a tectonically active region referred to as the Rio Grande Rift, delineated by high heat flow, late Quaternary faults, late Pliocene and younger volcanoes and deep basins. Highlands are composed of rocks older than middle Tertiary and erosion has resulted in the deposition of thick (several thousand feet) middle Tertiary or younger basinfill deposits. Bedrock basins contain many layers of sedimentary rock, ranging from Mississippian to Quaternary in age. The material composing the bedrock was deposited in a wide range of depositional environments ranging from deep water marine to arid continental; consequently, there is a large range of permeability. The Chama drainage forms a major bedrock basin in the upper Rio Grande; however, there are smaller localized bedrock basins found throughout the study area along smaller tributaries (Anderholm, Radell and Richey 1995).

Hydrology

Natural streamflows in the Rio Grande vary throughout the watershed in response to variability in elevation, precipitation, temperature, geology, soils, topography and vegetation (Anderholm, Radell and Richey 1995). Typically, discharges rise and fall in response to spring snowmelt and late summer rainfalls. Some streams are intermittent, particularly at lower elevations. Perennial (i.e., continuous) streamflows are more typical at higher elevations in the mountains, and surface flows commonly are absent before the tributaries reach the Rio Grande. They then flow only ephemerally in response to high intensity rainstorms and runoff. Many streams are also intermittent because they are affected by irrigation diversions and impoundments.

Much of the streamflow of the Rio Grande and its major tributaries is artificially regulated. Regulated streamflow on the Rio Grande begins near the headwaters at the Rio Grande Reservoir in southern Colorado, but is not considered to have a very significant impact on flows in New Mexico. Roughly 50 miles of the main stem from the Colorado/New Mexico border through the Rio Grande Gorge is still considered free flowing and is protected by the Wild and Scenic Rivers Act of 1968 (Bullard and Wells 1992). South of the Gorge, the Rio Grande opens into a wide floodplain at Velarde and down through Española to where it narrows again at White Water Canyon [Gorge] leading to Cochiti Lake. Significant irrigation diversions occur and channel controls and modifications have been implemented for flood and erosion control, and water delivery.

In the upper Rio Grande, several tributary watersheds have also been altered. The Rio Chama, a large tributary draining the northwestern portion of the watershed contains three major water impoundments (Abiquiu, Heron and El Vado) and receives water from the San Juan River as well, via transmountain tunnels. Other smaller tributaries, for example Embudo Creek, are contained by small levees bordering the channel, and have water diverted into small irrigation systems (acequias).

The main stem of the Rio Grande through the middle watershed from Cochiti to Elephant Butte Dams (roughly 150 miles), is intensely managed and altered hydrologically. Nearly every major tributary, with the exception of the Rio Puerco and Rio Salado, contains a reservoir or diversion dam for flood and sediment control, or irrigation. Flows are regulated at Cochiti Dam to meet irrigation and water delivery demands. The channel is periodically dredged and straightened, and banks are rip-rapped to prevent erosion. Additionally, river bars are mowed of their vegetation to maximize water delivery along a 600-foot-wide corridor. Flows are additionally controlled within a network of flood-control fencing (jetty jacks), levees, and ditches that drain an area of nearly a quarter million square miles. Yet, despite these major alterations or rectifications, the Rio Grande still overflows its banks within the levees in certain localities (Crawford et al. 1993) and supports one of the most extensive and continuous riparian forests or "bosques" in the Southwest (Hink and Ohmart 1984).

Historical Development of Rio Grande Vegetation in New Mexico

Historically, the Rio Grande basin in New Mexico has a lengthy cultural heritage with longstanding agricultural traditions, and a water development legacy that is perhaps the oldest in the United States (Bullard and Wells 1992). Referring to Table 1, fossil records indicate that the modern day riparian vegetation that we know today, which is dominated by a cottonwood (*Populus deltoides* ssp. *wilizenii*) bosque, may have developed about two million years ago during the colder climate of the early Pleistocene (Crawford et al. 1993). The flora at that time may have been similar to what is familiar to us now as montane vegetation of higher elevations consisting of birch, *Betula* spp.; alder, *Alnus*

Table 1. Historical development of the Rio Grande bosque; data was compiled from Abert 1848, Emory 1848, Carroll and Haggard 1849, Fergusson 1933, Van Cleave 1935, Forsling 1950, Bolton 1964, Campbell and Dick-Peddie 1964, Hink and Ohmart 1984, Scurlock 1988, Crawford et al. 1993, and Anderholm, Radell and Richey 1995.

early Pleistocene (ca. 2 million y.a.)	Development of the modern day cottonwood bosque; dominant plants may have been cottonwood (*Populus* spp.), alder (*Alnus* app.), birch (*Betula* spp.), chokecherry (*Prunus* spp.)
ca. 20,000 y.a.	Arrival of nomadic Paleo-Indians to the Rio Grande valley
ca. 1,500-2,000 y.a.	Arrival of prehistoric Pueblo Indians to the Rio Grande valley
first Spanish explorers (ca. 1540)	Don Francisco Vásquez de Coronado; noted that 12 pueblos were scattered throughout the Rio Bravo del Norte in a valley "planted with maize and dotted with cottonwood groves"
ca. 1598	Spanish colonization of the valley and integration with the Pueblo Indians
Pedro Bautista Piño (1812)	explorer; commented; "this imposing Nile... heart of the territory" with "the richest settlements located on its banks" has "a variety of luxurient groves embellishing it"
Josiah Gregg (1839)	One of the first Anglo-Americans; explorer/trader; noted that the timber along the Rio del Norte was nearly bare due to the settlements along the river
Frederick A. Wislizenus (1846)	German physician/naturalist; noted that grasslands were nearly decimated by sheep; cottonwoods were few in Albuquerque, but were extensive below Isleta Pueblo
Lt. J.W. Abert (1846)	U.S. Topographical Engineer; noted that unlike the northern reaches, the riverbanks at LaJoya are heavily timbered with cottonwood
Henry Turner Smith (1846)	Below Albuquerque, cottonwood is seen only occasionally in groves on private "preserves"
George Rutledge Gibson (1847)	From LaJoya to above Peralta there was no firewood and very little grass for livestock
W.H. Emory (1848)	On a reconnaissance for building a railroad to link the East to the West, he took various measurements including altitude and cross-sections of the river from San Felipe Pueblo to Tomé to estimate the discharge of the river
1906	Saltcedar was first observed in New Mexico in the lower Pecos basin near the Texas border
J.R. Watson (1912)	Published the 1st vegetation community descriptions of the middle valley
Elephant Butte Reservoir (1916)	On the Rio Grande; this was then the largest dam in the world; managed by the U.S. Bureau of Reclamation (BOR); primary functions are irrigation, water supply and recreation; has a storage capacity of 2,065,000 acre-ft
Middle Rio Grande Conservancy District (MRGCD); est. 1926	Formed to provide flood protection, drain the land, and build an adequate irrigation system; constructed and maintain the present day levee and drainage network in the valley

Table 1 (continued).

ca. early 1930's	El Vado Reservoir (1935)	Marjorie Van Cleave (1935)	1941
Introduction of saltcedar, Russian olive, and Siberian elm to the bosque	On the Rio Chama; managed by the Middle Rio Grande Conservancy District (MRGCD); primary functions are for irrigation; has a storage capacity of 186,250 acre-ft	Wrote community descriptions and described vegetation changes in the valley since the construction of the levee and drain system by the MRGCD	The last major flood in the middle Rio Grande basin; destroyed and overtopped levees flooding parts of Albuquerque and adjacent riverside communities

ca. early 1950's	Jemez Canyon Reservoir (1954)	Abiquiu Reservoir (1963)
BOR installed jetty fields to confine the river and stabilize the channel.	On the Jemez River; managed by the U.S. Army Corps of Engineers (COE); functions primarily for sediment control; has a storage capacity of 88,990 acre-ft	On the Rio Chama and managed by COE; functions principally for flood and sediment control; has a storage capacity of 1,201,000 acre-ft

Campell & Dick-Peddie (1964)	Galisteo Reservoir (1970)	Heron Reservoir (1971)
Studied the "phreatophye" communities along the Rio Grande from Albuquerque to El Paso, Texas; saltcedar was the dominant tree in the south and Russian olive was intermixing with the cottonwood bosque	On Galisteo Creek; managed by COE; functions primarily for flood and sediment control; has a storage capacity of 88,990 acre-ft	On the Rio Chama and managed by BOR; functions principally as water storage for irrigation; has a storage capacity of 401,300 acre-ft

Table 1 (continued).

Cochiti Reservoir (1975)	M.D. Freehling (1982)	Hink & Ohmart (1984)	National Wetlands Inventory Maps (1989)
On the Rio Grande; managed by COE; functions primarily for flood and sediment control; has a storage capacity of 502,330 acre-ft	Studied the suitability of Russian olive as bird habitat in the middle valley	Mapped the major community-structure types for a terrestrial vertebrate and bird survey to the middle valley	Vegetation map of the middle Rio Grande from Cochiti Dam to San Marcial based on Cowardin's (1979) classification

Sivinski, Fitch, & Cully (1990)	Howe & Knopf (1991)	Bullard & Wells (1992)
Updated Hink & Ohmart's vegetation map through the Rio Grande State Park	Studied the cottonwoods of central New Mexico; projected that the cottonwoods along Rio Grande would begin a notable decline within 50 years unless management practices are implemented to control exotics while enhancing regeneration of cottonwoods	Published Hydrology of the Middle Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico; a good reference on the past and present hydrology of the Rio Grande

Biological Interagency Team (Crawford et al. 1993)
In response to concerns of the decline of the Rio Grande bosque, the Bosque Biological Management Plan was created "to determine conditions and recommend actions to sustain and enhance the biological quality and ecosystem integrity of the Middle Rio Grande bosque"

spp.; and chokecherry, *Prunus* spp. (Crawford et al. 1993). The first people arriving in the valley nearly 20,000 years ago were likely nomadic Indians. It is speculated that these people found stands of cottonwood and willow (*Salix* spp.) interspersed with extensive marshes and swamps dominated by sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), cattails (*Typha* spp.), and saltgrass meadows (*Distichlis* spp.). Prehistoric Pueblo Indians arrived in the valley about 1,500 to 2,000 years ago and may have been responsible for clearing cottonwoods for agriculture and constructing the first acequias for growing crops (Scurlock 1988).

Beginning in 1540 with the arrival of Coronado, Spanish explorers visited the valley, subsequently settling alongside the Pueblo Indians (ca. 1598). They traded goods, interbred and fought amongst the Navajo and Apache Indians of the surrounding hills (Emory 1848, Fergusson 1933). Coronado noted that there were twelve pueblos scattered throughout the valley which was "planted with maize and dotted with cottonwood groves" (Bolton 1964). In 1812, Pedro Bautista Piño described the Rio Grande as an "imposing Nile" with a "variety of luxuriant groves" having "infinite herds [of sheep and goats] that quench their thirst in its current" and "thousands of birds" (Carroll and Haggard 1849).

Anglo-Americans arrived in the valley not long after Piño to trade goods and explore the possibility of constructing a railroad that would link the eastern U.S. to the west. In Furgusson's (1933) writings, during the mid-1800's, the Spaniards referred to the river as the Rio Bravo del Norte, "not at all friendly to men" and "still a menace to what they build and plant in its valley". From 1839 to 1867 various traders, naturalists and military men (Gregg 1839, Smith 1846 in Scurlock 1988, Gibson 1847 in Scurlock 1988, Wislizenus 1847, Abert 1848, Emory 1848, and Davis 1855 in Scurlock 1988) noted that, with a growing population, wood in the valley was exceedingly scarce, especially through the Albuquerque sub-watershed. Marshes remained common features and cottonwood forests were seen more frequently from Isleta Pueblo south to San Marcial. According to Abert (1846), the town of Cienega in the northern reaches near Santa Fe "was a well-watered place" with "the neighboring hills full of springs." On his travels near the Rio Puerco, he writes, "forty-eight miles above its mouth, there is no water, and the valley, deep with sand, only nourishes artemisias, yucca, and cacti." Today, the Rio Puerco is largely dominated by saltcedar (*Tamarix chinensis*). Finally, near La Joya and Socorro, Abert (1846) describes the course of the Rio Grande as "tortuous" having "river banks heavily timbered with cottonwoods."

J. R. Watson (1908 and 1912) first described and broadly classified the major floristic associations of the middle Rio Grande as nearly pure stands of valley cottonwood mixed with willows (*Salix exigua*), seepwillows (*Baccharis salicifolia*) and various sedges (*Carex* spp.), or, wet meadows dominated by sedges and yerba mansa (*Anemopsis californica*), which was "exceedingly common", as well as seepwillows and various herbs (sunflower, *Helianthus annuus*; horsetails, *Equisetum* spp.; fleabane, *Erigeron* spp.; and cocklebur, *Xanthium* spp.). H. Fergusson (1933) seemed to understand the dynamics of the riparian area. He recounts Watson's observations and adds that beyond the narrow strips of cottonwood, which edge the river, a narrow belt of marshy meadow of coarse grass is "grizzled" with alkali. Of the cottonwood, he writes that although it is native to the valley, its wood is virtually useless for building and burning and "its real function in the economy of the valley is to keep the river within bounds." He briefly discusses riparian dynamics and cottonwood reproduction mentioning that "while the river is destroying the forest on one side a new one is growing on the other," and "but for this battle of the winged seeds floods would ravage the whole valley every year."

In 1916, the construction of Elephant Butte Reservoir on the Rio Grande for irrigation, water supply and recreation was completed by the U.S. Bureau of Reclamation (BOR). It was then the largest reservoir to be constructed in the world (Bullard and Wells 1992). In 1926, the middle Rio Grande Conservancy District (MRGCD) was formed to provide flood protection, drain the land, and build an adequate irrigation system (Van Cleave 1935). Earthen levees about eight feet high were excavated from the riverside drains to create a permanent 1,500-foot-wide floodway. By 1935, the district completed construction of El Vado Reservoir on the Rio Chama for irrigation and water storage; and by 1936 the levee system was completed (Crawford et al. 1993).

Van Cleave (1935) noted that prior to the creation of the MRGCD the river carried a heavy suspension of silt and had aggraded to levels above the valley floor. Consequently, the river meandered freely across the valley along new and lower channels, through an area that was originally anywhere from one to five miles wide. Irrigation of the valley was nearly impossible due to high water tables and what was irrigated was eventually wiped out by spring floods. Van Cleave documented vegetation changes as a result of draining the floodplain. Plant succession due to the construction of drains and lowering of the water table resulted in favoring the establishment of the exotics, saltcedar (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*), as well as the decline of the native willows, sedges, rushes, and aquatic or semi-aquatic vegetation (waterclovers, *Marsilea* spp.; algae, *Nostoc* spp.; alkali buttercup, *Ranunculus cymbalaria*; and watercress, *Rorippa nasturtium-aquaticum*), but there was not yet a noticeable reduction of cottonwood and yerba mansa.

Despite efforts of the MRGCD to provide flood protection a major flood in 1941 destroyed or overtopped portions of the levee system and inundated much of Albuquerque and other riverside communities (Crawford et al. 1993). To prevent future floods and to efficiently deliver water to users downstream, the BOR in the early 1950's installed an extensive network of jetty fields (Kellner jetty jacks) throughout the middle Rio Grande that would stabilize the channel and maintain a well-defined 600-foot-wide river channel within the levee system. Additionally, to maximize water delivery within the corridor, side bars were (and still are) mowed of their vegetation in the spring. The installation of jetty jacks proved effective in cutting off the natural meander of the channel and trapped sediment carried by the river. Consequently, the jetty jack system effectively created environments for the establishment of cottonwoods and built the forest which would additionally serve to protect the levees from future floods.

Nearly a thirty-year gap passed before ecological surveys of the riparian vegetation of the Rio Grande occur again. Campbell and Dick-Peddie (1964) studied the "phreatophyte" communities along the Rio Grande from Albuquerque to El Paso, Texas, focusing on saltcedar and Russian olive. No decline of the cottonwoods was apparent, but the southern sector of the study area was becoming increasingly dominated by saltcedar, and little else; while in the northern sector, Russian olive was intermixing within the interior cottonwood forest.

By 1975, four more flood and sediment control dams and reservoirs were constructed by the U.S. Army Corps of Engineers (COE). Jemez Canyon Reservoir on the Jemez River was constructed in 1954. Abiquiu Reservoir on the Rio Chama was constructed in 1963. Galisteo Reservoir on Galisteo Creek was constructed in 1970, and Cochiti Reservoir on the Rio Grande was completed in 1975. Meanwhile, in 1971, the Bureau of Reclamation completed the construction of Heron Reservoir on the Rio Chama for water storage and irrigation.

These impoundments and associated flow controls have had a significant impact on the dynamics of the river channel and associated riparian ecosystems downstream (Crawford et al. 1993). The Rio Grande now seldom overflows its banks unless it is a "planned" flood, hence, much of the remaining floodplain corridor is not watered directly by surface waters. This, in combination with the physical channel controls, has rigidly locked the riparian landscape into a single, unchanging configuration. The result is that the hydrological disturbances that originally drove the processes and determined the pattern expression of the riparian ecosystems have been minimized or eliminated. Scouring flooding and channel migration that are important factors in cottonwood and willow reproduction and the rejuvenation of the riparian ecosystem no longer occur (Howe and Knopf 1991, Crawford et al. 1993, Dick-Peddie 1993). Howe and Knopf (1991) suggest that the current forested riparian zone of the middle Rio Grande under the current hydrological regime is declining and will be replaced ultimately by exotic saltcedar and Russian olive stands within 50 to 100 years.

Recent Rio Grande Riparian Vegetation Research

A general overview of riparian vegetation communities in New Mexico is provided by Dick-Peddie (1993), with a listing of community types. Szaro (1989) described several riparian communities in Arizona and New Mexico primarily on the basis of overstory and shrub dominance. In the Rio Grande, much of the work was restricted to higher elevations of the upper watershed.

Much of the current research on vegetation in the Rio Grande is commonly done in the context of other ecosystem components or is associated with mapping inventories. Freehling (1982) developed general tree dominance types in conjunction with a bird survey of the middle Rio Grande. Hink and Ohmart (1984) conducted detailed terrestrial vertebrate habitat surveys and developed vegetation maps for the middle Rio Grande. Map units were based primarily on composition and structure of overstory and shrub dominants. These maps became the basis for the vegetation change analysis of Crawford et al. (1993), and revised maps of the middle Rio Grande through Albuquerque of Sivinski, Fitch and Culley (1990). Crawford et al. (1993) also provide the most in-depth assessment of the middle Rio Grande ecosystem as a whole, evaluating the status of the biota and associated ecosystem processes in the context of the complex socio-political as well natural environment of the riverine system. Ellis, Crawford and Moles (1993) are currently engaged in a detailed ecosystem analysis of Rio Grande floodplain forests at the Bosque Del Apache National Wildlife Refuge. Their research concentrates on understanding the response of the ecosystem to periodic inundation.

Outside the middle Rio Grande, biological investigations are limited. As part of the National Wetlands Inventory (NWI), maps of wetlands in New Mexico were developed using the Cowardin et al. (1979) wetlands classification system (National Wetlands Inventory 1989). These maps cover the state at 1:100,000 scale, with some local maps at 1:24,000. The map units in most cases are generalized to basic structural categories such as trees, shrubs and herbaceous-emergent wetlands. Occasionally species dominants are indicated.

A demonstration project by Muldavin, Wallace and Mehlhop (1993) outlined a methodology for application of the "riparian ecological site concept" (Leonard et al. 1992) to field conditions. They developed a methodology for describing these ecological sites in terms of detailed species composition, soils and successional status, along with developed mapping protocols for riparian vegetation at the 1:6,000 scale. The study was limited to a representative reach of the upper Rio Grande (Pilar to Velarde) and two associated tributaries (Agua Caliente and Rio Truchas). The quantitative data from that study have been integrated into this study.

For the Rio Chama, the most detailed work on vegetation and other biota is part of an instream flow assessment study (Fogg et al. 1992). Their work is done in the context of making recommendations for minimum releases from the various reservoirs along the river for sustaining riparian, aquatic and recreational resources.

At the southern end of the study area, Durkin et al. (1995) completed a biological assessment of riparian ecosystems on the east side of the Black Range on the Ladder Ranch (Las Animas, Seco and Palomas creeks). It included analyses and maps of fish, bird and snail fauna, as well as riparian vegetation communities. The vegetation investigations were a sister study to this one, and the results have been integrated into this report.

Hydrological studies by Bullard and Wells (1992), and in the middle Rio Grande management plan of Crawford et al. (1993) are important ancillary studies for understanding the biology of the Rio Grande. Also, the comprehensive water quality assessment of the Rio Grande from Colorado through Texas was recently completed by the U.S. Geological Survey (Anderholm, Radell and Richey 1995) and should be a useful tool for area managers and scientists.

Although the above studies make many important biological contributions to our knowledge of the Rio Grande as a riparian/wetland ecosystem, our understanding of vegetation communities remains incomplete. Most of the previous work does not attempt to directly quantify the relationship between soils, landforms and hydrological regimes, and vegetation community expression. To attain this, we developed a hierarchial community type classification based on a direct quantitative and detailed sampling of the vegetative species composition and specific site characteristics (i.e., soils, hydrology, and geomorphology). The classification framework provides a structure for analyzing the data and understanding the expression and processes of these ecosystems. It also provides a foundation for ecologically based inventory maps, the assessment of site specific ecosystem conditions, and generally aids in communicating information about the ecosystems.

METHODS

To understand the most critical components influencing riparian/wetland vegetation across the Rio Grande watershed, vegetation sampling was designed to characterize the communities throughout the study area and to evaluate their relationship to the hydrological regimes and soils. Vegetation and environmental data and information on management influences were collected at each sampling site. Physiographic, edaphic and floristic features of the sampling sites were collected to generate a riparian/wetland community type classification.

Sampling Design

Due to the size of the study area, the upper and middle watershedss were delineated into several sub-watersheds. Tributaries were further delineated into survey reaches of approximately two to five kilometers and classified according to stream gradient, elevation and the hydrologic regime. Within each survey reach potential sites for field sampling were identified and categorized by structure, gross composition, size and condition.

These variables generate a well-informed site selection based not only on preliminary vegetation information, but also on the variables to which vegetation responds. Elevation influences floristics through effects on temperature and precipitation. The hydrologic regime (i.e., flood and base flow levels) imposes a strong influence on the riparian/wetland vegetation, while the stream gradient manifests a substantial impact on the hydrologic regime.

Where available, aerial photography was used to initially evaluate potential sampling sites in terms of structure, composition and extent of the riparian vegetation. Additional aerial reconnaissance flights were used in the upper and middle Rio Grande main stem and its tributaries to aid in the evaluation, particularly in areas lacking available aerial photography. Areas thought to be of outstanding, satisfactory, or poor quality were transcribed on USGS 7.5 minute topographic maps and National Wetlands Inventory (NWI) maps were consulted to confirm the vegetation type (i.e. forested wetlands, shrublands, herbaceous wetlands, saltcedar woodlands, wet barren flats or other land-use types (e.g., farmlands). Topographic maps provided elevations from which stream gradients could be determined. These maps also provided other important features that facilitated determination of site selection, such as landform type, relief, streamflow regimen, as well as forested and marshy vegetation.

A preliminary sampling pool two to three times larger than the targeted final sample size was developed to account for possible access problems on private and public lands, as well as on-the-ground unsatisfactory conditions not previously detected by aerial assessments. Prior to collecting the data in the field, landownership information was determined from county tax rolls, BLM land status maps, and interviews with knowledgeable individuals (i.e., agency personnel). Landowners, both public and private, were contacted for permission to access their property.

Final sampling site selection was structured to maximize geographic distribution, floristic variation and stand quality and was based on on-the-ground reconnaissance. Sites that were drastically altered by human activity such as cultivation, dumping of refuse, livestock holding sites, logging and mining were not included in the sampling. Site selection was also dependent on finding a relatively homogeneous stand of vegetation at 0.1 hectare in size (1,000 $meters^2$). Sites dominated by or contaminated by exotic vegetation were not necessarily excluded (e.g., saltcedar or Russian olive woodlands).

Environmental Data Collection and Analysis

Hydrology

One of the most important environmental influences on a riparian/wetland community is the flooding environment. To evaluate potential flows at a site, cross sections of the channel and the adjacent floodplain were surveyed. A transit level and stadia rod were used to survey all of the tributaries and portions of the mainstem. The stadia rod measures elevation (relative to the transit level) to the nearest inch. Each cross section extended across the active channel and floodplain (within levees) and was measured at every meter. Channel substrate character and significant topographical breaks were recorded. Additionally, each cross section included both the vegetation and soil plots. Fluvial landforms (island bars, side bars, and terraces) along the cross section were described. The elevations of current water surface heights, high water marks, location of flood debris, root crown heights for significant riparian species, and bank heights were measured. Stream gradients were also measured with the transit level and stadia rod. The elevations at varying points along the water's edge from upstream to downstream positions were measured and the angle of the slope determined.

For wadeable streams, discharge measurements were taken on the day of site sampling using a Marsh-McBirney Model 2000 Flow Meter. Velocity was measured in feet/second at designated channel distances and depths. Streamflows or cfs (cubic feet/second) were then estimated using the combination of these measurements.

Measuring cross sections across the Rio Grande was in many cases problematic and dangerous. With the cooperation of the U.S. Bureau of Reclamation (BOR), we were able to make use of several previously ground-surveyed BOR cross sections and 1992 Aggradation-Degradation Rangeline Digitizing (Agg-Deg) surveys of the main channel and floodplain of the middle Rio Grande (from Cochiti to Elephant Butte). The Agg-Deg survey uses aerial photographs to photogrammetrically determine elevation and distance along a cross section (Bureau of Reclamation 1995). Sites that did not have BOR cross sections of the channel were surveyed by NMNHP.

The channel morphology of the Rio Grande and its tributaries was classified following Rosgen's (1992) stream classification. Parameters used included: channel gradient (measured as energy slope of the water surface); sinuosity (ratio of channel length to valley length); width/depth ratio (width of bankfull stage divided bankfull depth); dominant particle size of bed and bank materials; entrenchment of channel and confinement of valley; and landform features including their stability or erodibility and soil texture.

Additionally, Rosgen (1992) defines a list of physical characteristics of channels for delineation to stream sub-types. These criteria were used to further define the channel morphology of the Rio Grande watershed and included: 1) riparian vegetation; 2) organic debris and/or channel blockages; 3) stream size (width); 4) flow regimen (perennial, ephemeral, subterranean, intermittent channels, streamflow variations and sources (i.e., stormflow or snowmelt); 5) depositional features; and 6) meander patterns.

The Rosgen (1992) stream classification can be briefly summarized as follows:

A2. This stream type has a high gradient (4-10%) and is slightly sinuous. Width to depth ratio is 10 or less. The channel is deeply entrenched, and valley walls are very confining. The bed of the channel consists of small and large boulders mixed with cobbles.

A3. This stream type is similar to the A2 type, except that channel materials consist of small boulders, cobbles, and coarse gravel.

B1. This stream type has a moderate gradient (2.5-4%) and is moderately sinuous. Width to depth ratio is 5 to 15. The channel is moderately entrenched, and valley walls are confining. The bed of the channel is consists of small boulders and very large cobbles.

B2. This stream type has a moderate gradient (1.5-2.5%) and is moderately sinuous. Width to depth ratio is 8 to 20. The channel is moderately entrenched, and valley walls are moderately confining. The channel consists of small and large cobbles, some small boulders, and coarse gravel.

B4. This stream type has a moderate gradient (1.5-4%) and is moderately sinuous. Width to depth ratio is 8 to 20. The channel is entrenched, and valley walls are confining. Channel materials consist of a mixture of coarse gravel, cobbles, and sand.

C1. This stream type has a low gradient (1.2-1.5%) and is moderately sinuous. Width to depth ratio is 10 or more. The channel is moderately entrenched, and valley walls are moderately confining. Channel materials consist of cobbles mixed with small boulders and coarse gravel.

C2. This stream type has a low gradient (0.3-1.0%) and is moderately sinuous. Width to depth ratio is between 15 and 30. The channel is moderately entrenched, and confinement by the valley is moderate. Channel materials consist of large cobbles with small boulders and coarse gravel.

C3. This stream type has a low gradient (0.5-1.0%) and is moderately sinuous. Width to depth ratio is 10 or greater. The channel is moderately entrenched, and valley confinement is slight. Channel materials consist of gravels mixed with small cobbles and sand.

C4. This stream type has a low gradient (0.1-0.5%) and is moderately sinuous. Width to depth ratio is 5 or greater. The channel is moderately entrenched, and valley confinement is slight. Channel materials consist of sand with mixtures of gravel and silt.

C5. This stream type has a low gradient (0.1% or less) and is moderately sinuous. Width to depth ratio is 5 or greater. The channel is moderately entrenched, and valley confinement is slight. Channel materials consist of silt or clay with mixtures of medium to fine sands.

C6. This stream type has a low gradient (0.1% or less) and is moderately sinuous. Width to depth ratio is 3 or greater. The channel is deeply entrenched, and valley confinement is slight. Channel materials consist of a sand bed mixed with silts and some gravel.

For all NMNHP surveyed cross sections, each point (distance and elevation) was entered into the cross sectional profile analyzer computer program XSPRO (Grant et al. 1992). This produces a profile of the channel and associated landforms. Hydraulic analysis results in modeled estimated flows through the cross section at designated stages. This was conducted for each cross section. Modeling parameters include stream cross sectional areas, stream gradients, and a user-assigned Manning's "n" channel roughness coefficient for each cross section. Manning's "n" was initially estimated using Barnes (1967). Stream gradients were calculated from field measurements and from 7.5 minute topographic maps.

Modeled flows were calibrated from discharge measurements for the date of sampling or from flows measured on that day from the nearest USGS stream gauge. Manning's "n" and the stream gradient were adjusted until the modeled flows matched discharge from the stream gauge. For the cross sections where flows were not directly measured or, where cross sections were not located near stream gauges, linear extrapolations were made between flow levels of adjacent USGS stream gauges to the point of the cross section.

Once the flows to flood the site for the NMNHP cross sections were calculated, the estimated return intervals for these flows was determined using the recurrence probabilities calculated at New Mexico stream gauges by Waltemeyer (1986). As with the daily flows, recurrence intervals were only calculated for the sites near gauging stations and then extrapolated to cross sections not located near stream gauging stations. For the cross sections located on smaller tributary watersheds without stream gauging stations recurrence intervals were calculated by determining the drainage watershed area and the average elevation of the stream. These two variables were then input into Waltemeyer's (1986) linear regression equations which estimate a recurrence interval for the specific watershed in New Mexico.

BOR cross sections were modeled using a BOR-created STARS program which estimates flood stage height and discharge by comparing the hydraulic gradients of two or more cross sections (back-water calculation). Water surface stages are interactively computed for all cross sections until they correspond (Bureau of Reclamation 1995). Like XSPRO, STARS requires a user-assigned Manning's "n" as well as other variables. BOR analysis of the middle Rio Grande estimates, for most areas, a Manning's "n" value to be 0.024 for the active channel and 0.080 for the floodplain (Bureau of Reclamation 1995).

For BOR cross sections, both the regulated and unregulated peak flows and recurrence intervals were estimated. These were calculated using USGS gaging station historical records, assumptions on reservoir operation, and other considerations (Bureau of Reclamation 1995). Flood discharge, stage height, and recurrence intervals are estimated calculations. Bureau of Reclamation (1995) states that their precision is limited by several factors:

1. The photogrammetric techniques used to determine elevation and distance in the Agg-Deg survey cannot be expected to be as precise as a transit level and stadia rod survey. Regulations for the 1992 Agg-Deg survey require that distances and elevations be off by no more than one foot.

2. The Agg-Deg survey is not capable of estimating elevations below the water surface. As a result, some channel area is lost and discharge flows are affected. To alleviate this problem, Agg-Deg flight lines were flown at low flow (~300 cfs) or the channel was surveyed using a transit level and stadia rod.

3. In channels where the stream bed consists of fine materials such as fine sands, silts, and clays, (the middle Rio Grande and much of the Rio Puerco, for example) the stream bed is continually changing shape. During high flows, changes occur drastically. Both of the computer programs used (XSPRO and STARS) assume a fixed bed.

4. There is no standardization or qualitative approach for the assignment of Manning's "n". Assignment of Manning's "n" is subjective and depends on experience. Also, channel roughness characteristics can change with sediment loads and with changes in stage height.

5. Upstream stream characteristics (stream bends, burms, or other topographical breaks) can affect the flooding (or lack of) in areas downstream. Because of this, low-lying areas may not be flooded at low flows and high areas may be flooded at lower flows.

As a corollary to recurrence interval, the ratio of the cross sectional area of the floodplain where sample plots are located to the cross sectional area of the channel at bankfull height was calculated. Each vegetation plot located on a cross section has a recurrence interval associated with it along with cross sectional ratios and actual cubic feet per (cfs) discharges necessary to flood the site.

Soils

Soil sampling and soil profile descriptions followed guidelines established in the National Soils Handbook (Soil Conservation Service 1991). At each plot a 1 m^3 soil pit was excavated and soil horizons were determined along with horizon depth. For each horizon soil structure, color, texture, consistency, percent rock fragments, size and abundance of pores and roots, calcium carbonate reaction ($CACO_3$), and any hydric soil redox features (i.e., mottling and gleying following Vepraskas 1992). Soil samples from each horizon were collected for laboratory analysis and later archiving. For each horizon, pH levels were determined using a 2:1 mixture of 0.01M calcium chloride ($CaCl_2$) and a sample of the soil. Salinity was measured by electrical conductivity (EC) in each horizon (in milliSeimens) within 20 cm (8 inches) of the surface. A soil paste (at the water saturation point of the sample) was used to make soil EC measurements.

All soils were then keyed and classified to the family level (Soil Survey Staff 1992). Soils were also ranked in terms of wetness based on Great Group and Family characteristics (Table 2). Plant available water percentages as calculated by Donahue,

Table 2. Soil Great Group wetness values. Wetness assigned to soil Great Groups based on the degree of aquic conditions. Values increase from 1.0 (ponded) to 13.0 (typic torrifluvent), as wetness decreases.

Great Group	Subgroup	Wetness Rank
Ponded		1
Mollic	Endoaquent	2
Mollic	Fluvaquent	2
Mollic	Psammaquent	2
Sulfic	Fluvaquent	2
Typic	Endoaquent	2
Typic	Fluvaquent	2
Typic	Psammaquent	2.5
Aeric	Endoaquept	3
Aeric	Fluvaquent	3
Aquic	Dystrochrept	4
Aquic	Ustifluvent	5
Aquic	Ustipsamment	5.5
Oxyaquic	Udifluvent	6
Mollic	Udifluvent	6.5
Aquic	Torrifluvent	7
Oxyaquic	Ustifluvent	7
Oxyaquic	Ustipsamment	7.5
Oxyaquic	Torrifluvent	9
Aquic	Camborthid	10
Fluventic	Dystrochrept	11
Fluventic	Ustochrept	12
Typic	Ustifluvent	12
Typic	Torrifluvent	13

Miller and Shickluna (1983), based on soil texture, were estimated for the moisture control section of the soil profile. Depth to gleying and redox features were also determined.

Vegetation

Vegetation data were collected so as to be closely compatible with the standards of the U.S. Forest Service's Terrestrial Ecosystem Survey (Edwards et al. 1987) and Habitat Type classification databases (Muldavin, Ronco and Aldon 1990), and other ongoing community classification projects of the New Mexico Natural Heritage Program (Muldavin and Mehlhop 1992; Muldavin, Sims, and Johnson 1993; Muldavin, Wallace and Mehlhop 1993; Durkin et al. 1994; Muldavin et al. 1994; Muldavin, Mehlhop and DeBruin 1994).

At each selected sampling site, homogeneous stands of vegetation were identified that were representative of the Community Type(s) of the site. Within each stand a 400 m^2 square or rectangular plot was established and the species present in both the plot and in the surrounding riparian and upland stands were recorded. Percent canopy cover for each species present within the plot was estimated. Where trees were present, stems were tallied in two-inch size classes and one or more dominant tree was cored to determine age.

Other variables estimated or measured at each site included: elevation; aspect (stream bearing); valley floor width (from topographic maps); ground cover of bare soil, litter, wood, gravel, rock, bryophyte, and non-vascular plants; height of the center of the community above bankfull stage of the channel; distance of the center of the community from bankfull stage of channel; landscape position (point bar, floodplain, old channel, terrace, etc.); signs of wildlife or domestic livestock utilization; signs of disturbances (flooding, fire, windthrow, logging, etc.); successional relationships where trends are observed; adjacent upland communities; hydrologic and geomorphic features (beaver dams, point bars, etc.); evidence of landuse history (from landowner or manager); and plot photographs of the stream reach environment featuring representative species of the Community Type(s) and associated landforms, as well as unique attributes of the stream and floodplain.

All plants not identifiable in the field, particularly of difficult genera such as *Salix*, *Carex*, and *Juncus* were collected and pressed for later identification. All voucher specimens are archived at the University of New Mexico Herbarium of the Museum of Southwestern Biology.

The vegetation community classification was developed using agglomerative cluster analyses using Euclidean distance and Ward's Method as an initial organizational tool to define riparian/wetland community types. The program SYNTAX IV (Podani 1990) was used to generate a dendrogram of hierarchical groupings of plots with similar vegetation associates. Plots were then sorted using synthesis stand tables into final vegetation community type groups following procedures outlined in Mueller-Dombois and Ellenberg (1974). Hydrological, soil and other site characteristics were then correlated to the community types. Summary tables were produced which average the species values and environmental variables among all plots within a community type. These summary values provide the quantitative basis for the development of community type descriptions. Full descriptions were developed for each community type which include sections on distribution, vegetation, environmental setting, adjacent vegetation, a discussion of ecological dynamics, and relevant documentation. With these data, plant communities can then be constructed and organized into a vegetation classification scheme.

The classification is organized in a multi-level hierarchical and open-ended system that allows for expansion, contraction, or transference of community types as additional data are accumulated. The system is based primarily on the existing natural vegetation. The classification draws upon Cowardin et al.'s (1979) Classification of Wetlands and Deepwater Habitats of the United States; Brown, Lowe and Pase's (1979) classification of biotic communities of the Southwest; UNESCO's Physiognomic-Ecological Classification of Plant Formations of the Earth (Mueller-Dombois and Ellenberg 1974; Driscoll et al. 1984) and its modification by The Nature Conservancy (Bourgeron and Engelking 1994). The UNESCO system is currently used by Natural Heritage Programs throughout the United States as a basis for regional, national and international comparisons. The Cowardin et al. (1979) Classification was adopted by the U.S. Fish and Wildlife Service for use in its National Wetland Inventory.

Hierarchical levels of the classification are as follows:

I. **Class** — major physiognomic type. Class of Cowardin et al. (1979) and UNESCO (Driscoll et al. 1984);

II. **Zone** — moisture and temperature defined sub-classes. Similar to Brown, Lowe and Pase's (1979) Climatic Zone, SubClass and Group; in part, of UNESCO;

III. **Regional Biome** — biogeographically related Series Groups. Similar to Brown, Lowe and Pase's (1979) Biome;

IV. **Series Group** — the dominant plant communities within the same biome, zone, and class related by equivalent sets of morphological, environmental or floristically related series; commonly equivalent to the Cowardin et al. (1979) Sub-class and UNESCO Formation (Driscoll et al. 1984);

V. **Series** — sets of Community Types related by at least a single common dominant. Equivalent to the primary Dominance Types of Cowardin et al. (1979) and patterned after the Series of Daubenmire (1968), and the Alliance of Braun-Blanquet (1965) and Bourgeron and Engelking (1994).

VI. **Community Type** — fundamental repeated assemblages of species. Synonymous with plant association of Braun-Blanquet (1965) and Bourgeron and Engelking (1994). Somewhat equivalent to secondary Dominance Types of Cowardin et al. (1979)

VII. **Phase** — floristic variants of Community Types. Synonymous with sub-association of Braun-Blanquet (1965). The term Typic refers to the modal species composition of the Community Type.

Essential to a riparian classification is the consideration of natural fluvial disturbances. This classification, as in others (Padgett, Youngblood and Winward 1989, Hansen et al. 1990, Kittel 1993, Kittel and Lederer 1993; and Muldavin, Wallace and Mehlhop 1993), considers riparian vegetation communities to be either relatively stable, or at least to be predictable assemblages that are dependent on the fluvial dynamics of a river system for long-term maintenance and regeneration. This complex process of riparian ecosystem development has been referred to as "site progression" by Leonard et al. (1992) and is a critical process in the maintenance and growth of these communities. Where possible, we have made a preliminary evaluation of the dynamic status of each community type in terms of successional or stage of site progression, and have developed general concepts and models of riparian/wetland community dynamics along each major reach.

Databases

All field data were entered into computer databases for storage and retrieval, and is accessible to all participating agencies. Selected information collected during this project will be entered into The Nature Conservancy's Biological and Conservation Data System (BCD) maintained by the New Mexico Natural Heritage Program at the University of New Mexico's Biology Department, Albuquerque. The New Mexico Natural Heritage Program seeks to continually update and inventory the biological and ecological features, and biodiversity preservations of New Mexico utilizing the BCD. This system houses descriptions of plant associations and rare plant species, information on their locations in the state, information on high quality examples of plant communities, and literature relevant to the management and protection of the biodiversity of plant communities and rare species. Information stored in the BCD is available to biologists, land managers, consultants, and any other interested party. However, the New Mexico Natural Heritage Program reserves the right to respect the confidentiality of certain data.

Determination of Ecologically Significant/Restorable Sites

To aid in the development of a wetlands protection plan for New Mexico, a list of the most current significant and/or restorable sites in the Rio Grande watershed was developed. The New Mexico Natural Heritage Program is responsible for gathering and updating features of natural biodiversity in New Mexico and has developed a ranking system for significant natural biological elements. Biological elements are either species or assemblages of species, or community types in this case. Each occurrence of a stand of vegetation representing a community type is graded in terms of the current condition (size, vigor, native versus exotic species, overall diversity), the long-term viability (regeneration, intact ecosystem processes), and the defensibility (ease or difficulty of protecting from further degradation of diversity and ecosystem process). Overall grades of quality are assigned running from A (highest quality) to D (lowest quality).

Each community type is assessed with respect to its global and state rarity, based on the number and quality of the occurrences, and is then ranked on a five-point scale (i.e., 1 = critically imperilled due to rarity, low viability and/or high threats vs. 5 = abundant and relatively unthreatened). Priorities can then be established for the protection of the most sensitive high quality sites.

Sites were defined as riparian/wetland communities that continue in relatively intact stands along a river reach. A given site tended to have several communities, each associated with different soils and/or hydrology. Site boundaries were delineated from aerial photos, over flights and ground reconnaissance and drawn onto topographic maps. These were primary site boundaries that encompassed the riparian vegetation, but excluded upland vegetation. In reality, site management and conservation must take into consideration the management and condition of the uplands since they directly impact the riparian zone.

The sites themselves were ranked based on their community ranks, hydrologic regime, channel manipulations and more localized floodplain impacts. The following ranks were assigned:

High: The best examples of ecologically significant riparian/wetland sites found in the Rio Grande watershed are proposed as those that support high quality plant community occurrences of at least an A or B grade. They must be in good to excellent condition and occur along more or less hydrologically intact rivers or streams with as minimal as possible alteration by dams and channelization. They must show indications of sustainability, such as regeneration of native species, and they must be defensible from major local negative human floodplain impacts, though some impacts were detected. These ecologically significant sites are also valuable as reference areas for long-term research and comparison with impacted areas.

Potentially High: These sites were not ground sampled, but appear to be high quality, based on initial air, photo and driveby assessment.

Medium: At medium quality sites, the hydrologic regime is not intact due to regulated flows, levees on both sides, severe bank incision, high channel modification, high water withdrawals, or a combination of these. However, exotic species are not dominant, though they may be co-dominant. Local floodplain impacts, including grazing, are generally moderate. At many of these sites, the hydrologic regime is restorable, at least in part. The community ranks at these site may be marginally graded ("C") at the present time, yet may potentially be restored and upgraded to a "B" ranking upon at least partial restoration of natural hydrological processes and, possibly, removal of exotics or abatement of floodplain impacts.

Low: At low quality sites, the hydrology is not intact and not reasonably restorable. Exotic plants are dominant, and most or all native plant communities are ranked "C" or "D". Some local floodplain impacts are heavy.

No Rank: Sites were not ranked if they were not ground sampled and information from other sources was inadequate.

RESULTS

A total of 109 sites were assessed in the Rio Grande watershed as part of this study (Table 3, Figure 1). Of these, 49 were ground sampled quantitatively. The remaining 60 were assessed using aerial photography, over flights and driveby evaluations. Figures 2 - 6 are more detailed maps of the river segments that identify the sites by number and indicate whether they were quantitatively ground sampled or not.

At the 49 sites that were quantitatively ground sampled, 66 vegetation community types were described on the basis of 155 plots on 73 stream channel - floodplain cross sections. Of these, 104 plots on 52 cross sections were directly sampled during the summer of 1994 as part of this project. The other 51 plots and 21 cross sections were drawn from the NMNHP database from the upper Rio Grande and associated tributaries as sampled in 1992 (Muldavin, Wallace and Mehlhop 1993). In addition, where community types were common to both the Rio Grande and the Pecos watersheds, previously collected project data were drawn upon from the Pecos (Durkin et al. 1994) to enhance the community descriptions.

Below we present overviews of the hydrological regimes and soils, followed by a summary of the vegetation classification and plant species found, and of the sites that were identified in the Rio Grande watershed. Data that were used to produce these overviews and summaries are provided in appendices. In Appendix A, each Community Type is characterized in detail on the basis of vegetation, soils and hydrology from the data collected in this and other studies. Appendix B provides a list of all plants encountered in the riparian zones of the Rio Grande watershed during this study. A preliminary key to the riparian/wetland communities of the watershed that is based on the 1994 data is provided in Appendix C. Information on the highest quality sites identified and sampled during this study is provided in detail in Appendix D. Appendix E provides a diagnostic description of each of the riparian/wetland soil types that were classified.

Table 3. Sites Assessed in the Rio Grande watershed.

Site No	River	Site Name	County	Quad	Jurisdiction *	Sampled?
1	Rio Grande	Ute Mountain	Taos	UTE MOUNTAIN	BLM AND STATE	No
2	Rio Grande	La Junta	Taos	GUADALUPE MOUNTAIN	BLM	Yes
3	Rio Grande	Rio Grande St. Park at Pilar	Taos	TAOS SW	BLM	Yes
4	Rio Grande	Embudo	Rio Arriba	VELARDE	Private	Yes
5	Rio Grande	Canon del Rio Grande	Rio Arriba	VELARDE	BLM and private	Yes
6	Rio Grande	Lyden	Rio Arriba	LYDEN	Private	No
7	Rio Grande	Pueblito	Rio Arriba	SAN JUAN PUEBLO	San Juan Pueblo	Yes
8	Rio Grande	Espanola	Rio Arriba	ESPANOLA	Santa Clara Pueblo?	No
9	Rio Grande	Chama confluence	Rio Arriba	SAN JUAN PUEBLO	San Juan Pueblo	No
10	Rio Grande	Black Mesa	Rio Arriba	ESPANOLA	Pueblo of Santa Clara	No
11	Rio Grande	Pojoaque Confluence	Santa Fe	ESPANOLA	Pueblo of San Ildefonso	Yes
12	Rio Grande	Otowi Bridge	Rio Arriba	PUYE	San Ildefonso Pueblo	No
13	Rio Grande	White Rock Canyon	Santa Fe	WHITE ROCK		No
14	Rio Grande	Cochiti	Sandoval	SANTO DOMINGO PUEBLO	Cochiti Pueblo	No
15	Rio Grande	Pena Blanca	Sandoval	SANTO DOMINGO PUEBLO	Private	No
16	Rio Grande	Galisteo Confluence	Sandoval	SANTO DOMINGO PUEBLO	Pueblo of Santo Domingo	No
17	Rio Grande	Cañon Santo Domingo	Sandoval	SANTO DOMINGO PUEBLO SW	Santo Domingo Pueblo Reservation	No
18	Rio Grande	Borrego	Sandoval	SAN FELIPE PUEBLO NE	Santo Domingo Pueblo	Yes
19	Rio Grande	Arroyo de la Vega de Los Tanos	Sandoval	SAN FELIPE	San Felipe Pueblo	No
20	Rio Grande	Arroyo Tonque	Sandoval	SAN FELIPE	San Felipe Pueblo	No
21	Rio Grande	Algodones	Sandoval	SAN FELIPE	San Felipe Pueblo	No
22	Rio Grande	Jemez Confluence	Sandoval	BERNALILLO	Santa Ana Pueblo	Yes
23	Rio Grande	Coronado St Park	Sandoval	BERNALILLO	MRGCD	Yes
24	Rio Grande	Bernalillo	Sandoval	BERNALILLO	MRGCD	No
25	Rio Grande	Bernalillo south	Sandoval	BERNALILLO	MRGCD	No
26	Rio Grande	Corrales	Sandoval	BERNALILLO	MRGCD and Sandia Pueblo	Yes
27	Rio Grande	Alameda	Sandoval	ALAMEDA	Sandia Pueblo; MRGCD	No
28	Rio Grande	Coronado Airport	Bernalillo	ALAMEDA	MRGCD	Yes
29	Rio Grande	Rio Grande Nature Center	Bernalillo	LOS GRIEGOS	MRGCD and the RG Nature Center	Yes
30	Rio Grande	Barelas Bridge	Bernalillo	ALBUQUERQUE WEST	RGVSP	No
31	Rio Grande	Rio Bravo Bridge	Bernalillo	ALBUQUERQUE WEST	RGVSP	Yes
32	Rio Grande	Los Padillas	Bernalillo	ISLETA	RGVSP	No
33	Rio Grande	Isleta marsh	Bernalillo	ISLETA	Isleta Pueblo	No
34	Rio Grande	Isleta Pueblo	Bernalillo	ISLETA	Isleta Pueblo	No
35	Rio Grande	Isleta	Bernalillo	ISLETA	Isleta Pueblo	Yes
36	Rio Grande	Bosque Farms	Valencia	LOS LUNAS	Isleta Pueblo	No
37	Rio Grande	Valencia	Valencia	LOS LUNAS	MRGCD	No
38	Rio Grande	Los Lunas	Valencia	LOS LUNAS	MRGCD	Yes
39	Rio Grande	Tome	Valencia	TOME	MRGCD	No
40	Rio Grande	La Constancia	Socorro	SAN MARCIAL	MRGCD	No
41	Rio Grande	Turn	Valencia	VEGUITA	MRGCD	Yes
42	Rio Grande	Veguita	Socorro	VEGUITA	MRGCD	Yes
43	Rio Grande	San Juan Church	Valencia	VEGUITA	MRGCD	No
44	Rio Grande	Abeytas	Socorro	ABEYTAS	MRGCD	Yes
45	Rio Grande	New Mexico Boys Ranch	Socorro	ABEYTAS	MRGCD	No

Site No	River	Site Name	County	Quad	Jurisdiction *	Sampled?
46	Rio Grande	Bernardo	Socorro	ABEYTAS	MRGCD	Yes
47	Rio Grande	La Joya	Socorro	LA JOYA	NM Game and Fish	No
48	Rio Grande	Rio Salado Confluence	Socorro	LA JOYA	MRGCD	No
49	Rio Grande	San Acacia	Socorro	LEMITAR	MRGCD	No
50	Rio Grande	Polvadera	Socorro	LEMITAR	MRGCD	Yes
51	Rio Grande	Lemitar	Socorro	LEMITAR	MRGCD	No
52	Rio Grande	Socorro	Socorro	LOMA DE LAS CANAS	MRGCD	Yes
53	Rio Grande	Arroyo de la Presilla	Socorro	LOMA DE LAS CANAS	MRGCD	No
54	Rio Grande	Bosquecito	Socorro	SAN ANTONIO	MRGCD	No
55	Rio Grande	Laborcita	Socorro	SAN ANTONIO	MRGCD	No
56	Rio Grande	San Antonio	Socorro	SAN ANTONIO	MRGCD	No
57	Rio Grande	Bosque del Apache	Socorro	SAN ANTONIO	Bosque Del Apache Wildlife Refuge	Yes
58	Rio Grande	Elmendorf	Socorro	INDIAN WELL WILDERNESS	MRGCD	No
59	Rio Grande	Val Verde	Socorro	SAN MARCIAL	Bosque del Apache	No
60	Rio Grande	South of Bosque Del Apache	Socorro	SAN MARCIAL	Bosque del Apache	No
61	Rio Grande	San Marcial	Socorro	SAN MARCIAL	MRGCD	Yes
62	Rio Grande	Caballo	Socorro	WILLIAMSBURG	Unknown	No
63	Red River	June Bug Campground	Taos	RED RIVER		No
64	Red River	El Aujae Campground	Taos	GUADALUPE MOUNTAIN	Carson NF and BLM	No
65	Rio Pueblo	Vadito	Rio Arriba	PENASCO	Private and Pueblo	No
66	Rio Pueblo	Canon Tio Maes	Taos	Tres Ritos	Carson NF	Yes
67	Jemez	Upper Jemez	Sandoval	Ponderosa	Private and SFNF	No
68	Jemez	Canon	Sandoval	Ponderosa	Private and SFNF	Yes
69	Jemez	Jemez Indian Mission	Sandoval	Ponderosa	Jemez Pueblo	Yes
70	Jemez	Lower Jemez	Sandoval	SAN YSIDRO	Pueblo and private	No
71	Arroyo Hondo	Arroyo Hondo	Taos	ARROYO SECO	Carson NF	Yes
72	Embudo Creek	Embudo Canyon	Rio Arriba	TRAMPAS	BLM	Yes
73	Embudo Creek	Dixon	Rio Arriba	VELARDE	Private	No
74	Embudo Creek	Rio Grande Confluence	Rio Arriba	VELARDE	Private	Yes
75	Canada de Ojo Sarco	Upper Canada de Ojo Sarco	Rio Arriba	TRAMPAS	Private	No
76	Canada de Ojo Sarco	Lower Canada de Ojo Sarco	Rio Arriba	TRAMPAS	BLM	Yes
77	Rio Brazos	Rio Brazos	Rio Arriba	Penasco Amarillo	Private	Yes
78	Cabresto Creek	Cabresto Creek	Taos	RED RIVER	Carson NF	Yes
79	Rio Chama	Upper Chama	Rio Arriba	CHAMA 15'	NM Game and Fish and private	Yes
80	Rio Chama	Rio Chama Canyon	Rio Arriba	NAVAJO PEAK	SFNF	No
81	Rio Chama	Middle Chama	Rio Arriba	LAGUNA PEAK	SFNF	Yes
82	Rio Chama	El Rito confluence	Rio Arriba	MEDANALES	Private	No
83	Rio Chama	Abiquiu	Rio Arriba	ABIQUIU	Private	No
84	Agua Caliente	Agua Caliente	Taos	CARSON	BLM	Yes
85	Rio Truchas	Rio Truchas	Rio Arriba	VELARDE	BLM	Yes
86	Rio Fernado de Taos	Rio Fernado de Taos	Taos	TAOS SW	Carson NF	No
87	Ojo Caliente	Rio Chama Confluence	Rio Arriba	CHILI		No
88	Rio Puerco	Cabezon	Sandoval	SAN LUIS	Private, BLM	No
89	Rio Puerco	Lower Rio Puerco	Bernalillo	Rio Puerco		Yes
90	Santa Fe	Santa Fe River at La Bajada	Santa Fe	TETILLA PEAK	Cochiti Pueblo and SFNF	No
91	Santa Fe	Santa Fe River Wetlands	Santa Fe	SANTO DOMINGO PUEBLO	Cochiti Pueblo and SFNF	No

Site No	River	Site Name	County	Quad	Jurisdiction *	Sampled?
92	Gallisteo	Gallisteo	Santa Fe	TETILLA PEAK	Private and Santo Domingo	No
93	Rio Paguate	Paguate	Cibola	SEBOYETA	Laguna Pueblo and private	Yes
94	Rio San Jose	Rio San Jose at rest area	Cibola	MC CARTYS	Acoma Reservation	Yes
95	Rio San Jose	The Indian Peaks	Cibola	LAGUNA	Laguna Pueblo	Yes
96	Mc Cartys Marsh	McCartys Marsh	Cibola	MC CARTYS	Acoma Indian Reservation	No
97	Rio Tesuque	Camel Rock	Santa Fe	TESUQUE	Tesuque Reservation	No
98	Rio Tesuque	Arroyo Cuma	Santa Fe	TESUQUE	Tesuque Reservation	Yes
99	Pojoaque	Pojoaque	Santa Fe	ESPANOLA	San Ildefonso Reservation	Yes
100	Alamocita Creek	Red Lake Ranch	Socorro	TABLE MOUNTAIN	Private	No
101	Cienega Creek	La Cienega	Santa Fe	TETILLA PEAK	Private	Yes
102	Palomas	Lower Palomas	Sierra	WILLIAMSBURG	Private; Ladder Ranch	Yes
103	Seco Creek	North Seco Canyon	Sierra	BELL MOUNTAIN	Private; Ladder Ranch	Yes
104	Seco Creek	Lower Seco Canyon	Sierra	BELL MOUNTAIN	Private; Ladder Ranch	Yes
105	Animas Creek	Chacon Park	Sierra	Apache Peak	Private; Ladder Ranch	No
106	Las Animas Creek	Dollar Mesa	Sierra	BELL MOUNTAIN	Private; Ladder Ranch	Yes
107	Las Animas Creek	Warm Spring	Sierra	BELL MOUNTAIN	Private; Ladder Ranch	Yes
108	Las Animas Creek	Saladone Tank	Sierra	SALADONE TANK	Private; Ladder Ranch	Yes
109	Canones Creek	Canones Creek/Box	Rio Arriba	CHAMA 15'	Private and NM Game and Fish	No

* Listed here are major, but not all, jurisdictions over each site. MRGCD = Middle Rio Grande Conservancy District; RGVSP = Rio Grande Valley State Park.

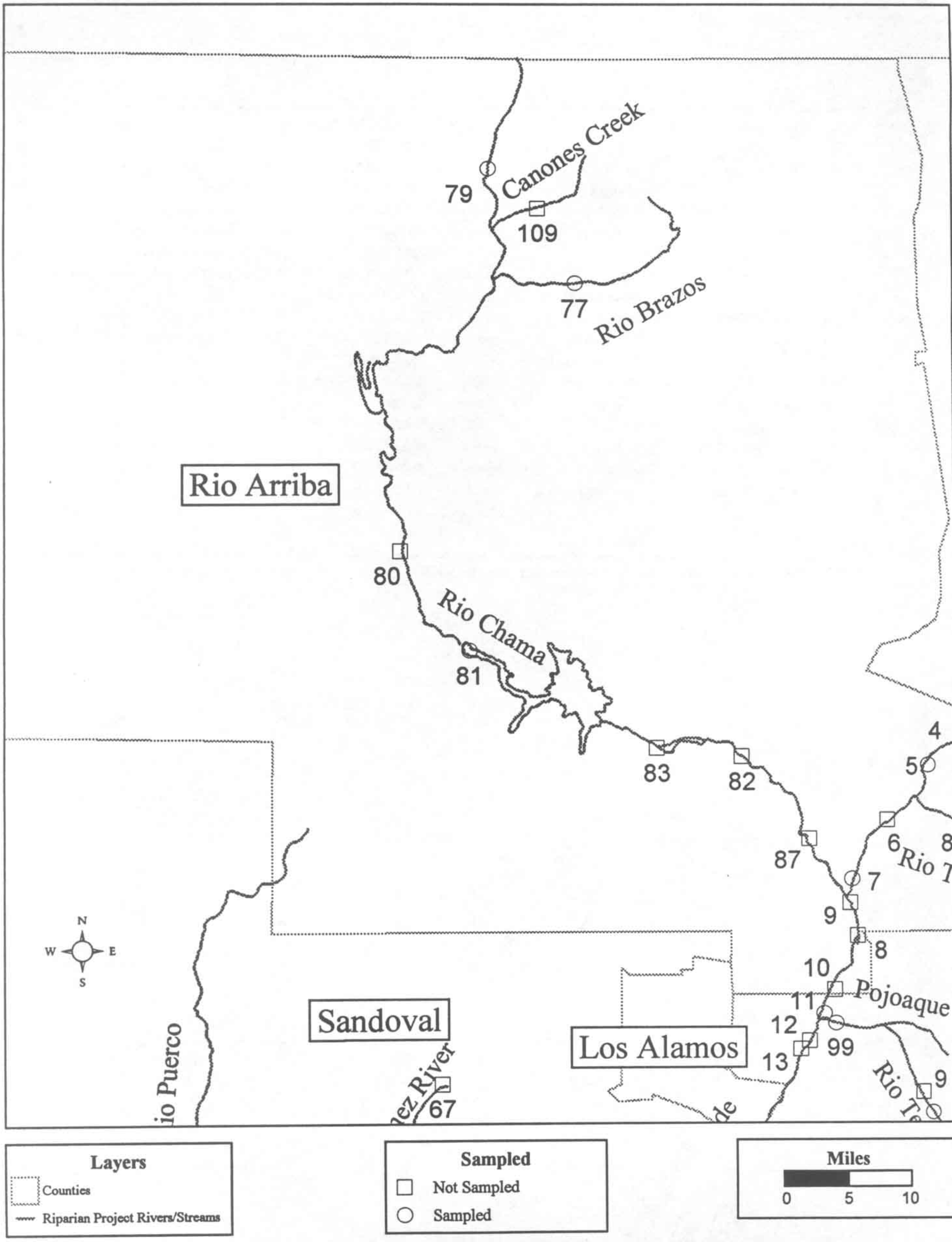


Figure 2. Riparian/wetland sites assessed in the Rio Chama watershed, New Mexico, identified by site number.

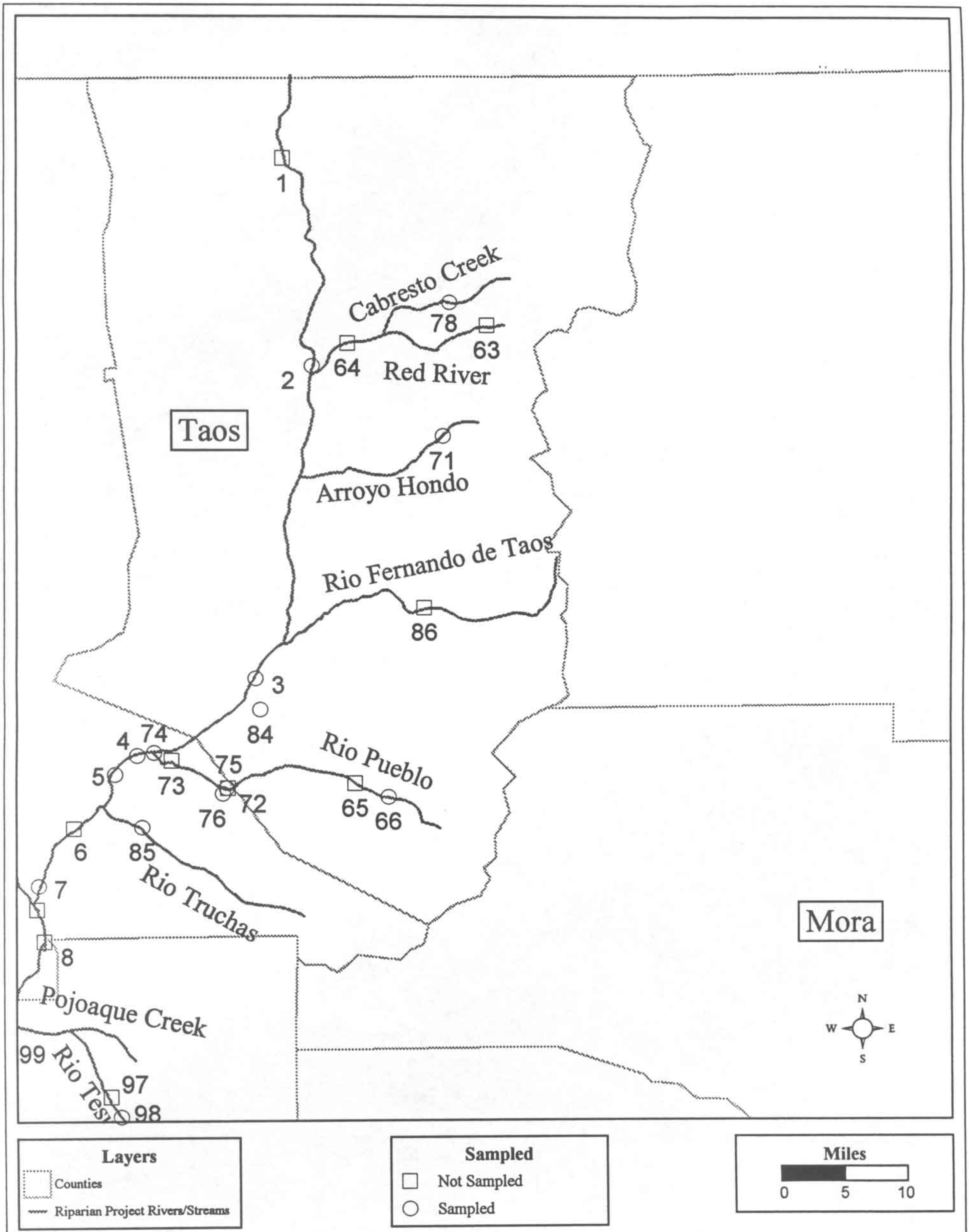


Figure 3. Riparian/wetland sites assessed in the upper Rio Grande watershed, New Mexico, identified by site number.

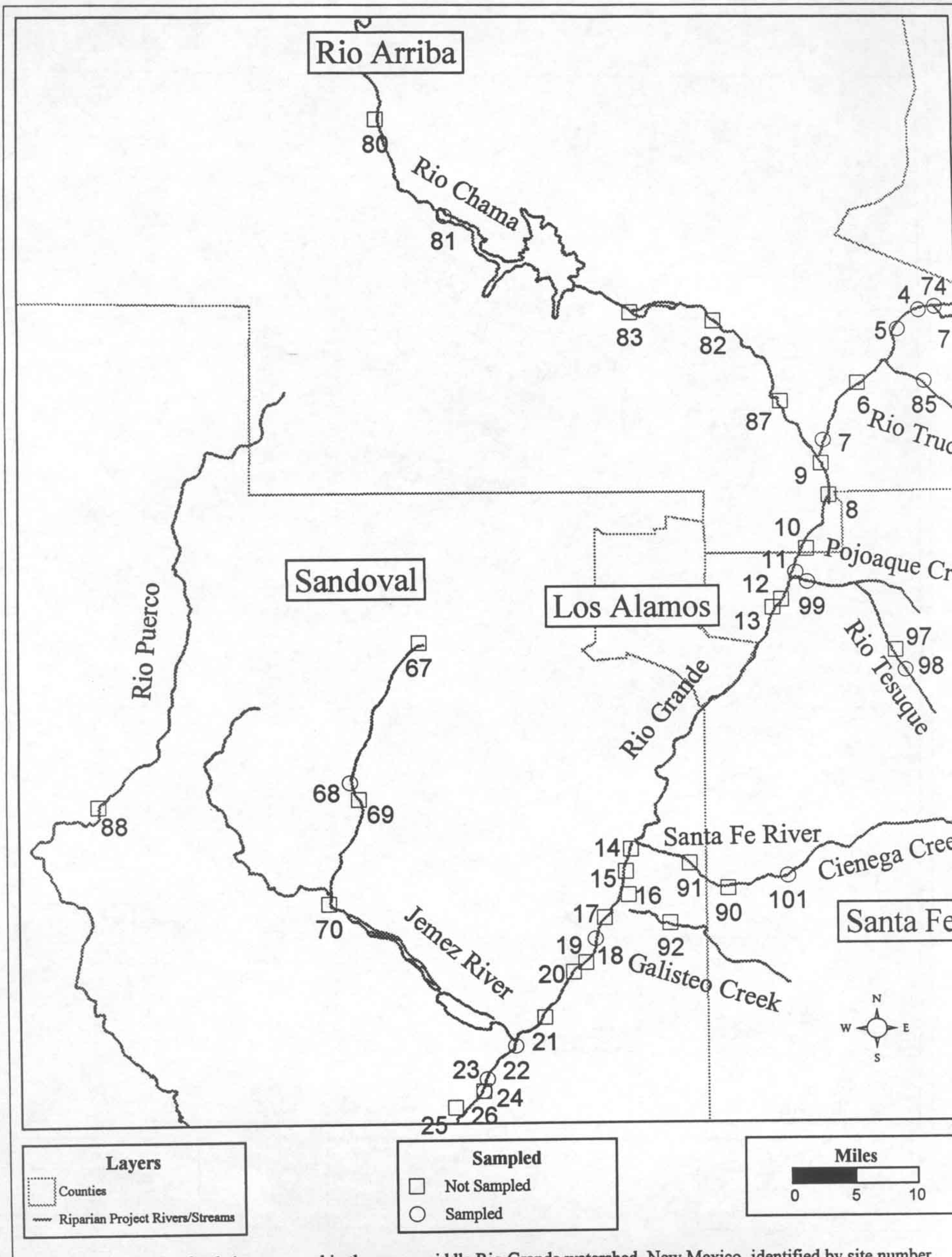


Figure 4. Riparian/wetland sites assessed in the upper middle Rio Grande watershed, New Mexico, identified by site number.

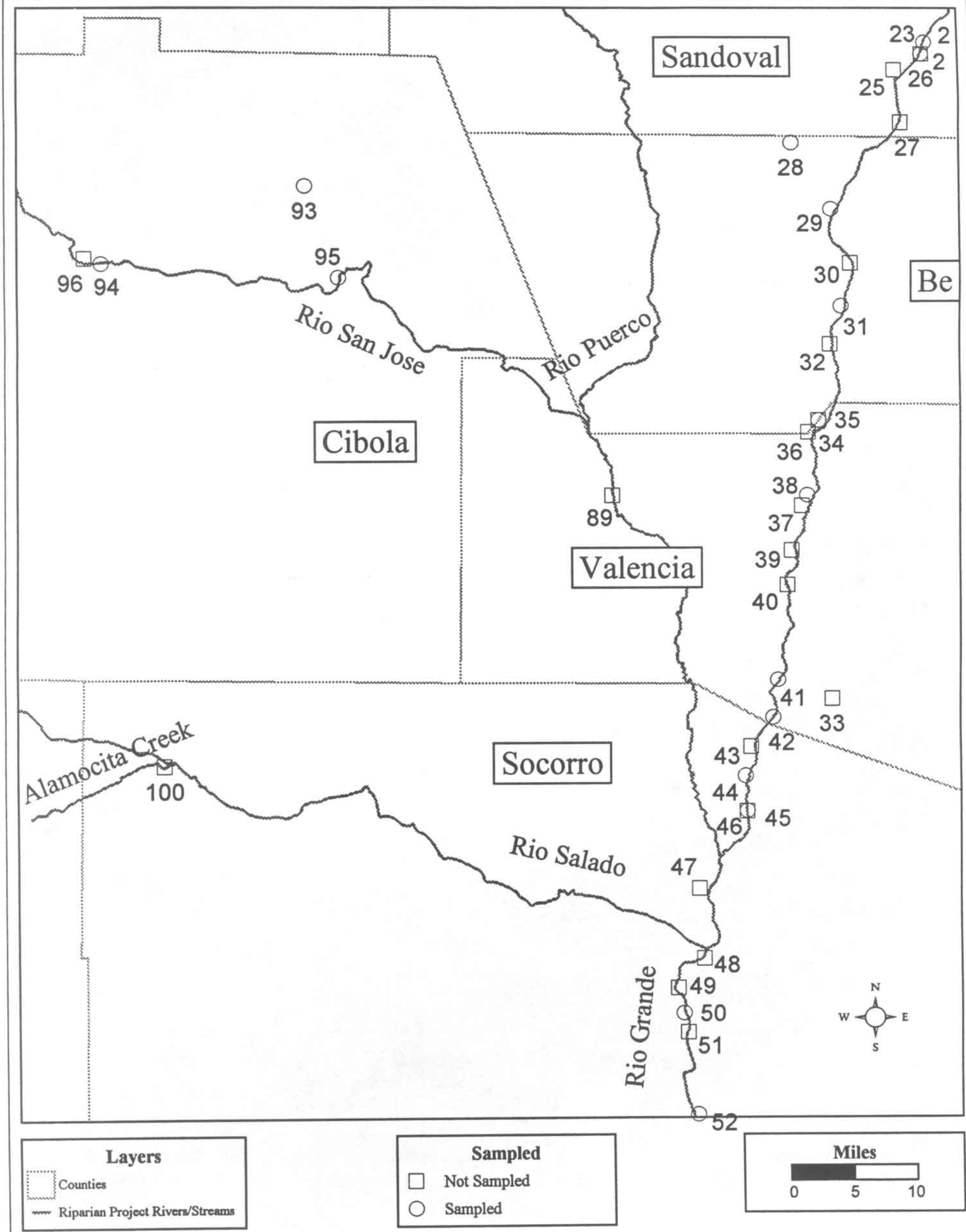


Figure 5. Riparian/wetland sites assessed in the lower middle Rio Grande watershed, New Mexico, identified by site number.

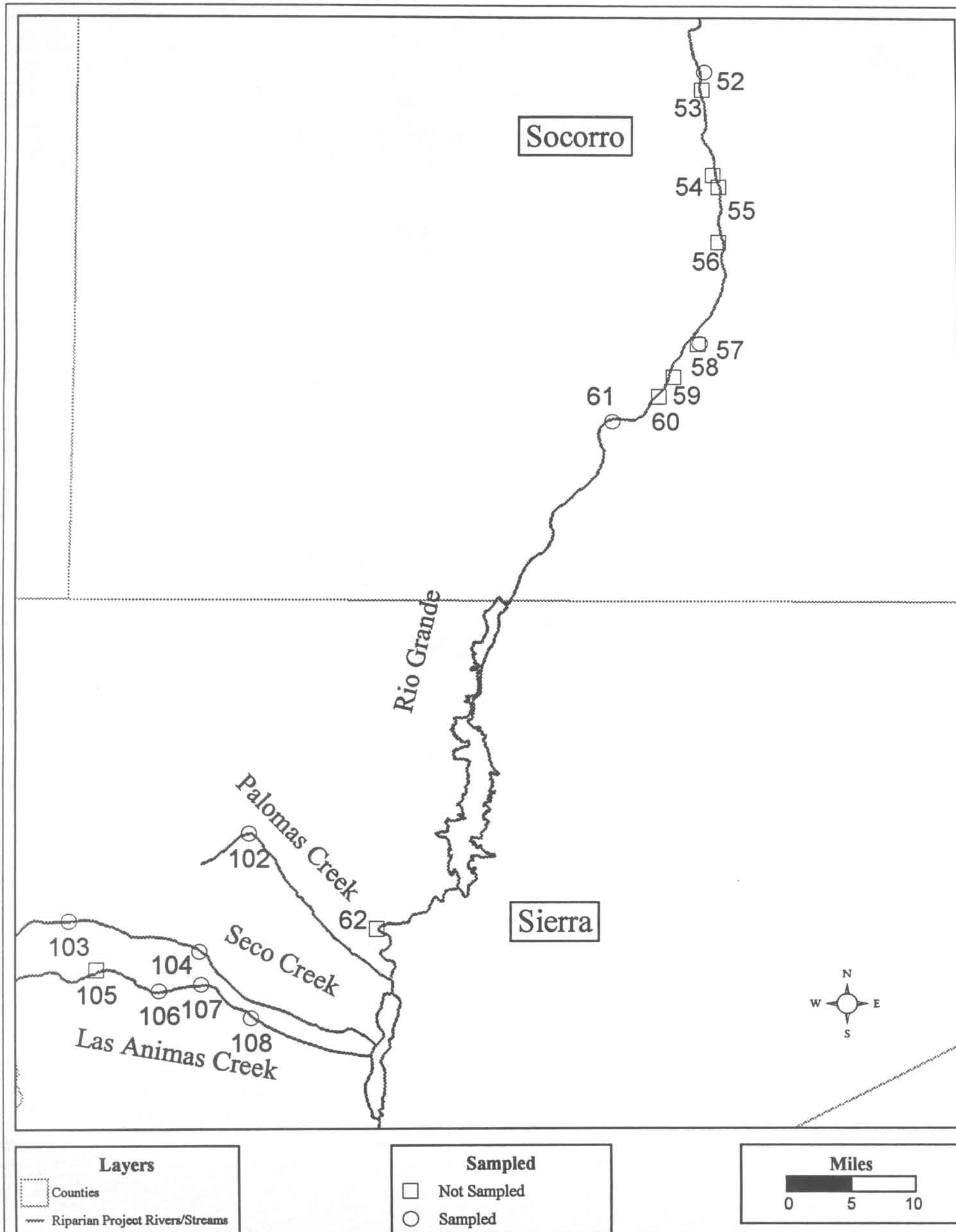


Figure 6. Riparian/wetland sites assessed in the lower Rio Grande watershed, New Mexico, identified by site number.

General Hydrological Regimes

Brief hydrological descriptions of the major reaches of the Rio Grande and its associated tributaries are presented here. These descriptions focus on sampled reaches and tributaries and are based on data from 73 stream channel cross sections. Cross sectional diagrams of the eighteen highest quality sites identified are given in Appendix D. Of the total 73 cross sections, 35 were sampled on the mainstem, which we have separated into four separate reaches. The remaining 38 cross sections were on the 21 tributary reaches distributed throughout the watershed (Table 4, Figures 2-6).

In Table 4, each reach is described in terms of Rosgen's (1992) stream type (channel morphology), whether it is impacted by significant flow regulations in terms of dams, if it is periodically dredged of sediments, if the banks have been stabilized by jetty jacks or riprap, and whether the river or stream has been channelized by one or more levees.

Rio Grande: Colorado Border to Velarde

From the Colorado border to Velarde, the Rio Grande is more or less unregulated and generally free of channel and flow modifications (Table 4). The impoundments that occur farther north in the San Juan Mountains of Colorado appear to have a limited impact on flows, particularly during the spring runoff. The major tributaries of this reach: Red River, Rio Hondo, Rio Pueblo de Taos, and Rio Embudo contribute significantly to the spring runoff and overall annual flow. Maximum peak discharges through this reach can be high. A one day maximum of 15,900 cfs was recorded in 1903 at Embudo Station (Bureau of Reclamation 1995). Since 1948 flows have not surpassed 10,000 cfs. This may be due to water withdrawals for irrigation from the San Luis Valley in Colorado, but this is not well understood, and the river remains more or less wild through this reach.

In the Rio Grande Gorge, the channel is characteristic of a B1 stream type of Rosgen (1992). It is deeply entrenched and confined by steep canyon sideslopes. The channel is well armored by large rocks and boulders. Floodplain depositional landforms, such as side bars and terraces, are uncommon. Yearly peak flows range from 1,500-2,000 cfs and commonly inundate the narrow side bars. As a result, flood flows scour the channel and commonly eliminate unstable bars, and clear significant amounts of vegetation.

In less confined canyon reaches below the Gorge, side and mid channel bars and narrow terraces are well developed. At Pilar, yearly peak discharges of greater than 2,000 cfs easily inundate the lowest positions of the floodplain (Figure D.1. in Appendix D). While the vegetation through the Gorge remains free of woody exotics, below the Gorge where the floodplain broadens and flows become less inundating, saltcedar dominates many bars. From Pilar to Velarde, Rio Grande cottonwoods begin to appear, saltcedar is uncommon, and Russian olives are scattered. Lower terraces occupied by

Table 4. Hydrologic status and impacts of reaches of the Rio Grande, Chama, Jemez, and tributaries sampled.

River	Stream Type	Flow Regulation	Dredging	Jetty Jacks	RipRap	Levee
Rio Chama - Colorado Border to El Vado	C1	No	No	No	No	No
Rio Chama - Rio Gallina to Abiquiu	C2	Yes	No	No	No	No
Rio Grande - Colorado Border to Velarde	B1	No	No	No	No	No
Rio Grande - Velarde to Cochiti	C3	No	Yes	Yes	No	Yes
Rio Grande - Cochiti to Los Lunas	C4	Yes	Yes	Yes	Yes	Yes
Rio Grande - Los Lunas to San Marcial	C5	Yes	Yes	Yes	No	Yes
Cabresto Creek - Upper	B1	No	No	No	No	No
Rio Brazos - Upper	C1	No	Unknown	No	No	Unknown
Arroyo Hondo - Upper	A2	No	No	No	No	No
Agua Caliente - Lower	A3	No	No	No	No	No
Rio Pueblo - Upper	B2	No	No	No	No	No
Embudo Creek - Picuris Pueblo Boundary	B2	No	No	No	No	No
Embudo Creek - Dixon to Rio Grande Confluence	C3	No	No	No	No	Yes
Canada de Ojo Sarco - Lower	B4	No	No	No	No	No
Rio Truchas - Lower	C3	No	No	No	No	No
Rio Tesuque - Middle	C3	Yes	No	No	No	Yes
Pojoaque River - Lower	C3	Yes	Yes	Yes	No	Yes
Cienega Creek	C2	No	No	No	No	No
Jemez River - Guadalupe Creek to Jemez Pueblo	C3	No	No	No	No	No
Rio Paguate - Upper	A3	No	No	No	No	No
Rio San Jose - Lower	C4	Yes	No	No	No	No
Rio Puerco - Lower	C5	No	No	No	No	No
Palomas Creek	C3	No	No	No	No	No
Seco Creek	B2	No	No	No	No	No
Las Animas Creek	C1	No	No	No	No	No

cottonwoods are flooded with flows between 4,000 and 5,000 cfs. Flows of this magnitude occur every two to five years (Figure 7).

Rio Grande: Velarde to Cochiti

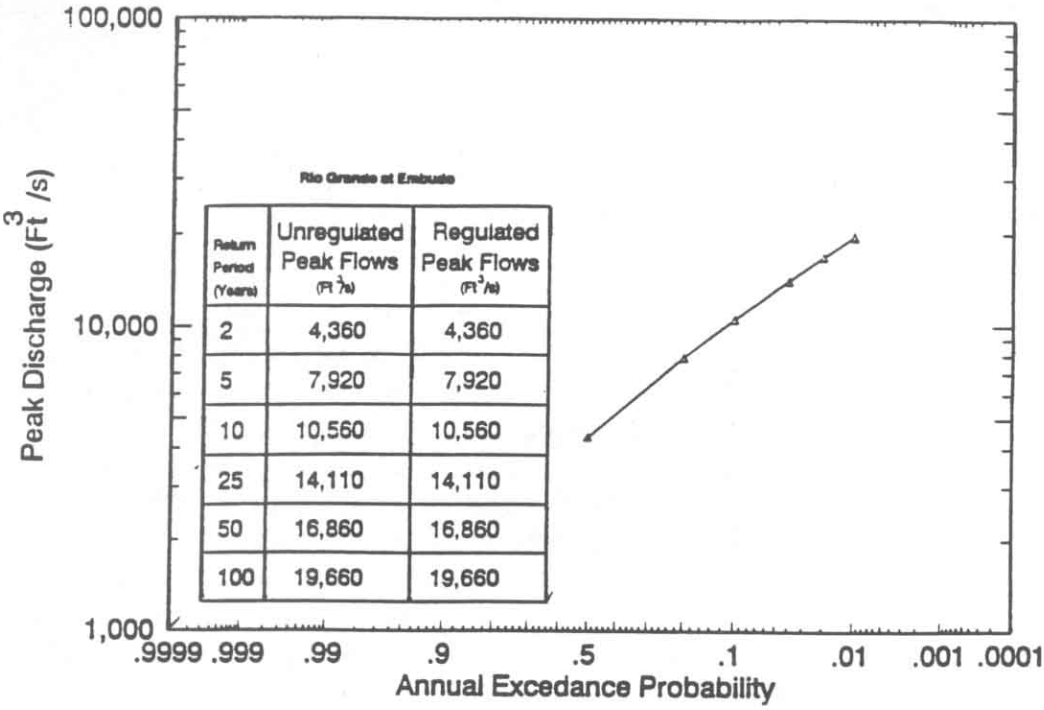
The reach from Velarde south to Cochiti widens into a broad floodplain with a gentle gradient (0.1-0.5%). Under natural conditions, the river would meander with little or no confinement, characteristic of Rosgen's (1992) C3 stream type with a predominantly gravel bed and mixtures of small cobbles, and sand. However, channel modifications such as straightening, levee construction and jetty jacking have cut off the natural meander pattern and effectively constrained the movement of the river (Table 4). At San Juan Pueblo, channelization has isolated old stream meanders, which consequently have been colonized by cattails and other wetland species. Exotics, mainly Russian olive, are common or dominant in some areas along this reach although mature stands of cottonwoods still exist.

Although there are no major impoundments in this reach, there are significant diversions for irrigation. Yet, at San Juan Pueblo just above the confluence with the Rio Chama, flows between 4,500 cfs and 5,000 cfs still occur and will inundate the floodplain. These flows probably re-occur every five years on average during spring runoff (Figure 8). Although the Rio Chama is highly regulated by a series of dams and diversions, it still contributes significant discharges to the Rio Grande (Figure 9). Areas downstream from the Rio Chama confluence have discharges that are estimated to occur every other year in excess of 6,000 cfs (Figure 10). These flows are enough to inundate the lower portion of the floodplain. A one day maximum peak flow of 22,200 cfs was recorded at Otowi Bridge in 1920. In 1985, after completions of both El Vado and Abiquiu reservoirs, the last highest maximum peak flow for one day at that site was 12,000 cfs (Bureau of Reclamation 1995).

Other tributaries in this reach, such as the Rios Pojoaque, Tesuque, Frijoles and Truchas, the Santa Fe River and La Cienega Creek, are relatively small and do not contribute significant surface flows during most the year. Along their lower reaches their primary contribution is from short term, ephemeral flows following summer thunderstorms.

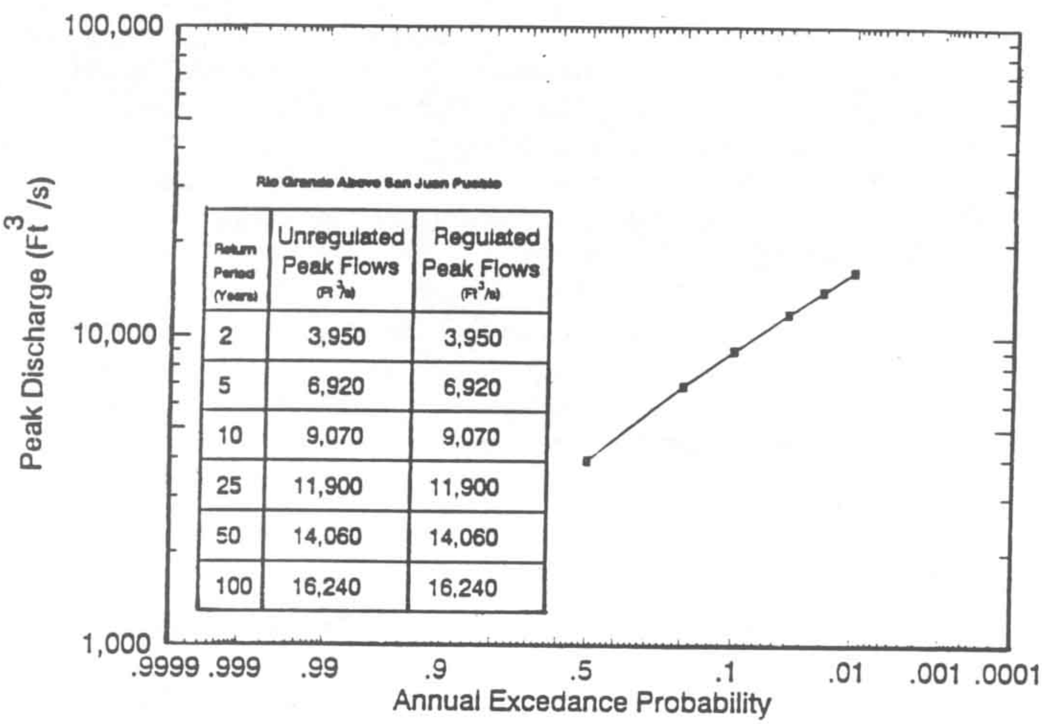
Rio Grande: Cochiti to Los Lunas

Along this reach, the Rio Grande is typical of a C4 stream type (Rosgen 1992). with a predominantly sandy bed with mixtures of gravel and silt and a very low gradient (0.1% or less). Flows from the last major flood to occur in this reach (the 1941 flood) are not on record; subsequently, between 1943 and 1975 a maximum flow of 12,100 cfs for one day was recorded in Albuquerque in 1948 (Bureau of Reclamation 1995). Since the closure of Cochiti Dam in 1975, the maximum discharge of water released at one time was 8,290 cfs in 1985 (Bureau of Reclamation 1995).



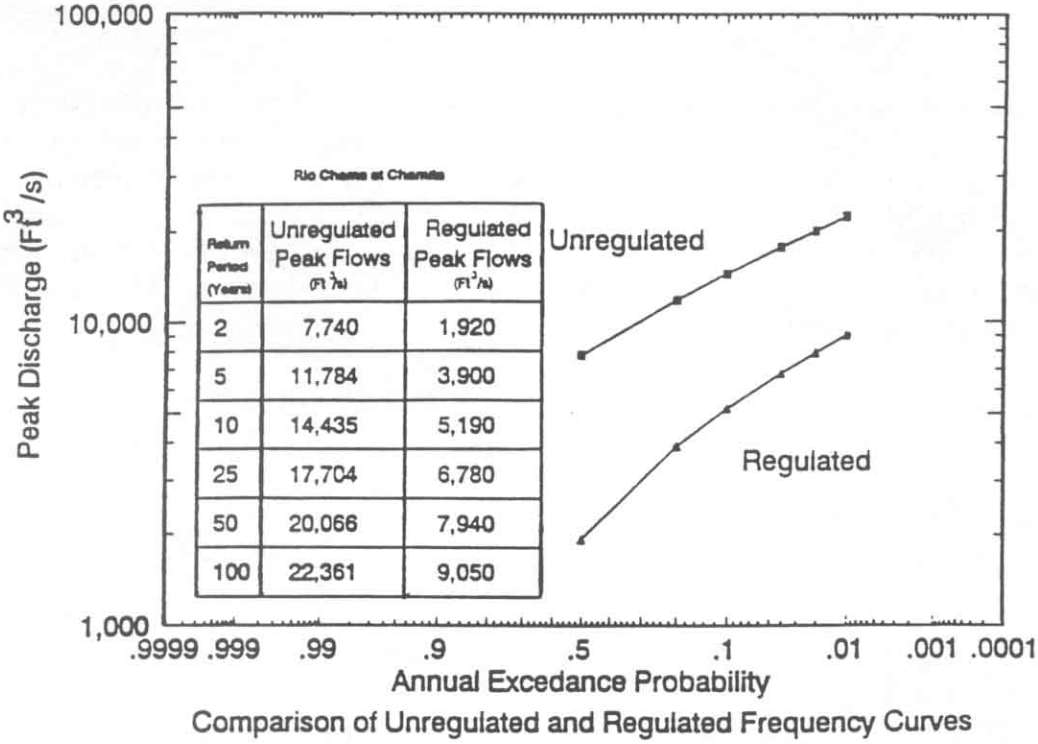
Return Period (Years)	Unregulated Peak Flows (Ft^3/s)	Regulated Peak Flows (Ft^3/s)
2	4,360	4,360
5	7,920	7,920
10	10,560	10,560
25	14,110	14,110
50	16,860	16,860
100	19,660	19,660

Figure 7. Projected peak discharges and their corresponding recurrence intervals for the Rio Grande at Embudo. This reach is unregulated, therefore regulated and unregulated peak flows are equal (from BOR 1995 with permission).



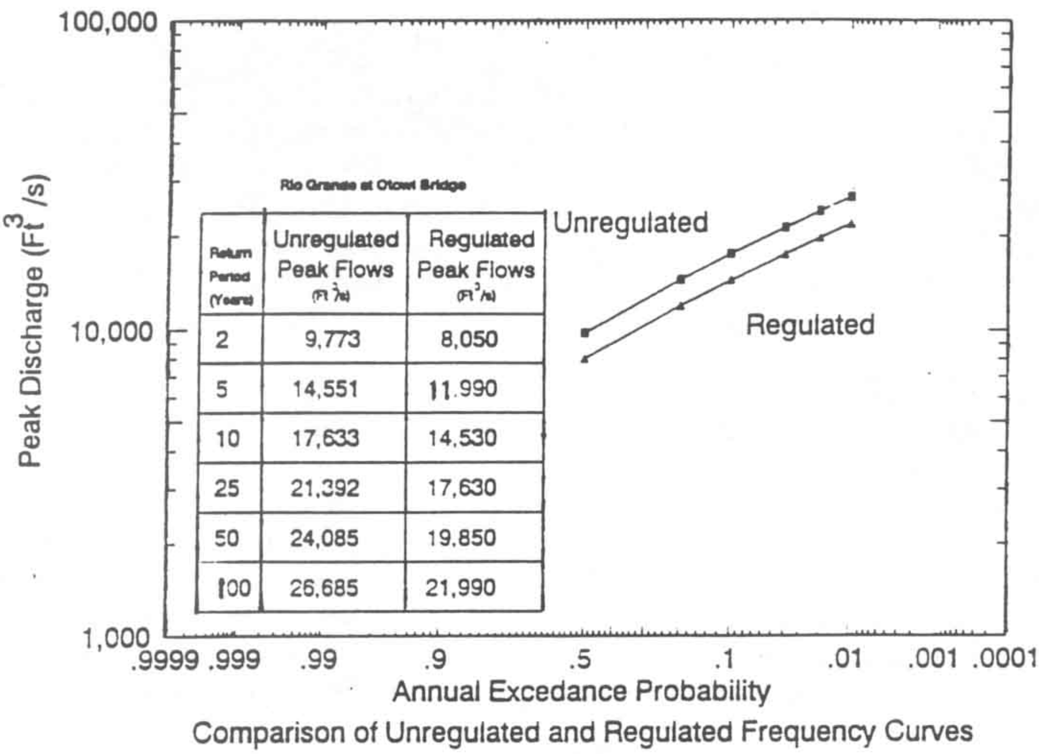
Return Period (Years)	Unregulated Peak Flows (Ft^3/s)	Regulated Peak Flows (Ft^3/s)
2	3,950	3,950
5	6,920	6,920
10	9,070	9,070
25	11,900	11,900
50	14,060	14,060
100	16,240	16,240

Figure 8. Projected peak discharges and their corresponding recurrence intervals for the Rio Grande at San Juan Pueblo. This reach is unregulated, therefore regulated and unregulated peak flows are equal (from BOR 1995 with permission).



Return Period (Years)	Unregulated Peak Flows (Ft³/s)	Regulated Peak Flows (Ft³/s)
2	7,740	1,920
5	11,784	3,900
10	14,435	5,190
25	17,704	6,780
50	20,066	7,940
100	22,361	9,050

Figure 9. Comparison of projected unregulated and regulated peak discharges and their corresponding recurrence intervals for the Rio Chama near the confluence of the Rio Grande (from BOR 1995 with permission).



Return Period (Years)	Unregulated Peak Flows (Ft³/s)	Regulated Peak Flows (Ft³/s)
2	9,773	8,050
5	14,551	11,990
10	17,633	14,530
25	21,392	17,630
50	24,085	19,850
100	26,685	21,990

Figure 10. Comparison of projected unregulated and regulated peak discharges and their corresponding recurrence intervals for the Rio Grande at Otowi bridge (from BOR 1995 with permission).

The main tributary to the Rio Grande in this reach is the Jemez River. Its flows are also regulated by a dam near the confluence. Jemez Canyon Reservoir was built in 1954, and like Cochiti Reservoir, it functions primarily for flood and sediment control (Crawford et al. 1993). In areas immediately below Cochiti Dam, particularly at Santo Domingo and Santa Ana Pueblos and south through Albuquerque, channel incision and erosion of the riverbank are common (Figure 11). In many areas terraces adjacent to the channel are several meters high.

To counteract erosion and to further control flows, the channel has been highly modified. Where the floodway was not naturally bounded by mesas and bluffs, levees were constructed to protect the remainder of the floodplain from floods. At Santo Domingo Pueblo and elsewhere, to stabilize the banks and to protect levees, banks are commonly riprapped with large stones (Figure 12). Along most of the reach, and particularly through Albuquerque, the course of the river is entirely determined by the jetties that line the banks. There are no natural meander patterns beyond the banks, and the river is essentially "locked" in place between a 600 ft. wide channel.

Flooding in this reach is confined to a few overflow channels and some low lying side bars within the levees. These can be flooded with flows of 6,000 to 7,000 cfs (e.g., at Rio Bravo bridge). Because of channel entrenchment, the highest terraces of the "bosque" would require more than 10,000 cfs to flood. This is beyond the maximum release that is currently allowed from Cochiti Dam (Figures 13 and 14). Hence, many of the cottonwoods on the terraces are left out of the active floodplain.

Rio Grande: Los Lunas to San Marcial

Between Los Lunas and San Marcial, the Rio Grande can be classified as a C5 stream type of Rosgen (1992) where the channel consists of a shifting sand bed with mixtures of silt or clay with a very low gradient (about .1%). The channel is moderately entrenched through much of the reach, but is not as incised as further upstream near the outfall of Cochiti. Entrenchment of the channel declines towards Elephant Butte Reservoir and is aggrading (Table 4).

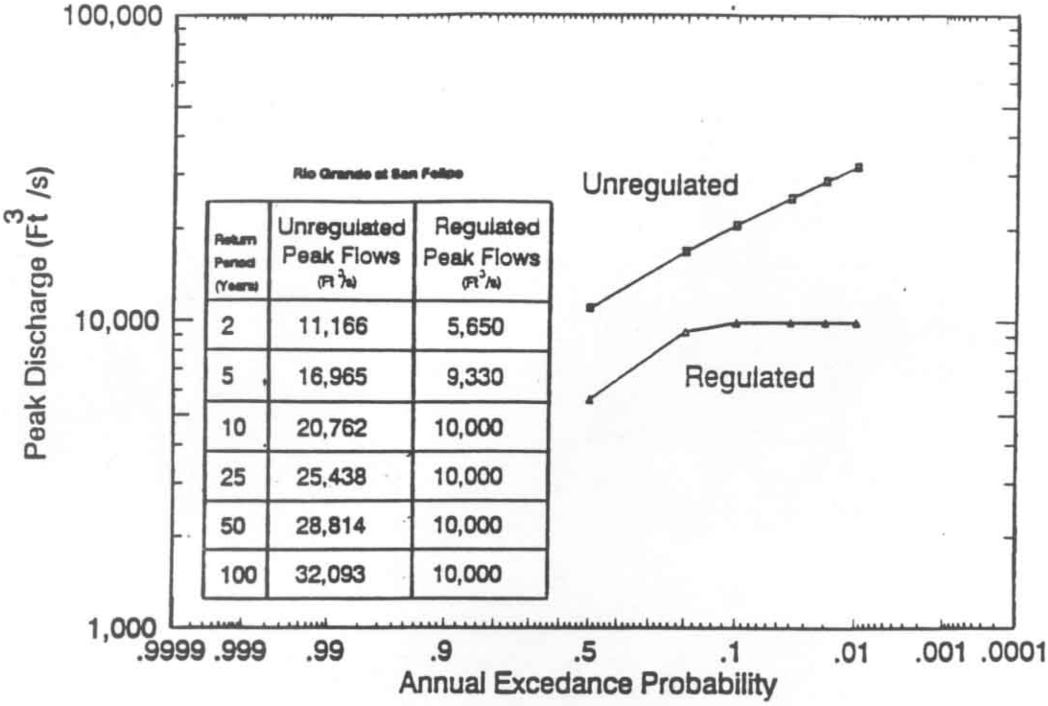
For the most part, this reach is as heavily modified as the reach from Cochiti to Los Lunas by levee confinement and water diversion. The floodplain is further stabilized by jetty jacks and the channel has been dredged in the past to keep it straight. At San Acacia, the active river channel is allowed to become completely dry when flows are <300 cfs by complete diversion to the low flow conveyance channel. Irrigation drains built and maintained by the Middle Rio Grande Conservancy District can also cause the channel to run dry. Much of the river south of Bernardo is free from the confining effects of the jetty jacks. Also, near Socorro the east side of the river lacks a levee (particularly at Bosque Del Apache), but it is still confined by the close proximity of the eastside upland slope.

Photo: Mike Bradley

Figure 11. Channel entrenchment and incision in the Cochiti to Los Lunas reach of the Rio Grande.

Photo: Mike Bradley

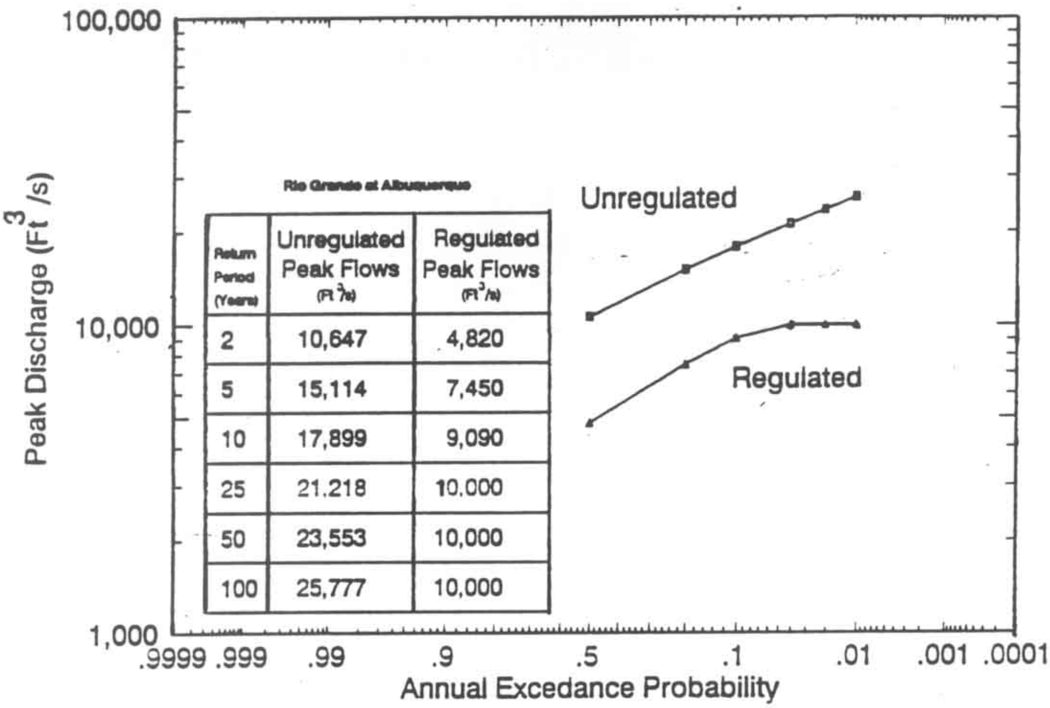
Figure 12. Riprapped left bank in the Cochiti to Los Lunas reach of the Rio Grande.



Rio Grande at San Felipe

Return Period (Years)	Unregulated Peak Flows (Ft³/s)	Regulated Peak Flows (Ft³/s)
2	11,166	5,650
5	16,965	9,330
10	20,762	10,000
25	25,438	10,000
50	28,814	10,000
100	32,093	10,000

Figure 13. Comparison of projected unregulated and regulated peak discharges and their corresponding recurrence intervals for the Rio Grande at San Felipe Pueblo (from BOR 1995 with permission).



Rio Grande at Albuquerque

Return Period (Years)	Unregulated Peak Flows (Ft³/s)	Regulated Peak Flows (Ft³/s)
2	10,647	4,820
5	15,114	7,450
10	17,899	9,090
25	21.218	10.000
50	23,553	10,000
100	25,777	10,000

Figure 14. Comparison of projected unregulated and regulated peak discharges and their corresponding recurrence intervals for the Rio Grande at Albuquerque (from BOR 1995 with permission).

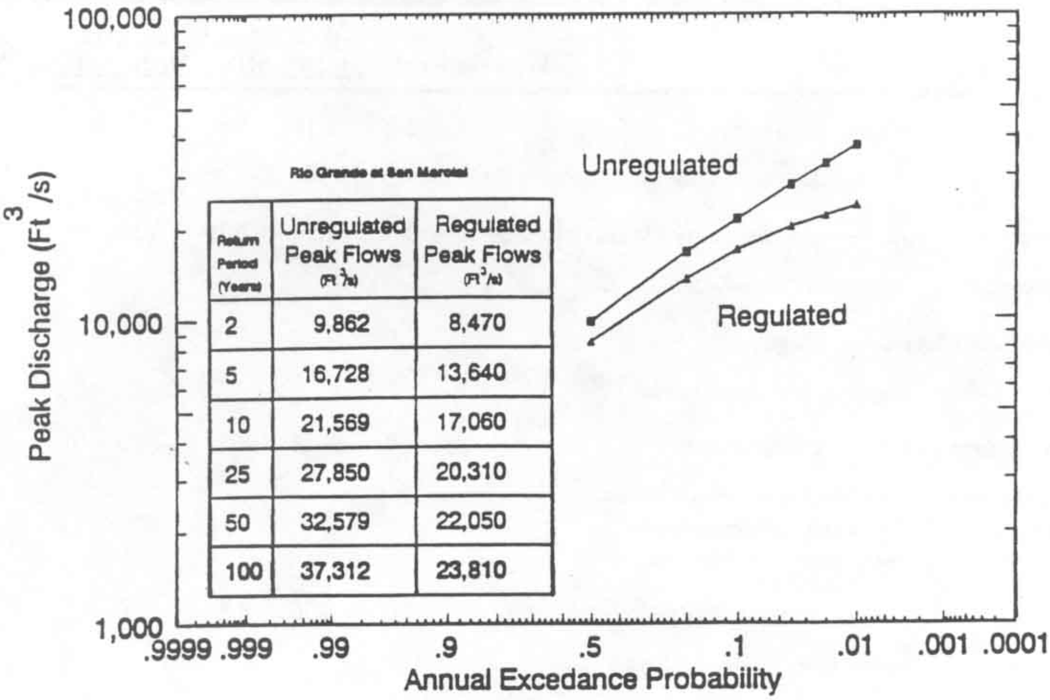
Over the past 35 years the highest maximum daily flow recorded in this reach was 9,580 cfs at Bernardo in 1958. Interestingly, since 1975 (when Cochiti was impounded), flows between 6,000 and 9,000 have occurred fairly regularly at Bernardo, San Acacia, and San Marcial (Bureau of Reclamation 1995). Despite jetties and Cochiti, areas near Los Lunas and south of Belen were flooded by approximately 7,000 cfs flows during spring runoff in 1992. During this flood, much of the bosque in this area was inundated. These flows are estimated to have a two year return frequency, based on projections from gauge readings downstream at Bernardo (Figure 15). Low-lying areas south of Bernardo to San Acacia are also easily flooded every two-years with flows of 8,000-9,000 cfs (Figure 16). This may be due, in part, to sediment and water contributions from the Rio Puerco and Rio Salado, major tributaries from the west. These rivers are moderately to extremely entrenched, and as they approach the Rio Grande they contain little perennial surface flow.

In some areas between Socorro and Elephant Butte Reservoir (particularly near San Antonio), overbank flooding occurred with flows of about 6,000 cfs in 1992. Significant flows and sediment transport do occur in response to localized summer thunderstorms as ephemeral flash floods. Again, the Rio Puerco and Rio Salado would contribute to such floods; a flood of 30,600 cfs was recorded in 1929 on the Rio Puerco (Cruz et al. 1993). During concurrent high runoff events, flows at the lower end of the reach at San Marcial can exceed 10,000 cfs (Figure 17).

Rio Chama

The Rio Chama has it headwaters in the San Juan Mountains of Colorado. It flows unregulated and lacks significant channel modifications until El Vado Reservoir, 50 miles south of the Colorado border. In this segment, the stream corresponds to a C1 stream type of Rosgen's (1992) with low gradients and moderate entrenchment. Channel materials consist of cobbles and large gravels. Flooding of side bars in the floodplain occurs every two to five years with flows of about 400-600 cfs. Higher positions in the floodplain (dominated by narrowleaf cottonwood) are flooded every 25 to 50 years with flows of 2,000 cfs (Figure D.6. of Appendix D). The major tributary in this segment is the Rio Brazos.

The Rio Chama is highly controlled from El Vado Reservoir through Abiquiu Reservoir to the confluence of the Rio Grande. In addition, waters from the San Juan River are delivered into the Rio Grande watershed via the San Juan-Chama Project. This project consists of three diversion dams, two siphons, and a tunnel which dumps water into Heron Reservoir, from where it is released to the Chama (Fogg et al. 1992). Below El Vado to the Rio Gallina confluence, the channel is confined by a deep canyon with a limited floodplain development. As with the Rio Grande Gorge, high flows tend to scour much of the riparian zone, precluding the development of significant wetland forests. From the Rio Gallina confluence, to Abiquiu, the river widens into a somewhat broader floodplain with lower gradients and finer bedload materials (gravels and cobbles)



Return Period (Years)	Unregulated Peak Flows (Ft^3/s)	Regulated Peak Flows (Ft^3/s)
2	9,862	8,470
5	16,728	13,640
10	21,569	17,060
25	27,850	20,310
50	32,579	22,050
100	37,312	23,810

Figure 17. Comparison of projected unregulated and regulated peak discharges and their corresponding recurrence intervals for the Rio Grande at San Marcial (from BOR 1995 with permission).

typical of a Rosgen (1992) C2 stream type. It is moderately entrenched, and flows of 2,000 cfs or more may be required for overbank flooding. In some lower positions, the floodplain may be flooded at between 500-1,500 cfs, corresponding to a two to five year return interval.

Jemez River

The Jemez River flows out of the Jemez mountains and meets the Rio Grande just north of Bernalillo. It remains unregulated for most of its length until Jemez dam, which is located a few miles upstream from the confluence on the Rio Grande. Aside from a few diversion dams and irrigation ditches, the hydraulic regime is natural and most channel impacts are absent (Table 4).

In the reach between the Guadalupe confluence and Jemez Pueblo the channel is classified as a Rosgen (1992) C3 stream type. It is moderately entrenched, has a relatively low gradient, and channel materials consist of cobbles and gravels. Lower positions in the floodplain are flooded annually with flows between 500-1000 cfs (Figure D.35. in Appendix D). Higher positions of the floodplain, which commonly support Rio Grande cottonwood and coyote willow, can be inundated with flows between 2,500-3,600 cfs. These flows are estimated to occur every five to twenty-five years.

Rio Grande Riparian/Wetland Soils

The soils in riparian zones of the Rio Grande watershed develop from flood deposited sediments. Most are relatively young and are classified in the Entisol soil order of Soil Taxonomy (Soil Survey Staff 1992) because they show little physical alteration from weathering or other processes (Buol et al. 1973). They lack significant structure and clay accumulations, which are indicative of age and the breaking down of coarser materials to finer ones. In a few cases there is evidence of soil development, particularly on older terraces that are no longer flooded, and these soils are classified as either from the Inceptisol or Aridisol Orders. Within orders, the soils are further hierarchically classified into several different suborders, great groups, and subgroups based primarily on environmental influences. Appendix E provides a brief description of the diagnostic properties of the various soil classes of the taxonomy as they apply to the riparian soils sampled.

From the point of view of riparian/wetland vegetation communities, indications of water saturation and water availability in the soil profile are particularly important. Water saturation is usually indicated by current or near-past low oxygen conditions (gleying or redoximorphic features), and is indirect evidence of the ground water influence on vegetation expression. In Table 5 we have ordered the various soil taxa that were found in the Rio Grande watershed by wetness rank and water availability. This results in arrangement of the soils primarily by their Subgroup level of taxonomy, and then by Family texture classes within Subgroups based on water availability (i.e., water

Table 5. **Riparian/wetland soil wetness and other characteristics, with all communities sampled that were associated with those soils.**

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Ponded	1.0						
Communities:							
Riverwash — sandy-skeletal	2.0	0.51	0.51				
Communities: Arizona alder / Goodding's willow Arizona sycamore / seepwillow bluestem willow / coyote willow coyote willow / redtop Fremont's cottonwood / velvet ash narrowleaf cottonwood / coyote willow seepwillow / prairie wedgescale							
Fluvaquent Typic — sandy-skeletal	2.0	1.95	1.95	7.38	0.32		
Communities: bluestem willow / coyote willow bluestem willow / sparse ground cover coyote willow / American bulrush coyote willow / Baltic rush coyote willow / redtop coyote willow / sparse ground cover Fremont's cottonwood / Goodding's willow narrowleaf cottonwood / bluestem willow narrowleaf cottonwood / coyote willow narrowleaf cottonwood / Kentucky bluegrass thinleaf alder / bluestem willow thinleaf alder / redosier dogwood							
Fluvaquent Mollic — sandy-skeletal	2.0	2.09	2.09	6.82	1.15	0.44	
Communities: American bulrush / common spikerush American bulrush / smooth horsetail							
Fluvaquent Mollic — sandy-skeletal / loamy-skeletal	2.0	2.30	2.30	6.87		0.70	
Communities: Arizona alder / Goodding's willow							
Fluvaquent Typic — loamy-skeletal	2.0	4.35	4.35	6.30	1.65	0.50	
Communities: American bulrush / common spikerush blue spruce / thinleaf alder Fremont's cottonwood / Goodding's willow narrowleaf cottonwood / thinleaf alder saltcedar / coyote willow thinleaf alder / bluestem willow thinleaf alder / redosier dogwood							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Psammaquent Mollic — sandy	2.0	5.10	5.10				
Communities: Baltic rush / common spikerush							
Fluvaquent Typic — coarse-loamy / loamy-skeletal	2.0	7.30	7.30	6.36		0.36	
Communities: blue spruce / thinleaf alder							
Fluvaquent Typic — clayey	2.0	7.90	7.90	7.88		0.40	
Communities: coyote willow / smooth horsetail							
Fluvaquent Typic — coarse-loamy	2.0	8.54	8.54	7.70	0.11	0.94	0.08
Communities: American bulrush / smooth horsetail Baltic rush / common spikerush water sedge / smooth horsetail							
Fluvaquent Typic — loamy / sandy-skeletal	2.0	8.56	8.56	6.26			
Communities: coyote willow / common spikerush							
Fluvaquent Mollic — fine-loamy	2.0	11.90	11.90	7.00			
Communities: coyote willow / American bulrush							
Psammaquent Typic — sandy	2.5	5.10	5.10	7.64	0.12	0.96	0.60
Communities: coyote willow / seepwillow coyote willow / water sedge Rio Grande cottonwood / coyote willow Rio Grande cottonwood / saltcedar							
Fluvaquent Aeric — sandy-skeletal	3.0	1.98	1.98	7.45	0.51	0.50	0.17
Communities: American bulrush / smooth horsetail Arizona alder / seepwillow Arizona sycamore / Arizona alder blue spruce / Kentucky bluegrass blue spruce / thinleaf alder bluestem willow / coyote willow common spikerush / smooth horsetail coyote willow / American bulrush coyote willow / redtop coyote willow / sparse ground cover narrowleaf cottonwood / coyote willow narrowleaf cottonwood / thinleaf alder Rio Grande cottonwood / coyote willow Rio Grande cottonwood / smooth horsetail							
Fluvaquent Aeric — coarse-loamy / sandy-skeletal	3.0	3.14	3.14	7.23	0.72	0.59	0.35
Communities: coyote willow / American bulrush coyote willow / redtop coyote willow / smooth horsetail narrowleaf cottonwood / thinleaf alder							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Fluvaquent Aeric — sandy	3.0	5.10	5.10	7.68		0.40	
Communities: common spikerush / rice cutgrass							
Fluvaquent Aeric — loamy / sandy-skeletal	3.0	5.94	5.94	7.30	0.42		
Communities: blue spruce / thinleaf alder coyote willow / redtop coyote willow / smooth horsetail							
Fluvaquent Aeric — fine-loamy / sandy-skeletal	3.0	6.22	6.22	6.24	1.21	0.42	0.34
Communities: broadleaf cattail / American bulrush narrowleaf cottonwood / thinleaf alder							
Fluvaquent Aeric — coarse-loamy / sandy	3.0	6.78	6.78	7.93		1.84	
Communities: American bulrush / smooth horsetail							
Fluvaquent Aeric — coarse-loamy	3.0	7.80	7.80	7.51	0.58	2.20	1.53
Communities: blue spruce / thinleaf alder coyote willow / redtop coyote willow / smooth horsetail coyote willow / water sedge Fremont's cottonwood / Goodding's willow Rio Grande cottonwood / New Mexico olive							
Fluvaquent Aeric — coarse-loamy / fragmental	3.0	7.90	7.90	5.86		0.27	
Communities: coyote willow / redtop							
Fluvaquent Aeric — very fine clayey	3.0	7.90	7.90	7.45		1.61	
Communities: broadleaf cattail / rice cutgrass							
Fluvaquent Aeric — sandy / loamy	3.0	8.60	8.60	7.83		0.60	
Communities: Baltic rush / smooth horsetail							
Fluvaquent Aeric — fine-loamy	3.0	11.30	11.30	8.00			
Communities: Rio Grande cottonwood / Russian olive							
Ustifluvent Aquic — coarse-loamy / sandy-skeletal	5.0	2.04	2.04	8.13			
Communities: saltcedar / sparse ground cover							
Ustifluvent Aquic — sandy-skeletal	5.0	4.39	4.39	7.61	0.31		
Communities: coyote willow / sparse ground cover narrowleaf cottonwood / Rocky Mountain juniper Rio Grande cottonwood / coyote willow saltcedar / coyote willow							
Ustifluvent Aquic — sandy / loamy-skeletal	5.0	4.89	4.89	8.00			
Communities: coyote willow / redtop							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Ustifluvent Aquic — loamy-skeletal	5.0	5.17	5.17	7.38	0.60		
Communities: coyote willow / redtop							
Ustifluvent Aquic — fine-loamy / sandy-skeletal	5.0	6.10	6.10	7.96			
Communities: coyote willow / false quackgrass							
Ustifluvent Aquic — coarse-loamy	5.0	10.60	10.60	7.92	0.17		
Communities: saltcedar / coyote willow							
Ustifluvent Aquic — fine-loamy	5.0	11.10	11.10	8.00			
Communities: saltcedar / coyote willow							
Ustifluvent Aquic — fine silty	5.0	11.90	11.90	7.95			
Communities: saltcedar / sparse ground cover							
Ustipsamment Aquic — sandy	5.5	5.10	5.10	7.79		2.55	
Communities: coyote willow / American bulrush Rio Grande cottonwood / Russian olive							
Udifluvent Oxyaquic — sandy-skeletal	6.0	2.81	2.81	5.80	0.83	0.36	0.11
Communities: narrowleaf cottonwood / coyote willow narrowleaf cottonwood / thinleaf alder							
Ustifluvent Oxyaquic — sandy-skeletal	7.0	3.94	3.94	7.62	0.28	0.44	0.28
Communities: coyote willow / redtop coyote willow / smooth horsetail narrowleaf cottonwood / Arizona alder Rio Grande cottonwood / coyote willow Rio Grande cottonwood / saltcedar Rio Grande cottonwood / sparse ground cover							
Ustifluvent Oxyaquic — sandy	7.0	5.10	5.10	7.70	0.06	2.77	3.46
Communities: Rio Grande cottonwood / Russian olive Rio Grande cottonwood / smooth horsetail							
Ustifluvent Oxyaquic — coarse-loamy / sandy-skeletal	7.0	5.95	5.95	7.76	0.21	0.78	0.35
Communities: Baltic rush / Nebraska sedge coyote willow / smooth horsetail Rio Grande cottonwood / Kentucky bluegrass Rio Grande cottonwood / smooth horsetail							
Ustifluvent Oxyaquic — sandy / loamy	7.0	6.18	6.18	7.58		0.70	
Communities: Rio Grande cottonwood / water sedge							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Torrifluvent Aquic — sandy-skeletal / clayey	7.0	6.37	6.37	7.77		0.49	
Communities: Rio Grande cottonwood / coyote willow							
Ustifluvent Oxyaquic — clayey / sandy	7.0	6.97	6.97	7.61	0.00	0.72	0.38
Communities: coyote willow / woolly sedge Fremont's cottonwood / Goodding's willow							
Ustifluvent Oxyaquic — coarse-loamy / sandy	7.0	7.28	7.28	7.80	0.29	2.82	2.82
Communities: coyote willow / smooth horsetail Rio Grande cottonwood / New Mexico olive Rio Grande cottonwood / Russian olive Russian olive / saltcedar							
Ustifluvent Oxyaquic — coarse-loamy	7.0	7.95	7.95	7.92	0.15	0.98	0.61
Communities: coyote willow / redtop coyote willow / rubber rabbitbrush Fremont's cottonwood / Goodding's willow Fremont's cottonwood / yerba mansa narrowleaf cottonwood / New Mexico olive Rio Grande cottonwood / New Mexico olive Rio Grande cottonwood / oneseed juniper Rio Grande cottonwood / Russian olive Rio Grande cottonwood / saltcedar							
Ustifluvent Oxyaquic — clayey /sandy	7.0	8.31	8.31	7.89	0.08	0.60	0.45
Communities: coyote willow / saltgrass Rio Grande cottonwood / saltcedar							
Ustifluvent Oxyaquic — clayey / coarse-loamy	7.0	9.66	9.66	7.98		1.16	
Communities: Rio Grande cottonwood / saltcedar							
Ustifluvent Oxyaquic — clayey / loamy	7.0	9.71	9.71	8.00		0.96	
Communities: coyote willow / yerba mansa							
Ustipsamment Oxyaquic — sandy	7.5	5.10	5.10	7.87		0.54	
Communities: Rio Grande cottonwood / Russian olive							
Torrifluvent Oxyaquic — coarse-loamy / sandy-skeletal	9.0	2.66	2.66	7.50	0.33	0.49	0.07
Communities: Arizona sycamore / sideoats grama Fremont's cottonwood / Goodding's willow							
Torrifluvent Oxyaquic — sandy-skeletal	9.0	4.00	4.00	6.79		0.36	
Communities: narrowleaf cottonwood / Arizona alder							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Torrifluvent Oxyaquic — coarse-loamy / sandy	9.0	5.37	5.37	7.84		0.40	
Communities: Fremont's cottonwood / Goodding's willow							
Torrifluvent Oxyaquic — fine-loamy / sandy-skeletal	9.0	5.45	5.45	7.86		1.45	
Communities: Fremont's cottonwood / Goodding's willow							
Torrifluvent Oxyaquic — clayey /sandy	9.0	6.12	6.12	7.97		4.18	
Communities: Fremont's cottonwood / Goodding's willow							
Torrifluvent Oxyaquic — clayey / sandy	9.0	6.50	6.50	7.74		1.08	
Communities: Rio Grande cottonwood / saltcedar							
Torrifluvent Oxyaquic — fine-loamy / sandy	9.0	6.60	6.60	7.92		0.36	
Communities: Rio Grande cottonwood / saltcedar							
Torrifluvent Oxyaquic — coarse-loamy	9.0	6.64	6.64	7.88	0.13	3.06	3.83
Communities: Rio Grande cottonwood / coyote willow Rio Grande cottonwood / saltcedar							
Torrifluvent Oxyaquic — fine-loamy	9.0	9.85	9.85	7.68		0.65	
Communities: Arizona sycamore / sparse ground cover							
Camborthid Aquic — sandy-skeletal / coarse-loamy	10.0	7.46	7.46	6.67		0.25	
Communities: Arizona walnut / sideoats grama							
Ustifluvent Typic — coarse-loamy / sandy	12.0	5.56	5.56	7.92		0.36	
Communities: Rio Grande cottonwood / New Mexico olive							
Ustochrept Fluventic — coarse-loamy / sandy-skeletal	12.0	6.00	6.00	7.85		0.60	
Communities: Rio Grande cottonwood / Kentucky bluegrass							
Ustifluvent Typic — course-silty / sandy	12.0	6.46	6.46	7.85		0.30	
Communities: Rio Grande cottonwood / sparse ground cover							
Ustochrept Fluventic — coarse-loamy / sandy	12.0	8.49	8.49	7.82	0.12	2.94	2.80
Communities: Rio Grande cottonwood / oneseed juniper Rio Grande cottonwood / saltcedar							
Ustochrept Fluventic — coarse-loamy	12.0	9.05	9.05	7.95	0.14	1.56	0.79
Communities: Rio Grande cottonwood / New Mexico olive							

Group	Wetness Rank	Water Avail Mean	Water Avail StDev	pH Mean	pH StDev	EC Surface Mean	EC Surface StDev
Ustochrept Fluventic — course-silty / sandy	12.0	9.13	9.13	8.03	0.06	3.03	3.57
Communities: Rio Grande cottonwood / New Mexico olive; Rio Grande cottonwood / Russian olive							
Torrifluvent Typic — sandy-skeletal	13.0	1.02	1.02	7.75		0.68	
Communities: netleaf hackberry / skunkbush sumac							
Torrifluvent Typic — coarse-loamy / fragmental	13.0	3.23	3.23	7.74		0.30	
Communities: Fremont's cottonwood / velvet ash							

holding capacity). Within each texture class we have also indicated the community types that occur on that soil type.

The wettest sites were ranked 1.00 and were ponded throughout most of the growing season. As such, no soil profile information was directly available. These sites have obvious extreme hydric conditions and typically support herbaceous wetland communities dominated by cattails, bulrushes and spikerushes.

Riverwash, Typic Fluvaquents and Mollic Psammaquents form the next wettest group of soils (2.00 wetness rank). These soils are typically found within the active channel on low-lying island bars or adjacent sidebars. They usually are flooded at least once or more during the growing season, and the water table is very near surface (within 50 cm). Because of inundation, these soils display hydric qualities, such orange, gray or black mottles due to a fluctuating water table or prolonged anaerobic conditions. Soils with fine textures and higher soil water availability tend to support herbaceous communities dominated by spikerushes and horsetails. More coarse textured soils have a somewhat lower water holding capacity, and commonly support young shrubland riparian/wetland communities dominated by willows or alders. Occasionally, young narrowleaf or Rio Grande cottonwood stands have become established on the soils. All species that get established on these sites must be well rooted and resilient to frequent scouring floods, and tolerant of near saturated water conditions.

The next driest soil group includes Aeric Fluvaquents (3.00), Aeric Endoaquepts (3.00) and Typic Psammaquents (2.50). These soils tend to occur on side and island bars that are less frequently flooded than the previous group. Over time they have either aggraded as a result of continued deposits of sediments during flooding events, or the channel has incised, or moved laterally away from the sites, ultimately drying out the soils. The water saturation indicators are lower in the soil profile, but are still consistently within 75 cm of the surface. Herbaceous dominated communities are not as common on these sites, rather, shrubs or young trees, which are well-rooted in or near the zone of saturation prevail.

The trend towards shrub dominated communities continues with the drier Aquic Ustifluvents (5.00). In these soils the hydric indicators are commonly found within 100 cm of the surface. Young to mature narrowleaf or Rio Grande cottonwood stands can also occasionally occur on these soils.

Most mature or senescent stands of riparian forest are found on Oxyaquic Ustifluvents, Oxyaquic Udifluvents, Aquic Torrifluvents, Oxyaquic Torrifluvents and Aquic Camborthids. These soils rank in wetness from 6.00 to 10.00 respectively, and are found on the highest bars of the floodplain and lower terraces. Flooding is infrequent and hydric indicators are as deep as 150 cm from the soil surface. Cottonwood and willow sexual reproduction is rare on these sites, and the effectiveness of asexual reproduction by sprouting is unclear.

The driest soils are Typic Ustifluvents, Typic Torrifluvents, and Fluventic Dystrochepts. These soils occur at the highest landscape positions, upper terraces and against adjacent uplands. Flooding does not occur and the indicators of water table saturation are generally absent. These sites support either senescent riparian forest, or communities that are transitional to upland communities (dominated by "facultative" riparian species).

Rio Grande Riparian/Wetland Vegetation

The preliminary classification of riparian vegetation communities of the Rio Grande is summarized in Table 6. Fifty-eight riparian/wetland community types have been delineated among 20 Series. For each community type, we have summarized the most important environmental characteristics in Table 7. For soils, these include their wetness rankings, indicators of hydric conditions (i.e., mottles and redox features), pH of surface soils, salinity (EC) of surface and subsurface soils, and estimated water holding capacity (% by volume). Hydrological variables include the mean flooding recurrence intervals (regulated and unregulated), and stream channel types. Also included is the cross-section ratio of plot position cross-sectional area to bankfull cross-sectional area, and elevations of the sampled community. For the cross-section ratio, the higher the value, the higher a community is in the floodplain. Table 8 summarizes the community type and their associated soils classified to the subgroup, great group and family level. In Appendix A, each community type is characterized separately in detail with respect to geographic distribution, species composition, environmental setting, ecological dynamics and process, along with supportive data and literature references.

What follows is a summarization of the classification based on the community descriptions (Appendix A), and Tables 6, 7 and 8. A key to the communities is presented in Appendix C. At its coarsest level, Class, the classification is broken into forested, scrub-shrub, and persistent-emergent herbaceous riparian/wetland communities following Cowardin et al. (1974). These in turn are dominated by either cold-temperate species floristically aligned with the Rocky Mountains or the Rio Grande/Great Plains, or by warm-temperate species of the Southwest that are extensions from the southern latitudes of the sub-tropics or the Sierra Madres of Mexico. In the summary we use only common names of plant species, refer to Appendix B for the scientific names.

Forested Wetland Communities (Forests and Woodlands)

Forested wetlands are dominated by single- or multi-stemmed trees that are five meters in height or greater. Canopies range from open "woodlands" (10-60% cover) to closed "forests" (greater than 60% cover). Overstory dominants are usually obligate riparian species that are dependent to some degree on flooding and/or the close proximity of the water table for maintenance and reproduction. In the Rio Grande watershed, forested wetland communities are widely distributed and diverse. We have identified 32 community types across varying stream types and elevations. In the highly regulated and controlled middle Rio Grande corridor, forested wetlands are currently

Table 6. A preliminary riparian/wetland vegetation community classification of New Mexico for the upper and middle Rio Grande watershed. The classification is hierarchically arranged within the Palustrine System into Class (level I), Zone (level II), Regional Biome (level III), Series Group (level IV), Series (level V) and Community Type (CT). Organization of the classification system follows Cowardin's (1979) classification system with modifications based on NMNHP's statewide classification (see text). Cross references to the UNESCO classification (as presented in Mueller-Dombois and Ellenberg 1974) at the Series Group level (IV) are also presented. Community Types are identified by their scientific nomenclature, common name, and six- or seven-letter acronym.

PALUSTRINE SYSTEM—RIPARIAN/WETLAND VEGETATION

I. FORESTED WETLANDS CLASS - FORESTS AND WOODLANDS

II. COLD TEMPERATE RIPARIAN/WETLANDS

III. ROCKY MOUNTAIN MONTANE FORESTED WETLANDS

IV. NEEDLE-LEAVED EVERGREEN SERIES GROUP (closed forests, cold temperate, evergreen)

V. BLUE SPRUCE *(PICEA PUNGENS)* SERIES

1. Blue Spruce—Thinleaf Alder CT *(Picea pungens—Alnus incana;* PICPUN—ALNINCT)

IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (closed forests, cold temperate, deciduous with evergreens)

V. THINLEAF ALDER *(ALNUS INCANA)* SERIES

1. Thinleaf Alder/Bluestem Willow CT (*Alnus incana/Salix irrorata*; ALNINCT/SALIRR)

V. *POPULUS ANGUSTIFOLIA* (NARROWLEAF COTTONWOOD) SERIES

1. Narrowleaf Cottonwood—Thinleaf Alder CT (*Populus angustifolia—Alnus incana*; POPANG—ALNINCT)
2. Narrowleaf Cottonwood—Arizona Alder CT (*Populus angustifolia—Alnus oblongifolia*; POPANG—ALNOBL)
3 Narrowleaf Cottonwood—Rocky Mountain Juniper CT *(Populus angustifolia—Juniperus scopulorum*; POPANG—JUNSCO)
4. Narrowleaf Cottonwood/New Mexico Olive CT (*Populus angustifolia/Forestiera pubescens* CT; POPANG/FORPUBP)
5. Narrowleaf Cottonwood/Coyote Willow CT (*Populus angustifolia/Salix exigua*; POPANG/SALEXI)
6. Narrowleaf Cottonwood/Bluestem Willow CT (*Populus angustifolia/Salix irrorata*; POPANG/SALIRR)
7. Narrowleaf Cottonwood/Kentucky Bluegrass CT *(Populus angustifolia/Poa pratensis*; POPANG/POAPRA)

III. SOUTHWEST MONTANE FORESTED WETLANDS

IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (closed forests, cold temperate, deciduous with evergreens)

V. *ALNUS OBLONGIFOLIA* (ARIZONA ALDER) SERIES

1. Arizona Alder—Goodding's Willow CT (*Alnus oblongifolia—Salix gooddingii*; ALNOBL—SALGOO)
2. Arizona Alder/Seepwillow CT (*Alnus oblongifolia/Baccharis salicifolia*; ALNOBL/BACSAL)

III. RIO GRANDE/GREAT PLAINS FORESTED WETLANDS

IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (woodlands, cold temperate, deciduous with microphyllous shrublands or thickets)

V. RIO GRANDE COTTONWOOD (*POPULUS DELTOIDES*) SERIES

1. Rio Grande Cottonwood—Russian Olive CT*(Populus deltoides—Elaeagnus angustifolia*; POPDELW—ELAANG)

2. Rio Grande Cottonwood—Oneseed Juniper CT (*Populus deltoides—Juniperus monosperma*; POPDELW—JUNMON)
3. Rio Grande Cottonwood—Saltcedar CT (*Populus deltoides—Tamarix chinensis*; POPDELW—TAMCHI)
4. Rio Grande Cottonwood/New Mexico Olive CT (*Populus deltoides/Forestiera pubescens*; POPDELW/FORPUBP)
5. Rio Grande Cottonwood/Coyote Willow CT (*Populus deltoides/Salix exigua*; POPDELW/SALEXI)
6. Rio Grande Cottonwood/Water Sedge CT (*Populus deltoides/Carex aquatilis*; POPDELW/CARAQU)
7. Rio Grande Cottonwood/Smooth Horsetail CT (*Populus deltoides/Equisetum laevigatum*; POPDELW/EQULAE)
8. Rio Grande Cottonwood/Kentucky Bluegrass CT (*Populus deltoides/Poa pratensis*; POPDELW/POAPRA)
9. Rio Grande Cottonwood/Sparse CT (*Populus deltoides*/Sparse; POPDELW/SPARSE)

V. RUSSIAN OLIVE (*ELAEAGNUS ANGUSTIFOLIA*) SERIES
1. Russian Olive—Saltcedar CT (*Elaeagnus angustifolia—Tamarix chinensis*; ELAANG—TAMCHI)

IV. NEEDLE-LEAVED DECIDUOUS SERIES GROUP (cold deciduous microphyllous thickets)

V. SALTCEDAR (*TAMARIX CHINENSIS*) SERIES
1. Saltcedar/Coyote Willow CT (*Tamarix chinensis/Salix exigua*; TAMCHI/SALEXI)
2. Saltcedar/Sparse CT (*Tamarix chinensis*/Sparse; TAMCHI/SPARSE)

II. WARM TEMPERATE RIPARIAN/WETLANDS
III. SOUTHWEST LOWLAND FORESTED WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (closed forests, warm temperate, deciduous with evergreens, or microphyllous shrublands or thickets)

V. NETLEAF HACKBERRY (*CELTIS LAEVIGATA*) SERIES
1. Netleaf Hackberry/Skunkbush Sumac CT (*Celtis laevigata/Rhus trilobata*; CELLAER/RHUTRIT)

V. ARIZONA WALNUT (*JUGLANS MAJOR*) SERIES
1. Arizona Walnut/Sideoats Grama CT (*Juglans major/Bouteloua curtipendula*; JUGMAJ/BOUCUR)

V. ARIZONA SYCAMORE (*PLATANUS WRIGHTII*) SERIES
1. Arizona Sycamore—Arizona Alder CT (*Platanus wrightii—Alnus oblongifolia*; PLAWRI—ALNOBL)
2. Arizona Sycamore/Seepwillow CT (*Platanus wrightii/Baccharis salicifolia*; PLAWRI/BACSAL)
3. Arizona Sycamore/Sideoats Grama CT (*Platanus wrightii/Bouteloua curtipendula*; PLAWRI/BOUCUR)
4. Arizona Sycamore/Sparse CT (*Platanus wrightii*/Sparse; PLAWRI/SPARSE)

V. FREMONT'S COTTONWOOD (*POPULUS FREMONTII*) SERIES
1. Fremont's Cottonwood—Velvet Ash CT (*Populus fremontii—Fraxinus velutina*; POPFRE—FRAVEL)
2. Fremont's Cottonwood—Goodding's Willow CT (*Populus fremontii—Salix gooddingii*; POPFRE—SALGOO)
3. Fremont's Cottonwood/Yerba Mansa CT (*Populus fremontii/Anemopsis californica*; POPFRE/ANECAL)

I. SCRUB-SHRUB WETLANDS CLASS - SHRUBLANDS
II. COLD TEMPERATE RIPARIAN/WETLANDS
III. ROCKY MOUNTIAN MONTANE SCRUB-SHRUB WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (scrub, cold temperate, deciduous shrublands or thickets)

V. BLUESTEM WILLOW (*SALIX IRRORATA*) SERIES
1. Bluestem Willow—Coyote Willow CT (*Salix irrorata—Salix exigua*; SALIRR—SALEXI)
2. Bluestem Willow/Sparse CT (*Salix irrorata*/Sparse; SALIRR/SPARSE)

III. RIO GRANDE/GREAT PLAINS SCRUB-SHRUB WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (scrub, cold temperate, deciduous shrublands or thickets)

V. COYOTE WILLOW *(SALIX EXIGUA)* SERIES

1. Coyote Willow—Rubber Rabbitbrush CT *(Salix exigua—Chrysothamnus nauseosus*; SALEXI—CHRNAU)
2. Coyote Willow/Redtop CT *(Salix exigua/Agrostis gigantea*; SALEXI/AGRGIG)
3. Coyote Willow/Water Sedge CT *(Salix exigua/Carex aquatilis*; SALEXI/CARAQU)
4. Coyote Willow/Woolly Sedge CT *(Salix exigua/Carex lanuginosa*; SALEXI/CARLAN)
5. Coyote Willow/Saltgrass CT *(Salix exigua/Distichlis spicata*; SALEXI/DISSPI)
6. Coyote Willow/Common Spikerush CT *(Salix exigua/Eleocharis palustris*; SALEXI/ELEPAL)
7. Coyote Willow/False Quackgrass CT *(Salix exigua/Elymus* x *pseudorepens*; SALEXI/ELYPSE)
8. Coyote Willow/Smooth Horsetail CT *(Salix exigua/Equisetum laevigatum*; SALEXI/EQULAE)
9. Coyote Willow/Baltic Rush CT *(Salix exigua/Juncus balticus*; SALEXI/JUNBAL)
10. Coyote Willow/American Bulrush CT *(Salix exigua/Scirpus americanus*; SALEXI/SCIAME)

II. WARM TEMPERATE RIPARIAN/WETLANDS

III. SOUTHWEST LOWLAND SCRUB-SHRUB WETLANDS

IV. BROAD-LEAVED DECIDUOUS SERIES GROUP (scrub, cold temperate, deciduous shrublands or thickets)

V. SEEPWILLOW *(BACCHARIS SALICIFOLIA)* SERIES

1. Seepwillow/Prairie Wedgescale CT *(Baccharis salicifolia/Sphenopholis obtusata*; BACSAL/SPHOBT)

V. COYOTE WILLOW *(SALIX EXIGUA)* SERIES

1. Coyote Willow—Seepwillow CT *(Salix exigua—Baccharis salicifolia*; SALEXI—BACSAL)
2. Coyote Willow/Yerba Mansa CT (Salix exigua/Anemopsis californica; SALEXI/ANECAL)
3. Coyote Willow/Sparse CT *(Salix exigua*/Sparse; SALEXI/SPARSE)

I. PERSISTENT-EMERGENT WETLANDS CLASS - HERBACEOUS WETLANDS

II. COLD TEMPERATE RIPARIAN/WETLANDS

III. ROCKY MOUNTAIN MONTANE PERSISTENT-EMERGENT WETLANDS

IV. PERSISTENT SERIES GROUP (terrestrial herbaceous communities, sedge swamps or temperate reed swamps on river banks)

V. BALTIC RUSH *(JUNCUS BALTICUS)* SERIES

1. Baltic Rush—Nebraska Sedge CT *(Juncus balticus—Carex nebrascensi*; JUNBAL—CARNEB)
2. Baltic Rush—Common Spikerush CT *(Juncus balticus—Eleocharis palustris*; JUNBAL—ELEPAL)
3. Baltic Rush/Smooth Horsetail CT *(Juncus balticus/Equisetum laevigatum*; JUNBAL/EQULAE)

V. AMERICAN BULRUSH *(SCIRPUS AMERICANUS)* SERIES

1. American Bulrush—Common Spikerush CT *(Scirpus americanus—Eleocharis palustris*; SCIAME—ELEPA
2. American Bulrush/Smooth Horsetail CT *(Scirpus americanus/Equisetum laevigatum*; SCIAME/EQULAE)

III. SOUTHWEST LOWLAND PERSISTENT-EMERGENT WETLANDS

IV. PERSISTENT SERIES GROUP (terrestrial herbaceous communities, sedge swamps or temperate reed swamps on river banks)

V. WATER SEDGE (*CAREX AQUATILIS*) SERIES

1. Water Sedge/Smooth Horsetail CT *(Carex aquatilis/Equisetum laevigatum*; CARAQU/EQULAE)

V. COMMON SPIKERUSH (*ELEOCHARIS PALUSTRIS*) SERIES

1. Common Spikerush—Rice Cutgrass CT *(Eleocharis palustris—Leersia oryzoides*; ELEPAL—LEEORY)
2. Common Spikerush/Smooth Horsetail CT *(Eleocharis palustris/Equisetum laevigatum*; ELEPAL/EQULAI

V. BROADLEAF CATTAIL *(TYPHA LATIFOLIA)* SERIES

1. Broadleaf Cattail/American Bulrush CT *(Typha latifolia/Scirpus americanus*; TYPLAT/SCIAME)
2. Broadleaf Cattail/Rice Cutgrass CT *(Typha latifolia/Leersia oryzoides*; TYPLAT/LEEORY)

Table 7. Soil and flood characteristics of riparian/wetland communities sampled. Wetness ranks are defined in Table 2 with 1 being wettest. EC = electrical conductivity.

Community		Stream Types	Elevation (ft)		Wetness Rank		pH Surface		EC Surface (mS)		EC sub Surface (mS)		Recur Inv (yrs)		XS Ratio	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
American bulrush / common spikerush	Scirpus americanus / Eleocharis palustris	B2 C3	5873	613.3	1.7	.6	7.6		.4				1.0	.0	.6	.2
American bulrush / smooth horsetail	Scirpus americanus / Equisetum laevigatum	B2 C2 C3	5840	250.6	2.7	.6	7.3	.9	1.2	.9	5.3		2.3	2.3	.6	.5
Arizona alder / Goodding's willow	Alnus oblongifolia / Salix gooddingii	C1	5350	42.4	2.0	.0	7.1		.7		.3		2.0		.9	.1
Arizona alder / seepwillow	Alnus oblongifolia / Baccharis salicifolia	C3	4980		3.0		7.7		.6				2.0		6.9	
Arizona sycamore / Arizona alder	Platanus wrightii / Alnus oblongifolia	C1	5380		3.0		7.0		.3		.2		5.0		1.5	
Arizona sycamore / seepwillow	Platanus wrightii / Baccharis salicifolia	C3	4700		2.0								2.0		.5	
Arizona sycamore / sideoats grama	Platanus wrightii / Bouteloua curtipendula	C1	5320		9.0		7.3		.4		.1		10.0		3.2	
Arizona sycamore / sparse ground cover	Platanus wrightii / Sparse	C3	4700		9.0		7.7		.6		.3		5.0		2.7	
Arizona walnut / sideoats grama	Juglans major / Bouteloua curtipendula	B2	6200		10.0		6.5		.3				100.0		82.5	
Baltic rush / common spikerush	Juncus balticus / Eleocharis palustris	C3	5780	84.9	2.0	.0	7.6		1.0				2.0		1.0	.1
Baltic rush / Nebraska sedge	Juncus balticus / Carex nebrascensis	B2	6480		7.0		7.4		.6		.4		1.0		1.1	
Baltic rush / smooth horsetail	Juncus balticus / Equisetum laevigatum	C5	4920		3.0		8.1		.6				1.0		1.0	
blue spruce / thinleaf alder	Picea pungens / Alnus incana	A2 B2 C2	7987	410.5	2.7	.6	6.3	.9	.4	.2			1.7	.6	1.3	.4
bluestem willow / coyote willow	Salix irrorata / Salix exigua	C1 C3	6743	724.0	2.5	.6	7.8	.2					4.3	1.5	1.0	.3
bluestem willow / sparse ground cover	Salix irrorata / Sparse	A3	6500		2.0		7.4						1.0		.4	
broadleaf cattail / American bulrush	Typha latifolia / Scirpus americanus	C4 C6	5680	56.6	2.0	1.4	6.9		.7				2.0		1.2	.1
broadleaf cattail / rice cutgrass	Typha latifolia / Leersia oryzoides	C4	6220		3.0		7.5		1.6						1.5	
common spikerush / rice cutgrass	Eleocharis palustris / Leersia oryzoides	C4	5520		3.0		7.7		.4				2.0		1.2	
common spikerush / smooth horsetail	Eleocharis palustris / Equisetum laevigatum	B4	6500		3.0		7.8		.5		.4				7.6	
coyote willow / American bulrush	Salix exigua / Scirpus americanus	B2 C4 C5	5695	798.2	2.5	.6	7.3	.9	.7	.1	.1		1.3	.5	1.0	1.0
coyote willow / Baltic rush	Salix exigua / Juncus balticus	C3	5720		2.0										.8	
coyote willow / common spikerush	Salix exigua / Eleocharis palustris	B2	6080		2.0		7.6						1.0		.4	
coyote willow / false quackgrass	Salix exigua / Elymus x pseudorepens	B2	6020		5.0		8.0						5.0		2.0	

Community		Stream Types	Elevation (ft)		Wetness Rank		pH Surface		EC Surface (mS)		EC sub Surface (mS)		Recur Inv (yrs)		XS Ratio	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
coyote willow / redtop	Salix exigua / Agrostis gigantea	B1 B2 C2 C3 C4	6149	336.3	3.5	1.4	7.7	.7	.5	.3	.5		4.8	7.5	1.3	1.1
coyote willow / rubber rabbitbrush	Salix exigua / Chrysothamnus nauseosus	C5	5050		7.0		7.8		.6				1.0		1.0	
coyote willow / saltgrass	Salix exigua / Distichlis spicata	C5	4840		7.0		7.8		.9		1.2		1.0		6.1	
coyote willow / seepwillow	Salix exigua / Baccharis salicifolia	C5	4600		2.5		8.2		1.9		1.2		1.0			
coyote willow / smooth horsetail	Salix exigua / Equisetum laevigatum	B2 C1 C3 C4	6100	433.9	3.8	2.2	7.9	.1	.5	.3	.7		1.8	.5	.4	.3
coyote willow / sparse ground cover	Salix exigua / Sparse	B2 C3	6325	296.2	3.0	1.1	7.8	.3					5.3	9.6	1.2	1.6
coyote willow / water sedge	Salix exigua / Carex aquatilis	C1 C5	5325	643.5	2.8	.4	7.6	.1	1.9	1.0	.2		3.0	2.8	1.1	
coyote willow / woolly sedge	Salix exigua / Carex lanuginosa	C5	4780		7.0		7.6		1.0		.3		2.0			
coyote willow / yerba mansa	Salix exigua / Anemopsis californica	C5	4840		7.0		7.8		1.0		1.1		1.0		6.4	
Fremont's cottonwood / Goodding's willow	Populus fremontii / Salix gooddingii	B2 C1	4788	305.9	6.9	3.1	7.7	.2	1.4	1.6	2.8	3.3	2.9	1.5	5.5	4.8
Fremont's cottonwood / velvet ash	Populus fremontii / Fraxinus velutina	B2	5000	.0	7.5	7.8	7.8		.3				2.0	.0	4.3	3.3
Fremont's cottonwood / yerba mansa	Populus fremontii / Anemopsis californica	C4 C5	4930	212.1	7.0	.0	7.9	.4	1.6	.5	1.3	.9	3.5	2.1		
narrowleaf cottonwood / Arizona alder	Populus angustifolia / Alnus oblongifolia	A3 B2	6460	367.7	8.0	1.4	6.9	.1	.6	.3	.5		2.0	.0	7.6	1.7
narrowleaf cottonwood / bluestem willow	Populus angustifolia / Salix irrorata	A3	6830		2.0		7.2						10.0		.4	
narrowleaf cottonwood / coyote willow	Populus angustifolia / Salix exigua	B2 C1 C3	6810	644.7	2.5	.6	7.9	.3					9.0	10.8	2.1	1.2
narrowleaf cottonwood / Kentucky bluegrass	Populus angustifolia / Poa pratensis	B2 C3	6620		2.0		7.6						25.0		8.7	
narrowleaf cottonwood / New Mexico olive	Populus angustifolia / Forestiera pubescens	C3	6300		7.0		7.8		.4		.8		10.0		2.6	
narrowleaf cottonwood / Rocky Mountain juniper	Populus angustifolia / Juniperus scopulorum	A3	6780		5.0		7.2						5.0		.3	
narrowleaf cottonwood / thinleaf alder	Populus angustifolia / Alnus incana	B1 B2 C1 C2	8072	445.6	4.0	1.9	6.4	.5	.3	.1	.2	.0	9.4	9.2	1.6	1.0
netleaf hackberry / skunkbush sumac	Celtis laevigata / Rhus trilobata	B2	5360		13.0		7.7		.7				5.0		6.5	
Rio Grande cottonwood / coyote willow	Populus deltoides / Salix exigua	A3 B2 B4 C1 C2 C3 C4 C5	5517	676.4	5.1	2.5	7.7	.2	.6	.3	.4	.2	4.6	8.3	2.5	2.6
Rio Grande cottonwood / Kentucky bluegrass	Populus deltoides / Poa pratensis	C3 C4	5743	194.5	9.5	3.5	7.8	.1	.6	.0	1.0	.9	3.5	2.1	1.7	.2

Community		Stream Types	Elevation (ft)		Wetness Rank		pH Surface		EC Surface (mS)		EC sub Surface (mS)		Recur Inv (yrs)		XS Ratio	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Rio Grande cottonwood / New Mexico olive	Populus deltoides / Forestiera pubescens	C3 C4 C5	5349	298.0	9.3	3.6	7.9	.4	1.7	1.4	1.0	.7	7.4	7.8	2.9	2.2
Rio Grande cottonwood / oneseed juniper	Populus deltoides / Juniperus monosperma	C3 C4	5145		12.0		7.9		4.9				2.0			
Rio Grande cottonwood / Russian olive	Populus deltoides / Elaeagnus angustifolia	C3 C4 C5	5269	442.1	7.0	2.7	7.9	.3	3.6	2.5	2.5	3.5	16.3	36.9	16.0	34.6
Rio Grande cottonwood / saltcedar	Populus deltoides / Tamarix chinensis	C3 C4 C5	4806	233.8	7.9	2.6	7.8	.1	1.4	2.3	1.4	2.2	2.0	1.2	4.2	4.2
Rio Grande cottonwood / smooth horsetail	Populus deltoides / Equisetum laevigatum	C2 C3	5980	277.1	5.7	2.3	7.7	.2	.7	.5	1.0		4.0	1.7	1.2	.5
Rio Grande cottonwood / sparse ground cover	Populus deltoides / Sparse	C2 C5	5430	608.1	9.5	3.5	7.8	.2	.2	.1			3.5	2.1	1.5	.4
Rio Grande cottonwood / water sedge	Populus deltoides / Carex aquatilis	C2	5860		7.0		7.2		.7		.2		2.0		1.6	
Russian olive / saltcedar	Elaeagnus angustifolia / Tamarix chinensis	C5	4780		7.0		7.7		.9				2.0			
saltcedar / coyote willow	Tamarix chinensis / Salix exigua	B2	6058	14.4	4.4	1.3	7.7	.1					11.6	10.1	1.1	.5
saltcedar / sparse ground cover	Tamarix chinensis / Sparse	B2 C4	6045	7.1	5.0	.0	8.1	.1					1.0	.0	1.1	.0
seepwillow / prairie wedgescale	Baccharis salicifolia / Sphenopholis obtusata	C3	4980		2.0								1.0		1.2	
thinleaf alder / bluestem willow	Alnus incana / Salix irrorata	A3 B2 C1	6544	146.0	2.0	.0	7.1	.3					2.3	3.4	.1	.1
water sedge / smooth horsetail	Carex aquatilis / Equisetum laevigatum	B1 C3	6590	268.7	2.0		7.9		.9		1.4		2.0	.0	.9	

Table 8. Riparian/wetland communities and their associated soil types.

Community		Great Group	Subgroup	Family
American bulrush / common spikerush	Scirpus americanus / Eleocharis palustris	Ponded		
		Typic	Fluvaquent	loamy-skeletal
		Mollic	Fluvaquent	sandy-skeletal
American bulrush / smooth horsetail	Scirpus americanus / Equisetum laevigatum	Aeric	Fluvaquent	coarse-loamy / sandy
		Aeric	Fluvaquent	sandy-skeletal
		Mollic	Fluvaquent	sandy-skeletal
Arizona alder / Gooding's willow	Alnus oblongifolia / Salix gooddingii	Riverwash		sandy-skeletal
		Mollic	Fluvaquent	sandy-skeletal / loamy-skeletal
Arizona alder / seepwillow	Alnus oblongifolia / Baccharis salicifolia	Aeric	Fluvaquent	sandy-skeletal
Arizona sycamore / Arizona alder	Platanus wrightii / Alnus oblongifolia	Aeric	Fluvaquent	sandy-skeletal
Arizona sycamore / seepwillow	Platanus wrightii / Baccharis salicifolia	Riverwash		sandy-skeletal
Arizona sycamore / sideoats grama	Platanus wrightii / Bouteloua curtipendula	Oxyaquic	Torrifluvent	coarse-loamy / sandy-skeletal
Arizona sycamore / sparse ground cover	Platanus wrightii / Sparse	Oxyaquic	Torrifluvent	fine-loamy
Arizona walnut / sideoats grama	Juglans major / Bouteloua curtipendula	Aquic	Camborthid	sandy-skeletal / coarse-loamy
Baltic rush / common spikerush	Juncus balticus / Eleocharis palustris	Typic	Fluvaquent	coarse-loamy
		Mollic	Psammaquent	sandy
Baltic rush / Nebraska sedge	Juncus balticus / Carex nebrascensis	Oxyaquic	Ustifluvent	coarse-loamy / sandy-skeletal
Baltic rush / smooth horsetail	Juncus balticus / Equisetum laevigatum	Aeric	Fluvaquent	sandy / loamy
blue spruce / thinleaf alder	Picea pungens / Alnus incana	Aeric	Fluvaquent	coarse-loamy
		Typic	Fluvaquent	coarse-loamy / loamy-skeletal
		Aeric	Fluvaquent	sandy-skeletal
bluestem willow / coyote willow	Salix irrorata / Salix exigua	Riverwash		sandy-skeletal
		Aeric	Fluvaquent	sandy-skeletal
		Typic	Fluvaquent	sandy-skeletal
bluestem willow / sparse ground cover	Salix irrorata / Sparse	Typic	Fluvaquent	sandy-skeletal
broadleaf cattail / American bulrush	Typha latifolia / Scirpus americanus	Ponded		

Community		Great Group	Subgroup	Family
broadleaf cattail / American bulrush	Typha latifolia / Scirpus americanus	Aeric	Fluvaquent	fine-loamy / sandy-skeletal
broadleaf cattail / rice cutgrass	Typha latifolia / Leersia oryzoides	Aeric	Fluvaquent	very fine clayey
common spikerush / rice cutgrass	Eleocharis palustris / Leersia oryzoides	Aeric	Fluvaquent	sandy
common spikerush / smooth horsetail	Eleocharis palustris / Equisetum laevigatum	Aeric	Fluvaquent	sandy-skeletal
coyote willow / American bulrush	Salix exigua / Scirpus americanus	Mollic	Fluvaquent	fine-loamy
		Aeric	Fluvaquent	sandy-skeletal
		Typic	Fluvaquent	sandy-skeletal
coyote willow / Baltic rush	Salix exigua / Juncus balticus	Typic	Fluvaquent	sandy-skeletal
coyote willow / common spikerush	Salix exigua / Eleocharis palustris	Typic	Fluvaquent	loamy / sandy-skeletal
coyote willow / false quackgrass	Salix exigua / Elymus x pseudorepens	Aquic	Ustifluvent	fine-loamy / sandy-skeletal
coyote willow / redtop	Salix exigua / Agrostis gigantea	Riverwash		sandy-skeletal
		Aeric	Fluvaquent	coarse-loamy
		Aeric	Fluvaquent	coarse-loamy / fragmental
		Aeric	Fluvaquent	loamy / sandy-skeletal
		Aeric	Fluvaquent	sandy-skeletal
		Typic	Fluvaquent	sandy-skeletal
		Aquic	Ustifluvent	loamy-skeletal
		Aquic	Ustifluvent	sandy / loamy-skeletal
		Oxyaquic	Ustifluvent	sandy-skeletal
coyote willow / rubber rabbitbrush	Salix exigua / Chrysothamnus nauseosus	Oxyaquic	Ustifluvent	coarse-loamy
coyote willow / saltgrass	Salix exigua / Distichlis spicata	Oxyaquic	Ustifluvent	clayey /sandy
coyote willow / seepwillow	Salix exigua / Baccharis salicifolia	Typic	Psammaquent	sandy
coyote willow / smooth horsetail	Salix exigua / Equisetum laevigatum	Typic	Fluvaquent	clayey
		Aeric	Fluvaquent	coarse-loamy / sandy-skeletal
		Aeric	Fluvaquent	loamy / sandy-skeletal
		Oxyaquic	Ustifluvent	coarse-loamy / sandy
coyote willow / sparse ground cover	Salix exigua / Sparse	Aeric	Fluvaquent	sandy-skeletal
		Typic	Fluvaquent	sandy-skeletal

Community		Great Group	Subgroup	Family
coyote willow / sparse ground cover	Salix exigua / Sparse	Aquic	Ustifluvent	sandy-skeletal
coyote willow / water sedge	Salix exigua / Carex aquatilis	Aeric	Fluvaquent	coarse-loamy
		Typic	Psammaquent	sandy
coyote willow / woolly sedge	Salix exigua / Carex lanuginosa	Oxyaquic	Ustifluvent	clayey / sandy
coyote willow / yerba mansa	Salix exigua / Anemopsis californica	Oxyaquic	Ustifluvent	clayey / loamy
Fremont's cottonwood / Goodding's willow	Populus fremontii / Salix gooddingii	Oxyaquic	Torrifluvent	clayey /sandy
		Oxyaquic	Torrifluvent	coarse-loamy / sandy
		Oxyaquic	Torrifluvent	coarse-loamy / sandy-skeletal
		Oxyaquic	Torrifluvent	fine-loamy / sandy-skeletal
		Oxyaquic	Ustifluvent	clayey / sandy
Fremont's cottonwood / velvet ash	Populus fremontii / Fraxinus velutina	Riverwash		sandy-skeletal
		Typic	Torrifluvent	coarse-loamy / fragmental
Fremont's cottonwood / yerba mansa	Populus fremontii / Anemopsis californica	Oxyaquic	Ustifluvent	coarse-loamy
narrowleaf cottonwood / Arizona alder	Populus angustifolia / Alnus oblongifolia	Oxyaquic	Torrifluvent	sandy-skeletal
		Oxyaquic	Ustifluvent	sandy-skeletal
narrowleaf cottonwood / bluestem willow	Populus angustifolia / Salix irrorata	Typic	Fluvaquent	sandy-skeletal
narrowleaf cottonwood / coyote willow	Populus angustifolia / Salix exigua	Riverwash		sandy-skeletal
		Aeric	Fluvaquent	sandy-skeletal
		Typic	Fluvaquent	sandy-skeletal
narrowleaf cottonwood / Kentucky bluegrass	Populus angustifolia / Poa pratensis	Typic	Fluvaquent	sandy-skeletal
narrowleaf cottonwood / New Mexico olive	Populus angustifolia / Forestiera pubescens	Oxyaquic	Ustifluvent	coarse-loamy
narrowleaf cottonwood / Rocky Mountain juniper	Populus angustifolia / Juniperus scopulorum	Aquic	Ustifluvent	sandy-skeletal
narrowleaf cottonwood / thinleaf alder	Populus angustifolia / Alnus incana	Aeric	Fluvaquent	coarse-loamy / sandy-skeletal
		Aeric	Fluvaquent	fine-loamy / sandy-skeletal
		Typic	Fluvaquent	loamy-skeletal
		Oxyaquic	Udifluvent	sandy-skeletal
netleaf hackberry / skunkbush sumac	Celtis laevigata / Rhus trilobata	Typic	Torrifluvent	sandy-skeletal
Rio Grande cottonwood / coyote willow	Populus deltoides / Salix exigua	Aeric	Fluvaquent	sandy-skeletal

Community		Great Group	Subgroup	Family
Rio Grande cottonwood / coyote willow	Populus deltoides / Salix exigua	Typic	Psammaquent	sandy
		Oxyaquic	Torrifluvent	coarse-loamy
		Aquic	Torrifluvent	sandy-skeletal / clayey
		Aquic	Ustifluvent	sandy-skeletal
		Oxyaquic	Ustifluvent	sandy-skeletal
Rio Grande cottonwood / Kentucky bluegrass	Populus deltoides / Poa pratensis	Oxyaquic	Ustifluvent	coarse-loamy / sandy-skeletal
		Fluventic	Ustochrept	coarse-loamy / sandy-skeletal
Rio Grande cottonwood / New Mexico olive	Populus deltoides / Forestiera pubescens	Aeric	Fluvaquent	coarse-loamy
		Oxyaquic	Ustifluvent	coarse-loamy
		Oxyaquic	Ustifluvent	coarse-loamy / sandy
		Typic	Ustifluvent	coarse-loamy / sandy
		Fluventic	Ustochrept	coarse-loamy
		Fluventic	Ustochrept	course-silty / sandy
Rio Grande cottonwood / oneseed juniper	Populus deltoides / Juniperus monosperma	Fluventic	Ustochrept	coarse-loamy / sandy
Rio Grande cottonwood / Russian olive	Populus deltoides / Elaeagnus angustifolia	Aeric	Fluvaquent	fine-loamy
		Oxyaquic	Ustifluvent	coarse-loamy
		Oxyaquic	Ustifluvent	coarse-loamy / sandy
		Oxyaquic	Ustifluvent	sandy
		Aquic	Ustipsamment	sandy
		Oxyaquic	Ustipsamment	sandy
		Fluventic	Ustochrept	course-silty / sandy
Rio Grande cottonwood / saltcedar	Populus deltoides / Tamarix chinensis	Typic	Psammaquent	sandy
		Oxyaquic	Torrifluvent	clayey / sandy
		Oxyaquic	Torrifluvent	coarse-loamy
		Oxyaquic	Torrifluvent	fine-loamy / sandy
		Oxyaquic	Ustifluvent	clayey / coarse-loamy
		Oxyaquic	Ustifluvent	clayey /sandy
		Oxyaquic	Ustifluvent	sandy-skeletal

Community		Great Group	Subgroup	Family
Rio Grande cottonwood / saltcedar	Populus deltoides / Tamarix chinensis	Fluventic	Ustochrept	coarse-loamy / sandy
Rio Grande cottonwood / smooth horsetail	Populus deltoides / Equisetum laevigatum	Aeric	Fluvaquent	sandy-skeletal
		Oxyaquic	Ustifluvent	coarse-loamy / sandy-skeletal
		Oxyaquic	Ustifluvent	sandy
Rio Grande cottonwood / sparse ground cover	Populus deltoides / Sparse	Typic	Ustifluvent	course-silty / sandy
		Oxyaquic	Ustifluvent	sandy-skeletal
Rio Grande cottonwood / water sedge	Populus deltoides / Carex aquatilis	Oxyaquic	Ustifluvent	sandy / loamy
Russian olive / saltcedar	Elaeagnus angustifolia / Tamarix chinensis	Oxyaquic	Ustifluvent	coarse-loamy / sandy
saltcedar / coyote willow	Tamarix chinensis / Salix exigua	Typic	Fluvaquent	loamy-skeletal
		Aquic	Ustifluvent	coarse-loamy
		Aquic	Ustifluvent	fine-loamy
		Aquic	Ustifluvent	sandy-skeletal
saltcedar / sparse ground cover	Tamarix chinensis / Sparse	Aquic	Ustifluvent	coarse-loamy / sandy-skeletal
		Aquic	Ustifluvent	fine silty
seepwillow / prairie wedgescale	Baccharis salicifolia / Sphenopholis obtusata	Riverwash		sandy-skeletal
thinleaf alder / bluestem willow	Alnus incana / Salix irrorata	Typic	Fluvaquent	sandy-skeletal
water sedge / smooth horsetail	Carex aquatilis / Equisetum laevigatum	Typic	Fluvaquent	coarse-loamy

predominant in the riparian landscape. On the less controlled tributaries and in the upper Rio Grande, these wetlands are usually found in a more diverse mix of shrublands and herbaceous wetlands.

Cold Temperate Rocky Mountain Montane Forests. - These forests are distributed along perennial streams in the northern mountains of New Mexico, usually at elevation above 6,500 ft (2,000 m). The growing season is often less than 150 days, and winters are cold (with frigid and colder soil temperature regimes). The forests are dominated by either the needle-leaved evergreen Blue Spruce Series, or the broad-leaved and deciduous Narrowleaf Cottonwood and Thinleaf Alder Series.

Blue spruce dominated forests are represented by the Blue Spruce—Thinleaf Alder Community Type (CT) that commonly occur along confined, moderately steep gradient channels (2%) of steep-sided canyons at elevations above 7,500 ft. (2,285 m). They either occur on small and narrow side or island bars, or along rocky, armored edges of the channel at the base of the upland slopes. On average, flooding occurs from yearly to five year intervals. Blue spruce are usually established at the upper edge of the floodplain out of the two year flood-zone. Other conifers such as white fir, Douglas fir, and ponderosa pine may be present, but usually not as close as blue spruce to the active channel. Along with thinleaf alder, other deciduous willows such as bluestem, yellow and Bebb willow are common. These are generally concentrated along the banks adjacent to the active channel. Overall diversity of species is characteristically high in these communities with 50 or more species possible in a given stand.

Thinleaf alder dominated forests are represented by the Thinleaf Alder/Bluestem Willow CT, and generally occur at somewhat lower elevations than blue spruce communities (down to 6,300 ft; 1,920 m). These forests typically form closed and multi-layered canopies with a shrubby understory of willows (Bebb, pacific and coyote), twinberry honeysuckle, Wood's rose, and redosier dogwood. The forests occur along channels that are commonly confined by valley side-slopes and are well armored by stones and cobbles, or entrenched and bounded by old channel walls. They are repeatedly flooded, usually on a yearly basis. Because of scouring floods in the narrowly confined channels, the stems of the alders and shrubs are repeatedly broken followed by re-sprouting. As a result, these types often appear as shrub-like thickets bordering and overhanging the streams. In the moist conditions of the undergrowth, the herbaceous layers can be diverse and luxuriant, and include cutleaf coneflower, cow parsnip, field horsetail, Canada wildrye and meadow fescue.

Narrowleaf cottonwood forests occur on depositional bars and terraces along stream channels that are only moderately confined or unconfined. Most stands are well out of the active channel, and in the 5 to 25 year floodplain (cross-section ratios commonly exceed 1.2). These forests are represented by seven community types. At higher elevations, the most common community is the Narrowleaf Cottonwood/Thinleaf Alder CT (7,000 to 8,500 ft; 2,130 to 2,590 m). This community has open canopies with a shrubby undergrowth of alder and other shrubs. It occurs on moderately wet soils, and is normally flooded within a five year time span. On higher, drier terraces where flood intervals exceed 25 years, there is little reproduction of narrowleaf cottonwood. These sites are commonly dominated by the open canopied Narrowleaf Cottonwood/Kentucky Bluegrass CT. The trees of this community are either mature or dying, and as the canopy opens up the site dries out further. As a result, this type has a grassy, meadow-like undergrowth dominated by Kentucky bluegrass, meadow fescue and forbs such as pineywoods geranium. If a major flood does not scour these sites and re-initiate cottonwood regeneration, these sites will eventually give way to meadows without trees.

At lower elevations (6,250 to 7,740; 1,905 m to 2,360 m), the Narrowleaf Cottonwood/Coyote Willow CT or the Narrowleaf Cottonwood/Bluestem willow CT become more prevalent on moist bars in the one to ten year floodplain. These moderately open-canopied forests develop diverse understories comprised of shrubs such as black chokecherry, skunkbush sumac and Wood's rose, and mesic perennial grasses and forbs such as mannagrass, bentgrass, rushes and horsetails. On drier sites that may no longer be within the active floodplain, the Narrowleaf Cottonwood/Rocky Mountain Juniper CT or Narrowleaf Cottonwood/New Mexico Olive CT may predominate. These types are dominated in the undergrowth by facultative riparian shrub species such rabbitbrush or sagebrush, or more upland grass and forb species (e.g. hairy grama, western wheatgrass, paintbrushes and golden asters).

The Narrowleaf Cottonwood—Arizona Alder CT is restricted in the Rio Grande watershed to southern mountain ranges (e.g., the Black Range) at upper elevations (down to 6,240 ft; 1,902 m). It occurs on depositional bars along stream channels in the two year floodzone on sandy-skeletal Oxyaquic Torrifluventic or Oxyaquic Ustifluventic soils. It is similar to the Narrowleaf Cottonwood—Thinleaf Alder CT, but undergrowth species have a more Southwestern affinity rather than Rocky Mountain. Common associates California brickellbush, hairy evening primrose and Arizona grape. This community type is transitional to Southwestern Montane Forest described next.

Cold Temperate Southwestern Montane Forests. - Arizona alder dominated forests are co-dominated by either Goodding's willow or seepwillow at elevations ranging between 4,980 to 5,350 ft (1,518 to 1,630 m). They replace thinleaf alder in the central and southwestern mountains along perennial stream segments of intermittent channels. Soils may be sandy-skeletal or loamy-skeletal Mollic Fluvaquents for the more developed sites which support the Arizona Alder—Goodding's Willow CT, or sandy-skeletal Aeric Fluvaqents that support the Arizona Alder/Seepwillow CT. These are typically moderately dense to dense forests with canopies that often overlap and extend out over the creek, effectively shading it. Younger stands are often well rooted with numerous single-trunked trees bordering shallowly cut, cobbly and rocky banks within the one- to two-year floodplain. They occur in long, linear, narrow bands along both sides of the creek, have sparse understories, and are extremely effective in stabilizing banks. Associated understory dominants are similar to thinleaf alder communities, but may also include species with more southwestern ties due to an overlap in distributions.

Cold Temperate Rio Grande/Great Plains Forests. - These forests are dominated by either broad-leaved or needle-leaved deciduous forests. The native Rio Grande cottonwood and the exotic Russian olive comprise the broad-leaved forests; while needle-leaved deciduous forests or woodlands are dominated by saltcedar.

Rio Grande cottonwood forests are generally less diverse than the montane forests and are a significant dominant along the wide floodplains of the middle Rio Grande basin between Cochiti and Elephant Butte where streamflows are highly regulated. They also extend into the upper basin canyons. Elevations range from 5,980 ft (1,823 m) down to 4,503 ft (1,372 m). Several terrace communities (Rio Grande Cottonwood/New Mexico Olive CT, Rio Grande Cottonwood—Russian Olive CT, Rio Grande Cottonwood—Saltcedar CT, Rio Grande Cottonwood—Oneseed Juniper CT or Rio Grande/Kentucky Bluegrass CT) are often situated well above the active channel where natural surficial fluvial processes are no longer, or are very rarely active. Soils are variable. Most are coarse-textured Fluventic Ustochrepts and Oxyaquic Ustifluvents. Canopies may be open or closed. Many of these forests are now approaching maturity where very little reproduction by these trees is occurring. Regeneration is largely due to root suckering and sexual reproduction is typically rare. Rather, replacement of the forests is largely by exotic trees (saltcedar and Russian olive) that were introduced into the system during the early part of this century following the construction of dams. Russian olive is a prominent tree in the central and northern reaches of the Rio Grande. These exotic trees also may be interspersed within the interior cottonwood forests on terraces and bars along with Siberian elm. Where dry conditions prevail, understories are predominantly weedy and sparse. The exotic sweetclovers are the most commonly encountered forb under these forests. Along streambanks and generally the lowest floodplain positions, several communities (Rio Grande Cottonwood/Water Sedge CT, Rio Grande Cottonwood/Coyote Willow and Rio Grande Cottonwood/Smooth Horsetail) still occur within the two- to ten-year floodzone and generally have lush and more diverse understories. Sexual reproduction may still be active and continuous.

Russian olive forests co-dominated by saltcedar (4,780 ft; 1,457 m) occur along the floodplains of the middle Rio Grande. These forests are generally situated towards the edges of the cottonwood bosque, along the banks, or along the exterior edge. However, they also are significant interior components of the bosque. Canopies are closed and diversity of species is poor. Cottonwoods may be present, but no longer dominate. Russian olive canopies overtop saltcedar, and a sparse and dry forest floor. Soils are coarse loamy over sandy Oxyaquic Ustifluvents. Bankside communities are well established and dense and often overhang a small portion of the channel. Herbaceous species present are grass dominated and include saltgrass, muhly grasses or dropseeds; while forbs are weedy and commonly represented by sweetclovers, American licorice, goldenrod and ragweed.

Saltcedar woodlands are a significant dominant in the southern reaches, although there are well established and mature stands dominating bars and terraces in the upper basin near Pilar. The Saltcedar/Sparse CT (5,275 ft; 1,608 m) are dominated by simple assemblages of plant species where diversity of species is extremely low. Soils are coarse loamy over sandy-skeletal or fine silty Aquic Ustifluvents. The community is widely distributed across the southern floodplains of the middle Rio Grande basin where they form extensive and at time impenetrable stands along the floodplains of the Rio Grande. They generally dominate the outermost floodplain where cottonwoods still dominate the interior floodplain, but will quickly become established along depositional bars and terraces that are rarely subjected to scouring floods. Canopies may be open or closed and diversity of species is poor. Herbaceous associates, much like the Russian olive forests are weedy and upland in character.

Warm Temperate Southwest Lowland Forests. - These forests are distributed along perennial segments of intermittent streams which drain the east side of the Black Range in south central New Mexico. They are dominated by broad-leaved deciduous forests with floristic ties that are endemic to the Sierra Madres of central Mexico and the Chihuahuan Desert of northern Mexico. Winters are mild and the growing season is long and warm. Netleaf hackberry, Arizona walnut and Arizona sycamore are characteristically diverse forests and occur where streams have not been regulated or stabilized. Fremont's cottonwood forests occur here as well, but can also be found bordering the channel in the southern reaches of the Rio Grande main stem.

Netleaf hackberry forests are represented by the Netleaf Hackberry/Skunkbush Sumac CT and generally occur at mid-elevations (5,360 ft; 1,634 m). They are dense and dry forests with interlocking canopies and often have sparse understories. They can occur directly adjacent to the active channel on terraces where banks are downcut. Floods could scour these sites every 6.5 years. Soils are sandy-skeletal Typic Torrifluvents. Often associated with these forests are grasses (e.g., sideoats grama and blue grama) and suffrutescent shrubs such as yucca, prickly pear cactus or cholla.

Arizona walnut forests are represented by the Arizona Walnut/Sideoats Grama CT. Like the netleaf hackberry forests, these can be found at elevations up to 6,200 ft (1,890 m). They are situated towards the outer portion of the floodplain (100 year flood intervals) furthest from the active channel, and at the toe of the adjoining hillslopes. Cross-section ratios are high (82.5) Tree canopies vary from open to closed. Soils sandy-skeletal over coarse loamy Aquic Camborthids. The understory vegetation reflects the drier environment associated with these terraces and is dominated by perennial grasses; commonly, sideoats grama and the sod-forming exotic bermudagrass as well as assorted shrubs, such as skunkbush sumac and honey mesquite.

Arizona sycamore forests are represented by the Arizona Sycamore—Arizona Alder CT, the Arizona Sycamore/Sideoats Grama CT and the Arizona Sycamore/Sparse CT of terraces, and the Arizona Sycamore/Seepwillow CT of narrow and low depositional bars bordering cobbly streams. Reproduction of other obligate woody riparian species often occurs in this last community. Elevations range from 4,700 ft (1,432 m) to 5,380 ft (1,640 m). Floodplains where these forests occur tend to be terraced or dissected by secondary or overflow channels and confined by a narrow to moderately wide valley. Soils are coarse or fine textured Oxyaquic Torrifluvents or coarse textured (sandy-skeletal) Aeric Fluvaquents. Canopies may be open to moderately open and trees are capable of reaching immense proportions with trunks measuring 2-3 foot diameters. Understories are variably diverse and commonly dominated by perennial grass species, such as sideoats grama or sand dropseed. Shrubs are scattered, but typically represented by California brickellbush, skunkbush sumac, and prickly pear cactus or cholla.

Fremont's cottonwood forests are represented by either the Fremont's Cottonwood—Velvet Ash CT, the Fremont's Cottonwood—Goodding's Willow CT or the Fremont's Cottonwood/Yerba Mansa CT. They occur along smaller tributary basins or are scattered along the central and southern floodplains of the middle Rio Grande where they are a southern replacement of the Rio Grande Cottonwood forests. Elevations range from 4,626 (1,410 m) to 5,000 ft (1,524 m). They occupy low, depositional sidebars or infilled channels within the floodplain forests (2 to 12 year return flow). There may be numerous pole-sized trees or relatively few mature trees comprising these communities. Diversity of species varies with community type. Often communities co-dominated by the forb, yerba mansa lack the diversity of the ash and willow forests. This forest community occurs along infilled channels where the water table fluctuates throughout the profile seasonally. Soils are coarse-loamy Oxyaquic Ustifluvents. The ash and willow communities occur on coarser textured, commonly Oxyaquic or Typic Torrifluvents, and are usually directly influenced by overbank flooding. Often associated with these forests are other woody riparian tree associates that may be mature or sapling-sized trees and include sycamores, alders, ashes, walnuts, as well as junipers. Shrubs may include coyote willow and bluestem willow while forbs include deergrass, horsetails and various other herbs.

Scrub-Shrub Wetland Communities

Scrub-shrub wetlands are widely scattered communities dominated by woody, multi-stemmed shrubs that are less than five meters in height, and commonly characterized by closed canopies (greater than 60% cover); or if open (10-60% cover), they are interspersed with individual trees and perennial or annual herbs. They tend to dominate the lowest depositional side and mid channel bars forming dense thickets and generally lack the overall diversity of the forests due to frequent scouring of the underlayers, though communities out of the immediate floodplain are able to develop lush understories. We have identified 16 community types across varying stream types and elevations.

<u>Cold Temperate Rocky Mountain Montane Shrublands</u>. - Like their forested counterparts, these shrublands are commonly distributed in cobble bars adjacent either to the active channel of perennial stream segments, or secondary (i.e., overflow) channels of both perennial streams in mountainous regions of northern New Mexico at higher elevations (up to 6,743 ft; 2,055 m) than the Rio Grande/Great Plains shrublands described next. These shrublands are dominated by bluestem willow with two community

border narrower, gravel bottomed channels (B2 and C3 stream types of Rosgen 1992) on higher and drier bars (5 year return flows). Diversity of species is low as canopy covers are dense (>60%) or very open (10%). Soils are either sandy-skeletal Aeric and Typic Fluvaquents, Aquic Ustifluvents or fine-textured Oxyaquic Ustifluvents.

Persistent-Emergent Wetland Communities

Persistent-Emergent wetlands of the Rio Grande and its tributaries are dominated by herbaceous perennials which normally have their roots annually, periodically or continually submerged in water. They commonly have well developed uniform canopies two meters tall or less. Often they develop in long, narrow strands along straight river runs bordering low gradient streams; or they occur along infilled channels cutoff from the main stem; or form wet, marshlike meadows that occur at the confluences of major tributaries or bordering upland fed springs. We have identified 10 community types across varying stream types.

<u>Cold Temperate Rocky Mountain Montane Herbaceous Wetlands</u>. - These communities are dominated by two series, the Baltic rush and American bulrush Series. They are situated at or below bankfull levels (cross-section ratio of 1 or less) within one to three year floodplains and along variable stream types that correspond to Rosgen's (1992) B2, or C2, C3 and C5. Elevations range from 4,920 ft (1,500 m) up to 6,900 ft (2,103 m).

Baltic rush communities are represented by the Baltic Rush—Nebraska Sedge CT and the Baltic Rush—Common Spikerush CT of infilled channels or marshy meadows of the upper basin, while the Baltic Rush/Smooth Horsetail CT of the middle basin commonly occupies the periphery of dissected bars of the middle basin. The communities are lush and require seasonal or frequent flooding for growth and maintenance. Soils are coarse-textured Aeric or Typic Fluvaquents, Mollic Psammaquents, or Oxyaquic Ustifluvents. Wetness ranks range from 1.7 to 5.

American bulrush communities are represented by the American Bulrush—Common Spikerush CT and the American Bulrush/Smooth Horsetail CT of infilled channels and marshy meadows of the upper basin. Like the Baltic rush communities, these communities also require moist or periodically saturated soils. Soils are sandy- or loamy-skeletal Mollic or Typic Fluvaquents. Diversity of species is low, yet, in the absence of outside disturbances, these are typically lush and well developed communities.

<u>Cold Temperate Rio Grande/Great Plains Herbaceous Wetlands</u>. - These communities occur in similar habitats as their Rocky Mountain montane counterparts and demand similar hydrological requirements. They are dominated by three series, the Water Sedge, Common Spikerush, and Broadleaf Cattail Series. Elevations range from 4750 ft (1448 m) to 6590 ft (2009 m). Commonly, these are streambank communities or occupy infilled channels of the middle basin but often extend into the upper basin as well. They require seasonally ponded or frequently flooded conditions for growth and maintenance.

They generally occupy the lowest positions at or below bankfull stages (cross-section ratio of 1 or less). Less often they sit high above the channel and are fed by sources other than the river (i.e., the Common Spikerush/Smooth Horsetail CT with a cross section ratio of 7.6).

Common spikerush communities are also represented by the Common Spikerush/Rice Cutgrass CT which borders the margins of frequently flooded island bars. Along moderate gradient (1.5%) gravelly and sandy bottomed channels. Soils are sandy and moist Aeric Fluvaquents. Communities are lush and diversity of species is low (15 or less) to moderate (15 to 25). Associated graminoids include other grasses (bentgrass, redtop and Canada wildrye) and forbs (Canada goldenrod, field horsetail and knotweeds)

Water sedge communities are represented by the Water Sedge/Smooth Horsetail CT that commonly occurs along confined, moderately steep gradient channels (2%) of steep-sided canyons. They are situated just below bankfull stages (cross section ratio less than 1) and are supported by soils that are coarse-loamy Typic Fluvaquents. Like the common spikerush communities, these are lush and diversity of species is low (15 or less) to moderate (15 to 25). Associated graminoids include rushes and few grasses, while forbs include dogbane, willowherb and potentilla.

Broad-leaf cattail communities are represented by the Broadleaf Cattail/American Bulrush CT and the Broadleaf Cattail/Rice Cutgrass CT. The commonly border pond margins or dominate infilled channels of old channels where the natural meander of the river was cutoff by channel rectification projects. They are seasonally saturated communities situated at or near bankfull stages (cross section ratio of 1.5 or less) that are supported by fine to coarse textured Aeric Fluvaquent soils. Diversity of species is generally very low (< 5), but these are lush communities with closed canopies.

Rio Grande Riparian/Wetland Species

The riparian plant species surveyed are listed alphabetically by their most recent scientific, common and family names following Kartesz (1994) in Appendix B. Synonymies of those species with recent nomenclatural changes are also included.

Four hundred and sixty-four species of vascular plants representing 277 genera and 83 families were found within the riparian/wetland communities. Nineteen per cent of the species belonged to the Asteraceae, while 18% were members of the Poaceae. All other families contained .05% (Cyperaceae and Rosaceae) or less.

Many of the trees and shrubs are obligate woody riparian species. These species naturally occur in riparian/wetland areas and depend on certain hydrologic aspects of a river or creek, such as flooding for reproduction, growth and maintenance. Important tree species present within the Rio Grande ecosystem include: alder (both *Alnus incana* ssp. *tenuifolia* and *A. oblongifolia*), ash (*Fraxinus velutina*), birch (*Betula occidentalis*), chokecherry (*Prunus virginiana* var. *melanocarpa*), cottonwood (*Populus angustifolia, P. deltoides, P. fremontii,* and *P.* x *acuminata*), sycamore (*Platanus wrightii*), walnut (*Juglans major*) and willow (*Salix amygdaloides* and *S. gooddingii*). Many obligate riparian shrubs further diversify the ecosystem and include: dogwood (*Cornus sericea* var. *sericea*), honeysuckle (*Lonicera involucrata*), indigobush (*Amorpha fruticosa*), New Mexico olive (*Forestiera pubescens* var. *pubescens*), seepwillow (*Baccharis salicifolia* and *B. salicina*) and several willows (*S. exigua, S. irrorata,* and *S. lutea*). Herbaceous obligate riparian/wetland species are numerous. Common are sedges (*Carex* spp.), rushes (*Juncus* spp., *Scirpus* spp.), horsetails (*Equisetum* spp.) and many grasses of various genera, especially the dropseeds (*Sporobolus* spp.), the muhlys (*Muhlenbergia* spp.) and bluegrasses (*Poa* spp).

Disregarding lifeform, 14% of the species found within the Rio Grande watershed are represented by exotic species (Table 9). Nearly one quarter (21%) of the woody riparian species, all trees, are known to be introduced. Of the herbaceous species, 17% of the graminoids (grasses and grass-like genera) surveyed were exotic, while 15% of the forbs were exotic. On the main stem of the Rio Grande alone, the percentage of exotic species increases significantly, especially for trees. Forty-one percent of tree species are exotic, while 19% of the graminoids and 24% of the forbs are known exotics. Several species have cosmopolitan distributions (Table 10) – occurring not only in North America, but on other continents as well.

Ecological Sites

Eighteen of the 109 sites assessed were of high quality, and an additional four sites were potentially high, lacking ground sampling to verify this (Table 11, Figure 18). Detailed descriptions of the 18 high quality sites are provided in Appendix D with supporting maps, photographs of the communities, and river cross-section diagrams that relate the communities and soils to flood stages. Table 12 summarizes the human-induced impacts to the sites, and an example of a high quality site is shown in Figure 19. High quality sites were absent from the middle Rio Grande between Cochiti and Elephant Butte Reservoirs because of regulated flows out of Cochiti Dam. The altered hydrology in that reach has decreased the viability and condition of many of the community types there. Because the reach contains most of the Rio Grande cottonwood communities in the Rio Grande watershed, those communities tended to be under-represent in the high quality sites we identified. Conversely, high quality communities tended to be at higher elevations on smaller streams where more montane communities, such as narrowleaf cottonwood communities, dominate.

Most of the 42 sites that were assessed to be medium quality (Table 11, Figure 20) had severely altered hydrologic regimes (Table 13), but offered potential for some recoverability or restorability through hydrologic means. Sites in the middle Rio Grande that were not dominated by saltcedar or Russian olive tended to be of medium quality because some community viability could be restored by overbank flooding. An example of a medium quality site is shown in Figure 21. Thirty-five sites were assessed as low quality (Table 11, Figure 22), due mainly to both altered hydrology and dominance of exotic vegetation, especially saltcedar and Russian olive (Table 14). An example of a low quality site is shown in Figure 23. We were unable to assign quality ranks to ten of the sites that were not quantitatively ground sampled due to insufficient information.

Table 9. Those species, by lifeform, which have been introduced, either deliberately or accidentally, to the Rio Grande watershed. UM = main stem, upper basin; MM = main stem, middle basin; UT = tributary, upper basin; MT = tributary, middle basin.

SPECIES		ORIGIN	DISTRIBUTION			
Scientific name	**Common name**		**UM**	**MM**	**UT**	**MT**
TREES — 41% of the total number of tree species occurring on the main stem alone are exotic. If tributary basins are included, 21% are exotic.						
Ailanthus altissima	tree-of-heaven	Asia		X		
Catalpa bignonioides	Southern catalpa	Native to SE U.S.		X		
Elaeagnus angustifoliä	Russian olive	Asia	X	X	X	X
Morus alba	white mulberry	China or Europe	X	X		
Robinia pseudoacacia	black locust	Native to SE U.S.		X	X	
Tamarix chinensis	saltcedar	MidEast/Med. region	X	X	X	X
Ulmus pumila	Siberian elm	Asia	X	X	X	
SHRUBS — There are no exotic shrub species occurring on either the main stem or tributary basins.						
GRAMINOIDS — 17% are exotic, including tributaries vs. 19% on the main stem alone.						
Aegilops cylindrica	jointed goatgrass	Europe			X	
Agrostis gigantea	redtop	Europe	X		X	X
Agrostis stolonifera	creeping bentgrass	Europe	X	X	X	
Bromus catharticus	rescuegrass	Eurasia		X		X
Bromus commutatus	meadow brome	Eurasia	X			
Bromus inermis	smooth brome	Eurasia	X		X	
Bromus japonicus	Japanese brome	Eurasia	X	X	X	X
Bromus tectorum	cheatgrass	Eurasia	X		X	X
Cynodon dactylon	bermudagrass	Carribean/Med. region				X
Dactylis glomerata	orchardgrass	Eurasia	X		X	
Digitaria sanguinalis	hairy crabgrass	Eurasia		X		
Echinochloa crus-galli	barnyardgrass	Eurasia		X		X
Elytrigia intermedia	intermediate wheatgrass	Europe			X	
Eragrostis cilianensis	stinkgrass	Eurasia		X		
Festuca pratensis	meadow fescue	Europe	X	X	X	X
Phleum pratense	timothy	Europe	X		X	
Poa pratensis	Kentucky bluegrass	Europe	X		X	X
Polypogon monspeliensis	annual rabbitsfootgrass	Eurasia	X	X	X	X
Polypogon viridis	beardless rabbitsfootgrass	Europe				X
Sorghum halapense	Johnsongrass	Europe		X		

Table 9 (continued).

SPECIES		ORIGIN	DISTRIBUTION			
Scientific name	**Common name**		**UM**	**MM**	**UT**	**MT**
FORBS — 15% are exotic, including tributaries vs. 24% on the mainstem alone.						
Arctium minus	lesser burdock	Europe	X			
Asparagus officinalis	garden asparagus	MidEast/Med. region	X	X	X	
Brassica nigra	black mustard	Europe	X			
Cannabis sativa	marijuana	Eurasia	X			
Chenopodium album	lambsquarters	Europe	X			
Chenopodium rubrum	red goosefoot	Europe	X			
Cirsium arvense	Canada thistle	Europe	X		X	
Cirsium vulgare	bull thistle	Europe	X			
Conium maculatum	poison hemlock	Europe	X			
Convolvulus arvensis	field bindweed	Eurasia		X		
Conyza canadensis	Canadian horseweed	MidEast/Med. region	X	X		X
Cynoglossum officinale	gypseyflower	Europe	X			X
Datura stramonium	jimsonweed	South America				X
Dipsacus fullonum	Fuller's teasel	Europe	X			
Galium aparine	stickywilly	Europe			X	
Lactuca serriola	prickly lettuce	Europe	X		X	X
Lepidium latifolium	broadleaved pepperweed	Europe	X			
Leucanthemum vulgare	oxeyed daisy	Europe			X	
Marrubium vulgare	horehound	Eurasia		X		
Medicago lupulina	black medic	Europe	X		X	X
Medicago sativa	alfalfa	Europe	X		X	
Melilotus officinalis	sweetclover	Europe	X	X	X	X
Mentha spicata	spearmint	Europe	X		X	
Nepeta cataria	catnip	Europe	X			
Plantago lanceolata	narrowleaf plantain	Europe	X		X	
Plantago major	common plantain	Europe	X	X	X	
Polygonum lapathifolium	curlytop knotweed	Europe		X		X
Polygonum persicaria	spotted ladysthumb	Europe	X			
Rorippa nast-aqua.	watercress	Eurasia			X	X
Rumex crispus	curly dock	Europe	X			X
Solanum ptychanthum	nightshade	Europe				X
Sonchus asper	spiny sowthistle	Europe	X		X	X
Tragopogon pratensis	meadow salsify	Europe	X		X	
Trifolium pratense	red clover	Europe			X	
Trifolium repens	white clover	Europe			X	
Verbascum thapsus	common mullein	Europe	X	X	X	X
Veronica ana.-aquatica	water speedwell	Europe			X	X

Table 10. Plant species of the upper and middle Rio Grande watershed that have cosmopolitan distributions, occurring not only in North America, but on other continents.

SCIENTIFIC NAME	COMMON NAME
TREES	
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SHRUBS	
Pentaphylloides floribunda	shrubby cinquefoil
GRAMINOIDS	
Cyperus squarrosus	bearded flatsedge
Juncus filiformis	threadrush
Luzula parviflora	smallflowered woodrush
Poa compressa	muttongrass
Scirpus americanus	American bulrush
Scirpus maritimus	slatmarsh bulrush
FORBS	
Berula erecta	cutleaf waterparsnip
Bidens bipinnata	spanish-needles
Bidens cernua	nodding beggarstick
Campanula rotundifolia	bluebell bellflower
Gaura parviflora	velvetweed
Heracleum maximum	common cowparsnip
Lappula occidentalis var. *occidentalis*	desert stickseed
Lobelia cardinalis ssp. *graminea*	cardinalflower
Maianthemum stellatum	starry false Solomon's seal
Potentilla norvegica	Norwegian cinquefoil
Prunella vulgaris	common selfheal
Ranunculus aquatilis	whitewater crowfoot
Rumex acetosella	common sheep sorrel
Salsola kali	Russina thistle
Scutellaria galericulata	marsh skullcap
Solanum elaeagnifolium	silverleaf nightshade
Taraxacum officinale	common dandelion
Typha latifolia	broadleaf cattail
Xanthium strumarium	rough cocklebur

Table 11. Communities found at sites along the Rio Grande and tributaries.

Site No	River	Site Quality	Site Size	Stream Length	Community	Comm Rank
2	Rio Grande	high	10 Ha	1540 m	coyote willow / redtop	A
					water sedge / smooth horsetail	B
4	Rio Grande	high	70 Ha	4300 m	American bulrush / smooth horsetail	B
					coyote willow / redtop	A
					Rio Grande cottonwood / coyote willow	A
					Rio Grande cottonwood / smooth horsetail	A
					Rio Grande cottonwood / sparse ground cover	A
					Rio Grande cottonwood / water sedge	A
66	Rio Pueblo	high	19 Ha	2750 m	blue spruce / thinleaf alder	A
					blue spruce / thinleaf alder	B
68	Jemez	high	35 Ha	2200 m	coyote willow / smooth horsetail	A
					Rio Grande cottonwood / New Mexico olive	A
72	Embudo Creek	high	51 Ha	5790 m	Baltic rush / Nebraska sedge	A
74	Embudo Creek	high	7 Ha	300 m	Baltic rush / common spikerush	A
					Rio Grande cottonwood / coyote willow	B
76	Canada de Ojo Sarco	high	6 Ha	550 m	common spikerush / smooth horsetail	A
					Rio Grande cottonwood / coyote willow	B
78	Cabresto Creek	high	13 Ha	1600 m	narrowleaf cottonwood / thinleaf alder	A
					narrowleaf cottonwood / thinleaf alder	B
79	Rio Chama	high	16 Ha	21 m	narrowleaf cottonwood / coyote willow	A
					narrowleaf cottonwood / thinleaf alder	A
84	Agua Caliente	high	16 Ha	1830 m	narrowleaf cottonwood / bluestem willow	B
					narrowleaf cottonwood / Rocky Mountain juniper	B
					thinleaf alder / bluestem willow	B
85	Rio Truchas	high	5 Ha	300 m	Baltic rush / common spikerush	A
					bluestem willow / coyote willow	B
					coyote willow / Baltic rush	B
					coyote willow / sparse ground cover	B
					narrowleaf cottonwood / coyote willow	B
					Rio Grande cottonwood / Russian olive	B
93	Rio Paguate	high	28 Ha	3780 m	narrowleaf cottonwood / Arizona alder	A
98	Rio Tesuque	high	10 Ha	920 m	American bulrush / common spikerush	A
102	Palomas	high	7 Ha	570 m	American bulrush / common spikerush	B
					Arizona alder / seepwillow	B
					Fremont's cottonwood / Goodding's willow	B
					Rio Grande cottonwood / coyote willow	B
					seepwillow / prairie wedgescale	B
103	Seco Creek	high	9 Ha	600 m	Arizona walnut / sideoats grama	B
					narrowleaf cottonwood / Arizona alder	B
104	Seco Creek	high	10 Ha	1830 m	Fremont's cottonwood / Goodding's willow	B
					netleaf hackberry / skunkbush sumac	A
106	Las Animas Creek	high	55 Ha	3760 m	Arizona alder / Goodding's willow	A
					Arizona sycamore / Arizona alder	A
					Arizona sycamore / sideoats grama	A
107	Las Animas Creek	high	5 Ha	550 m	Fremont's cottonwood / velvet ash	A
					Fremont's cottonwood / velvet ash	B
67	Jemez	pot. high	284 Ha	25800 m	N/A - Site not ground sampled	

Site No	River	Site Quality	Site Size	Stream Length	Community	Comm Rank
86	Rio Fernado de Taos	pot. high	2 Ha	600 m	N/A - Site not ground sampled	
96	Mc Cartys Marsh	pot. high	13 Ha		N/A - Site not ground sampled	
105	Animas Creek	pot. high	12 Ha	1200 m	N/A - Site not ground sampled	
3	Rio Grande	med	53 Ha	8520 m	American bulrush / smooth horsetail	B
					coyote willow / redtop	B
5	Rio Grande	med	3 Ha	900 m	coyote willow / water sedge	B
7	Rio Grande	med	53 Ha	900 m	broadleaf cattail / American bulrush	B
					Rio Grande cottonwood / New Mexico olive	B
8	Rio Grande	med	8 Ha	320 m	N/A - Site not ground sampled	
9	Rio Grande	med	29 Ha	600 m	N/A - Site not ground sampled	
11	Rio Grande	med	86 Ha	2100 m	common spikerush / rice cutgrass	B
					Rio Grande cottonwood / coyote willow	A
					Rio Grande cottonwood / New Mexico olive	B
					Rio Grande cottonwood / Russian olive	C
20	Rio Grande	med	88 Ha	1400 m	N/A - Site not ground sampled	
23	Rio Grande	med	17 Ha	470 m	coyote willow / American bulrush	A
					Rio Grande cottonwood / New Mexico olive	B
24	Rio Grande	med	28 Ha	980 m	N/A - Site not ground sampled	
25	Rio Grande	med	49 Ha	790 m	N/A - Site not ground sampled	
26	Rio Grande	med	28 Ha	1000 m	Rio Grande cottonwood / coyote willow	B
					Rio Grande cottonwood / New Mexico olive	B
					Rio Grande cottonwood / Russian olive	D
28	Rio Grande	med	72 Ha	1100 m	coyote willow / American bulrush	B
					Rio Grande cottonwood / New Mexico olive	C
29	Rio Grande	med	43 Ha	550 m	Rio Grande cottonwood / Russian olive	D
					Rio Grande cottonwood / sparse ground cover	C
33	Rio Grande	med	7 Ha		N/A - Site not ground sampled	
35	Rio Grande	med	111 Ha	1100 m	coyote willow / water sedge	A
					Rio Grande cottonwood / coyote willow	B
36	Rio Grande	med	48 Ha	1230 m	N/A - Site not ground sampled	
37	Rio Grande	med	46 Ha	670 m	N/A - Site not ground sampled	
38	Rio Grande	med	55 Ha	950 m	coyote willow / saltgrass	B
					coyote willow / yerba mansa	B
					Rio Grande cottonwood / saltcedar	B
39	Rio Grande	med	35 Ha	830 m	N/A - Site not ground sampled	
41	Rio Grande	med	23 Ha	490 m	Fremont's cottonwood / yerba mansa	C
					Russian olive / saltcedar	D
42	Rio Grande	med	56 Ha	1220 m	coyote willow / woolly sedge	A
					Fremont's cottonwood / Goodding's willow	B
					Rio Grande cottonwood / Russian olive	B
44	Rio Grande	med	76 Ha	1230 m	Rio Grande cottonwood / saltcedar	B
46	Rio Grande	med	600 Ha	900 m	Fremont's cottonwood / Goodding's willow	B
51	Rio Grande	med	93 Ha	600 m	N/A - Site not ground sampled	
54	Rio Grande	med	28 Ha	600 m	N/A - Site not ground sampled	
56	Rio Grande	med	49 Ha	900 m	N/A - Site not ground sampled	
57	Rio Grande	med	104 Ha	1300 m	Rio Grande cottonwood / coyote willow	B
					Rio Grande cottonwood / saltcedar	C
63	Red River	med	10 Ha	1530 m	N/A - Site not ground sampled	
65	Rio Pueblo	med	21 Ha	1220 m	N/A - Site not ground sampled	

Site No	River	Site Quality	Site Size	Stream Length	Community	Comm Rank
69	Jemez	med	5 Ha	300 m	coyote willow / redtop	A
					Rio Grande cottonwood / Kentucky bluegrass	B
71	Arroyo Hondo	med	2 Ha	450 m	blue spruce / thinleaf alder	B
73	Embudo Creek	med	15 Ha	1400 m	N/A - Site not ground sampled	
77	Rio Brazos	med	13 Ha	950 m	bluestem willow / coyote willow	B
					narrowleaf cottonwood / thinleaf alder	A
81	Rio Chama	med	41 Ha	1520 m	coyote willow / smooth horsetail	A
					narrowleaf cottonwood / New Mexico olive	B
					Rio Grande cottonwood / smooth horsetail	B
					water sedge / smooth horsetail	A
82	Rio Chama	med	19 Ha	760 m	N/A - Site not ground sampled	
83	Rio Chama	med	17 Ha	710 m	N/A - Site not ground sampled	
90	Santa Fe	med	67 Ha	4500 m	N/A - Site not ground sampled	
91	Santa Fe	med	164 Ha		N/A - Site not ground sampled	
94	Rio San Jose	med	5 Ha	300 m	broadleaf cattail / rice cutgrass	A
95	Rio San Jose	med	12 Ha	920 m	broadleaf cattail / American bulrush	A
					saltcedar / sparse ground cover	A
97	Rio Tesuque	med	2 Ha	300 m	N/A - Site not ground sampled	
108	Las Animas Creek	med	37 Ha	1800 m	Arizona sycamore / seepwillow	B
					Arizona sycamore / sparse ground cover	B
					Fremont's cottonwood / Goodding's willow	B
12	Rio Grande	low	12 Ha	450 m	N/A - Site not ground sampled	
14	Rio Grande	low	58 Ha	790 m	N/A - Site not ground sampled	
16	Rio Grande	low	51 Ha		N/A - Site not ground sampled	
17	Rio Grande	low	150 Ha	3030 m	N/A - Site not ground sampled	
18	Rio Grande	low	40 Ha	900 m	Rio Grande cottonwood / oneseed juniper	C
					Rio Grande cottonwood / saltcedar	C
19	Rio Grande	low	17 Ha	760 m	N/A - Site not ground sampled	
21	Rio Grande	low	35 Ha	750 m	N/A - Site not ground sampled	
22	Rio Grande	low	51 Ha	750 m	Fremont's cottonwood / yerba mansa	C
					Rio Grande cottonwood / saltcedar	B
30	Rio Grande	low	103 Ha	2450 m	N/A - Site not ground sampled	
31	Rio Grande	low	56 Ha	1370 m	Baltic rush / smooth horsetail	B
					Rio Grande cottonwood / Russian olive	C
32	Rio Grande	low	37 Ha	750 m	N/A - Site not ground sampled	
34	Rio Grande	low	116 Ha	900 m	N/A - Site not ground sampled	
40	Rio Grande	low	38 Ha	1030 m	N/A - Site not ground sampled	
43	Rio Grande	low	118 Ha	1030 m	N/A - Site not ground sampled	
45	Rio Grande	low	60 Ha	900 m	N/A - Site not ground sampled	
47	Rio Grande	low	1253 Ha	7950 m	N/A - Site not ground sampled	
48	Rio Grande	low	262 Ha	2200 m	N/A - Site not ground sampled	
49	Rio Grande	low	67 Ha	1550 m	N/A - Site not ground sampled	
50	Rio Grande	low	65 Ha	1250 m	Rio Grande cottonwood / saltcedar	B
					Rio Grande cottonwood / saltcedar	D
52	Rio Grande	low	93 Ha	1220 m	coyote willow / seepwillow	B
					Rio Grande cottonwood / saltcedar	B
53	Rio Grande	low	67 Ha	1200 m	N/A - Site not ground sampled	
55	Rio Grande	low	40 Ha	900 m	N/A - Site not ground sampled	
58	Rio Grande	low	126 Ha	1200 m	N/A - Site not ground sampled	

Site No	River	Site Quality	Site Size	Stream Length	Community	Comm Rank
59	Rio Grande	low	51 Ha	800 m	N/A - Site not ground sampled	
60	Rio Grande	low	88 Ha	1400 m	N/A - Site not ground sampled	
61	Rio Grande	low	16 Ha	610 m	Fremont's cottonwood / Goodding's willow	B
62	Rio Grande	low	19 Ha	1200 m	N/A - Site not ground sampled	
70	Jemez	low	72 Ha	2200 m	N/A - Site not ground sampled	
75	Canada de Ojo Sarco	low	27 Ha	1410 m	N/A - Site not ground sampled	
88	Rio Puerco	low	23 Ha	1250 m	N/A - Site not ground sampled	
89	Rio Puerco	low	8 Ha	600 m	coyote willow / rubber rabbitbrush	B
					Rio Grande cottonwood / saltcedar	D
92	Gallisteo	low	263 Ha	9150 m	N/A - Site not ground sampled	
99	Pojoaque	low	6 Ha	440 m	American bulrush / smooth horsetail	B
					Rio Grande cottonwood / New Mexico olive	B
100	Alamocita Creek	low	22 Ha	750 m	N/A - Site not ground sampled	
101	Cienega Creek	low	7 Ha	450 m	coyote willow / smooth horsetail	C
					Rio Grande cottonwood / Kentucky bluegrass	B
					Rio Grande cottonwood / Russian olive	D
1	Rio Grande	no rank	16 Ha	1540 m	N/A - Site not ground sampled	
6	Rio Grande	no rank	23 Ha	900 m	N/A - Site not ground sampled	
10	Rio Grande	no rank	114 Ha	1800 m	N/A - Site not ground sampled	
13	Rio Grande	no rank	13 Ha	1500 m	N/A - Site not ground sampled	
15	Rio Grande	no rank	69 Ha	790 m	N/A - Site not ground sampled	
27	Rio Grande	no rank	41 Ha	850 m	N/A - Site not ground sampled	
64	Red River	no rank	2 Ha	475 m	N/A - Site not ground sampled	
80	Rio Chama	no rank	58 Ha	9750 m	N/A - Site not ground sampled	
87	Ojo Caliente	no rank	118 Ha	1250 m	N/A - Site not ground sampled	
109	Canones Creek	no rank	21 Ha	2250 m	N/A - Site not ground sampled	

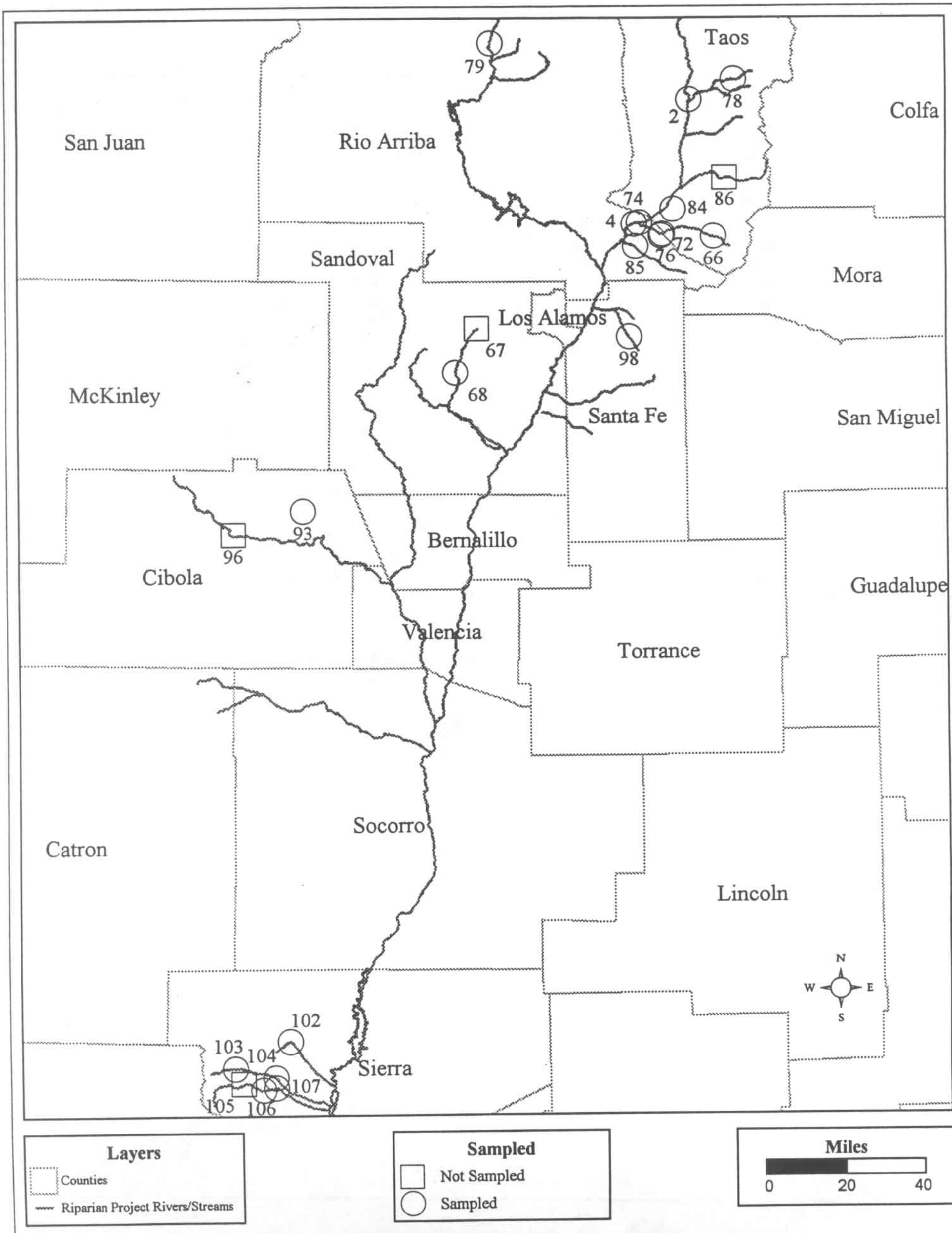

Figure 18. High and potentially high quality sites identified in New Mexico.

Table 12. High quality sites identified and ground sampled in the Rio Grande watershed in 1994

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
2 - La Junta Rio Grande Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: yes, moderate use by fishermen Exotic vegetation dominant: no
4 - Embudo Rio Grande Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence seen Dumping: yes, light ORV Use: yes, moderate Wood Cutting: no Roads: yes, highway out of active floodplain; some dirt roads Other Impacts: unknown Exotic vegetation dominant: no
66 - Canon Tio Maes Rio Pueblo Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence seen Dumping: no ORV Use: no Wood Cutting: yes, use in campfires Roads: yes, adjacent to river, and in campgrounds Other Impacts: yes, campgrounds; moderate use by fishermen Exotic vegetation dominant: no
68 - Canon Jemez Sandoval	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: unknown ORV Use: no Wood Cutting: unknown Roads: yes, adjacent to floodplain Other Impacts: yes, agricultural field on west side Exotic vegetation dominant: no
72 - Embudo Canyon Embudo Creek Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: yes, light use by fishermen Exotic vegetation dominant: no
74 - Rio Grande Confluence Embudo Creek Rio Arriba	Reg. Flows: no Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence seen Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: unknown Exotic vegetation dominant: no

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
76 - Lower Canada de Ojo Sarco Canada de Ojo Sarco Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light Dumping: no ORV Use: yes, moderate Wood Cutting: no Roads: yes, moderate Other Impacts: unknown Exotic vegetation dominant: no
78 - Cabresto Creek Cabresto Creek Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, Adjacent to river but up and away from floodplain in most areas Other Impacts: yes, light fishing Exotic vegetation dominant: no
79 - Upper Chama Rio Chama Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light Dumping: no, no evidence seen ORV Use: no, no evidence seen Wood Cutting: unknown Roads: no Other Impacts: yes, cabins and motels take up much of the floodplain Exotic vegetation dominant: no
84 - Agua Caliente Agua Caliente Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light horse and cattle grazing Dumping: unknown ORV Use: unknown Wood Cutting: unknown Roads: no Other Impacts: unknown Exotic vegetation dominant: no, some sweet clover however
85 - Rio Truchas Rio Truchas Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, occasional cattle Dumping: unknown ORV Use: yes, light Wood Cutting: unknown Roads: yes, dirt road adjacent to floodplain Other Impacts: unknown Exotic vegetation dominant: no
93 - Paguate Rio Paguate Cibola	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, moderate Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: yes, trail used by fishermen Exotic vegetation dominant: no

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
98 - Arroyo Cuma Rio Tesuque Santa Fe	Reg. Flows: no Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: yes, light; horses Dumping: no ORV Use: no Wood Cutting: no Roads: yes, dirt road down to the river Other Impacts: yes, agriculture Exotic vegetation dominant: no, but exotics common
102 - Lower Palomas Palomas Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light grazing by horses and bison Dumping: no ORV Use: no Wood Cutting: no Roads: yes, on the outer limits of the site Other Impacts: yes, ranch located at west boundary of site Exotic vegetation dominant: no
103 - North Seco Canyon Seco Creek Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light grazing by bison Dumping: no ORV Use: yes, by ranch hands Wood Cutting: no Roads: yes, on the outer reaches of the floodplain Other Impacts: no Exotic vegetation dominant: no
104 - Lower Seco Canyon Seco Creek Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light bison grazing Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: no Exotic vegetation dominant: no
106 - Dollar Mesa Las Animas Creek Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence Dumping: no ORV Use: no Wood Cutting: no Roads: yes, dirt road along river; road crosses river a few times Other Impacts: no Exotic vegetation dominant: no
107 - Warm Spring Las Animas Creek Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence seen Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: no Exotic vegetation dominant: no

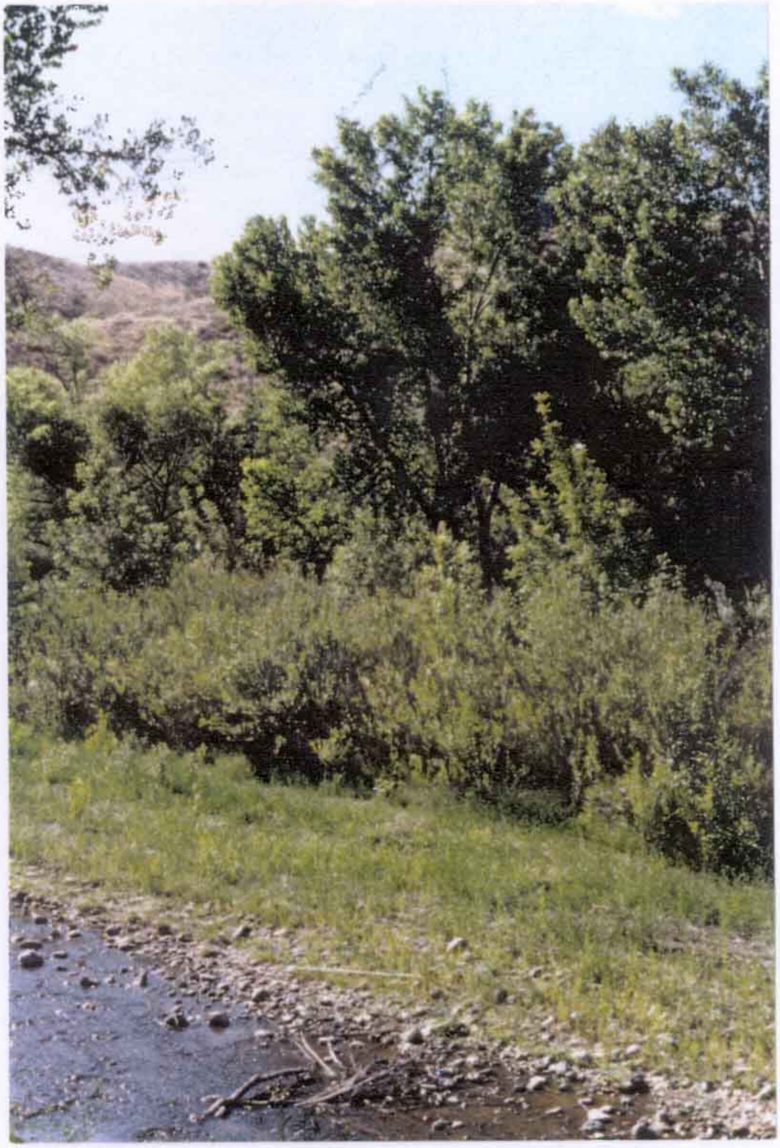

Photo: Mike Bradley

Figure 19. Example of a high quality site at the Lower Palomas Site. The unregulated hydologic regime allows for natural reproduction of riparian species.

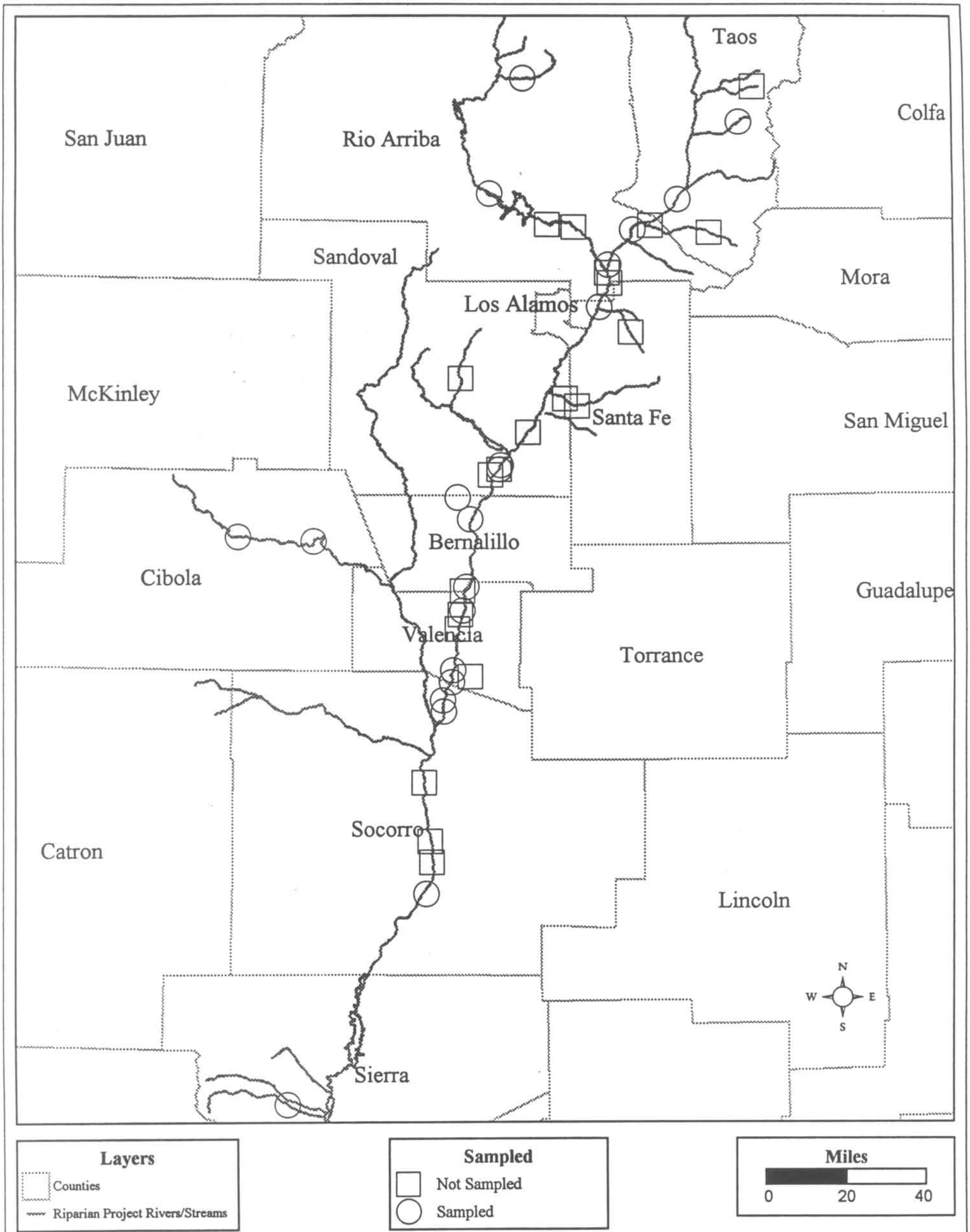

Figure 20. Medium quality sites identified in New Mexico.

Table 13. Medium quality sites identified and ground sampled in the Rio Grande watershed in 1994

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
3 - Rio Grande St. Park at Pilar Rio Grande Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: yes, moderate ORV Use: yes Wood Cutting: no Roads: yes, on upper terrace Other Impacts: yes, area heavily camped and rafted Exotic vegetation dominant: yes, salt cedar codominates
5 - Canon del Rio Grande Rio Grande Rio Arriba	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: unknown ORV Use: no Wood Cutting: no Roads: yes, highway adjacent to river Other Impacts: yes, rafters Exotic vegetation dominant: no, but Russian thistle and white mustard are common
7 - Pueblito Rio Grande Rio Arriba	Reg. Flows: no Dredging: yes Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, small not well traveled dirt road in floodplain; bridge Other Impacts: no Exotic vegetation dominant: no, but Russian olive common
11 - Pojoaque Confluence Rio Grande Santa Fe	Reg. Flows: no Dredging: unknown Levees: yes Jetty Jacks: unknown Rip Rap: unknown	Grazing: yes, heavy Dumping: unknown ORV Use: unknown Wood Cutting: yes, heavy on the west side of the river Roads: yes, throughout floodplain Other Impacts: unknown Exotic vegetation dominant: no, but Russian olive and saltcedar common
23 - Coronado St Park Rio Grande Sandoval	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: yes, light ORV Use: yes, light Wood Cutting: no Roads: yes, dirt road disects floodplain Other Impacts: yes, picnic area; large amounts of woody litter creates fire hazard Exotic vegetation dominant: no, some exotics are present

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
26 - Corrales Rio Grande Sandoval	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: yes, moderate on east side Dumping: no ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, trails on west side; fire hazard due to amounts of woody litter present Exotic vegetation dominant: yes, codominates on east side of river
28 - Coronado Airport Rio Grande Bernalillo	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, horse trails on west side; fire hazard due to amount of woody litter present Exotic vegetation dominant: no, but exotics present
29 - Rio Grande Nature Center Rio Grande Bernalillo	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: yes, trails throughout floodplain; fire hazard due to amounts of woody litter present Exotic vegetation dominant: no, but Russian olive dominates the banks
35 - Isleta Rio Grande Bernalillo	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, highway adjacent to the floodplain Other Impacts: yes, railroad, ditch, and lower potions of the floodplain are flooded freqently Exotic vegetation dominant: yes, in some areas of the floodplain
38 - Los Lunas Rio Grande Valencia	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: no Dumping: yes, moderate ORV Use: yes, moderate Wood Cutting: no Roads: yes, with the levee Other Impacts: yes, area flooded frequently Exotic vegetation dominant: yes, parts of the east floodplain

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
41 - Turn Rio Grande Valencia	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: unknown Dumping: yes, moderate ORV Use: yes Wood Cutting: no Roads: yes, on the levee and along the new ditch road Other Impacts: yes, area floods at a relatively low cfs Exotic vegetation dominant: no, but occurrences of salt cedar and Russian olive
42 - Veguita Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: unknown Rip Rap: no	Grazing: yes, light Dumping: yes, moderate ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, new ditch being constructed; parts of floodplain still flood Exotic vegetation dominant: yes, on some portions of the floodplain
44 - Abeytas Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, along levee Other Impacts: yes, beaver and flooding in the lower parts of the floodplain Exotic vegetation dominant: yes, in some parts of the floodplain that are flooded
46 - Bernardo Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: unknown Rip Rap: no	Grazing: yes, light Dumping: no ORV Use: no Wood Cutting: no Roads: yes, along levee Other Impacts: yes, beaver, fire evidence Exotic vegetation dominant: yes, in some spots in the floodplain
57 - Bosque del Apache Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: unknown Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, site is frequently flooded Exotic vegetation dominant: yes, salt cedar very extensive on east floodplain

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
69 - Jemez Indian Mission Jemez Sandoval	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, moderate Dumping: yes, unknown extent ORV Use: unknown Wood Cutting: unknown Roads: yes, roads occor through much of the floodplain Other Impacts: yes, farm fields; cottonwoods cut Exotic vegetation dominant: no, moderate infestation by exotics
71 - Arroyo Hondo Arroyo Hondo Taos	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: yes, road adjacent to river, fragments floodplain Other Impacts: yes, vegetation cleared for power line Exotic vegetation dominant: no
77 - Rio Brazos Rio Brazos Rio Arriba	Reg. Flows: no Dredging: unknown Levees: unknown Jetty Jacks: no Rip Rap: no	Grazing: no, no evidence seen Dumping: unknown ORV Use: unknown Wood Cutting: unknown Roads: yes, dirt road adjacent to floodplain Other Impacts: yes, many cabins and summer homes Exotic vegetation dominant: no
81 - Middle Chama Rio Chama Rio Arriba	Reg. Flows: yes Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: unknown Roads: yes, dirt road on the upper terrace Other Impacts: yes, moderate camping Exotic vegetation dominant: no
94 - Rio San Jose at rest area Rio San Jose Cibola	Reg. Flows: yes Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: no ORV Use: no Wood Cutting: no Roads: no Other Impacts: no Exotic vegetation dominant: no
95 - The Indian Peaks Rio San Jose Cibola	Reg. Flows: yes Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: yes, moderate ORV Use: unknown Wood Cutting: no Roads: yes, dirt road adjacent to marsh Other Impacts: yes, old breached dam; beaver Exotic vegetation dominant: no, but saltceder infestation upstream

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
108 - Saladone Tank Las Animas Creek Sierra	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, light evidence of bison grazing Dumping: no ORV Use: no Wood Cutting: no Roads: yes, fording the river and along the floodplain Other Impacts: yes, agriculture fields and dredged tanks; irrigation ditches Exotic vegetation dominant: no

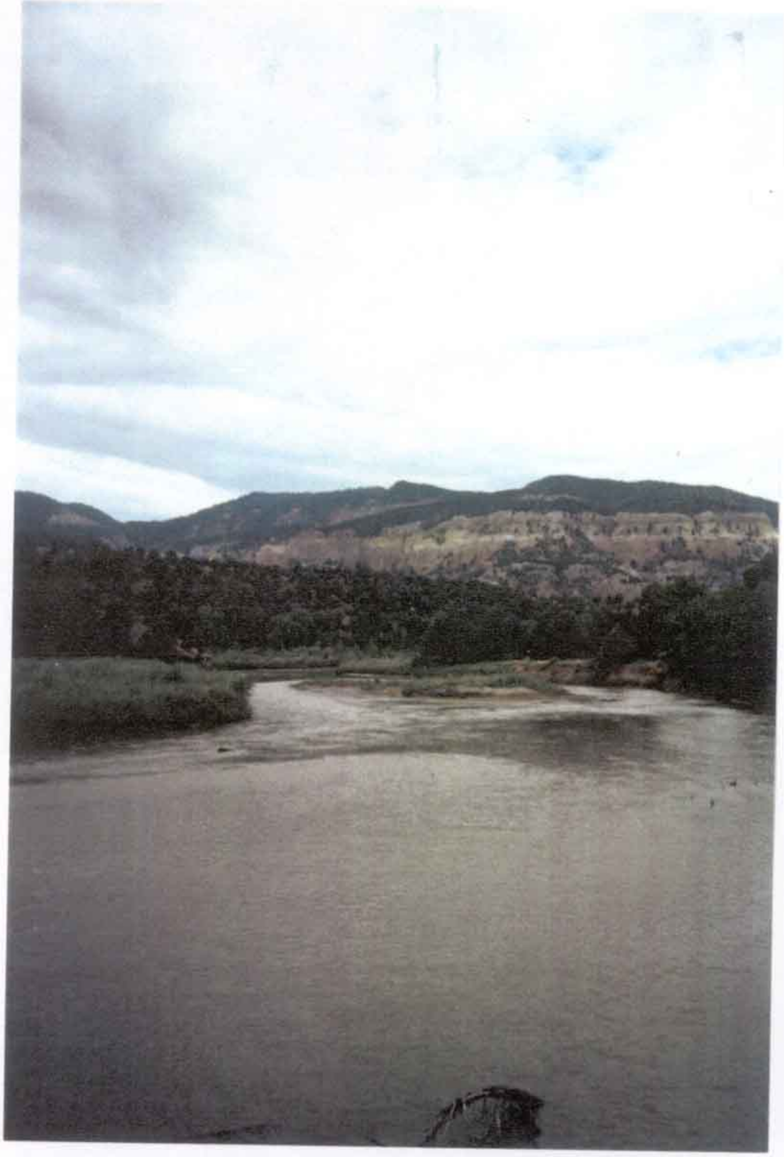

Photo: Mike Bradley

Figure 21. Example of a meduim quality site on the Rio Chama between El Vado and Abiquiu. Local floodplain impacts impacts are low to moderate. The vegetation communities in low positions in the floodplain seem unaffected by flow regulation, but those higher in the floodplain appear no longer to be flooded.

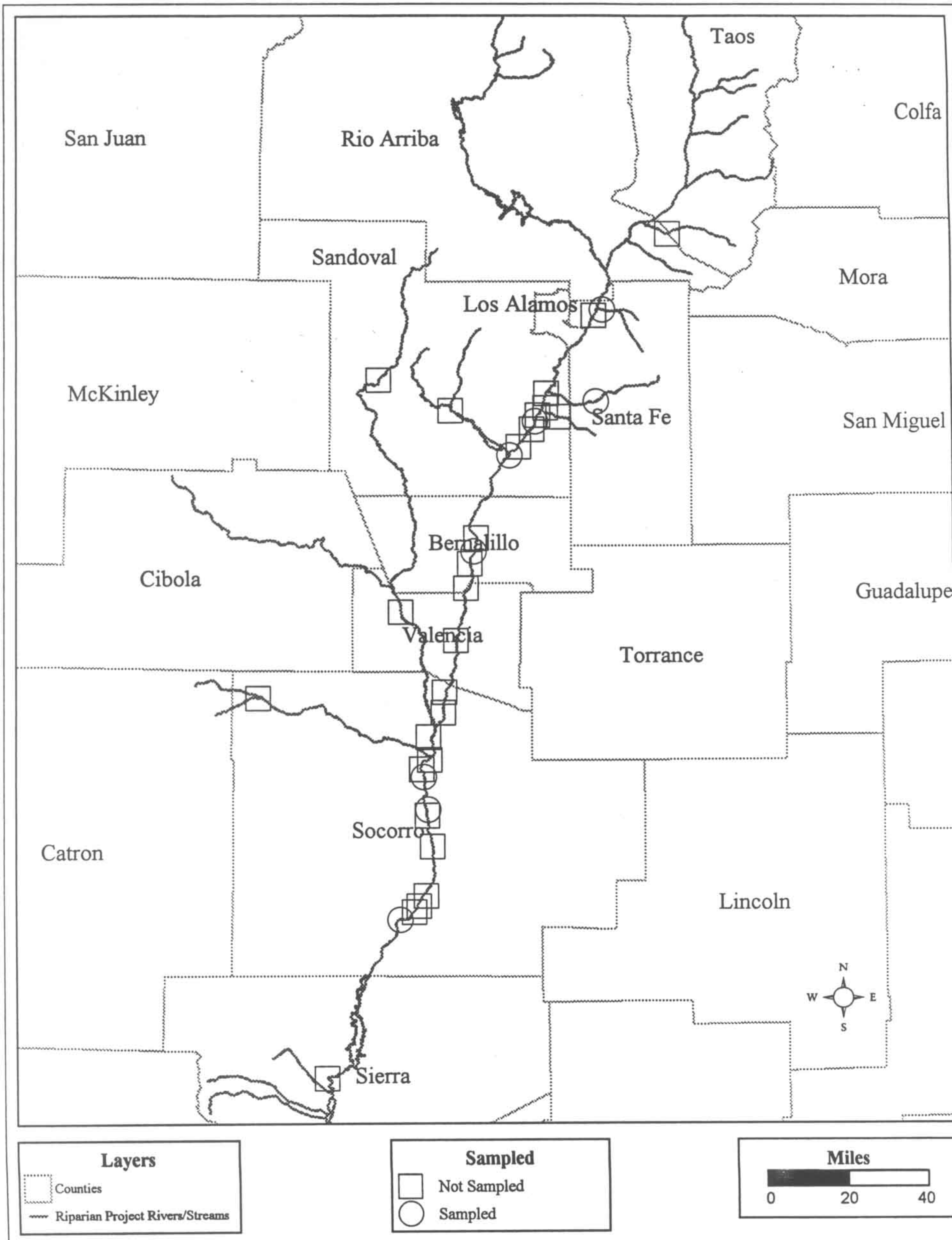

Figure 22. Low quality sites identified in New Mexico.

Table 14. Low quality sites identified and ground sampled in the Rio Grande watershed in 1994

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
18 - Borrego Rio Grande Sandoval	Reg. Flows: yes Dredging: yes Levees: yes Jetty Jacks: unknown Rip Rap: yes	Grazing: yes, moderate to heavy Dumping: unknown ORV Use: unknown Wood Cutting: yes, moderate Roads: yes, adjacent to channel Other Impacts: no Exotic vegetation dominant: yes, salt cedar codominates
22 - Jemez Confluence Rio Grande Sandoval	Reg. Flows: yes Dredging: yes Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: yes, light Dumping: unknown ORV Use: unknown Wood Cutting: unknown Roads: yes, on levee Other Impacts: unknown Exotic vegetation dominant: yes, salt cedar codominates
31 - Rio Bravo Bridge Rio Grande Bernalillo	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: no Dumping: yes, light ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, bosque cleared for power line; fire hazard due to amounts of woody debris present Exotic vegetation dominant: no, but common on banks
50 - Polvadera Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: yes, light Dumping: no ORV Use: no Wood Cutting: no Roads: yes, along levee and to river Other Impacts: unknown Exotic vegetation dominant: yes, salt cedar very common on west side of river
52 - Socorro Rio Grande Socorro	Reg. Flows: yes Dredging: unknown Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: yes, moderate Dumping: yes, moderate ORV Use: yes Wood Cutting: unknown Roads: yes, on east side especially Other Impacts: yes, flooding in the lower portions of the floodplain Exotic vegetation dominant: yes, saltcedar codominates with cottowoods

Site Number - Site Name River Name County	Hydrologic Impacts	Other Impacts
61 - San Marcial Rio Grande Socorro	Reg. Flows: yes Dredging: no Levees: yes Jetty Jacks: no Rip Rap: no	Grazing: yes, heavy Dumping: yes, moderate ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, railroad track; floodplain within the railroad track floods frequently Exotic vegetation dominant: yes, salt cedar very dominate on the other side of the railroad tracks
89 - Lower Rio Puerco Rio Puerco Bernalillo	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: yes, moderate to heavy Dumping: unknown ORV Use: unknown Wood Cutting: unknown Roads: yes, highway to Los Lunas bridge Other Impacts: Exotic vegetation dominant: yes, salt cedar infestation
99 - Pojoaque Pojoaque Santa Fe	Reg. Flows: yes Dredging: yes Levees: yes Jetty Jacks: yes Rip Rap: no	Grazing: yes, light horse grazing Dumping: no ORV Use: no Wood Cutting: no Roads: yes, on levee Other Impacts: yes, fording river downstream with bulldozer Exotic vegetation dominant: no, but exotics common
101 - La Cienega Cienega Creek Santa Fe	Reg. Flows: no Dredging: no Levees: no Jetty Jacks: no Rip Rap: no	Grazing: no Dumping: yes, light ORV Use: no Wood Cutting: no Roads: no Other Impacts: yes, urban development; river culverted in certain areas Exotic vegetation dominant: yes, codominant

Photo: Mike Bradley

Figure 23. Example of a low quality site on the Rio Puerco. Exotics dominate much of the floodplain and the banks are severely downcut.

DISCUSSION

Models of Rio Grande Riparian Ecosystem Dynamics

The floodplain ecology of the Rio Grande has undergone dramatic changes from its original natural state to its present condition. Although human settlement in the Rio Grande dates back centuries, the rate of change in the floodplain has been accelerating in response to increased settlement, population growth, and technology over the last century. Inherent in a healthy riparian ecosystem are the sudden and often extreme natural physical changes caused by stream dynamics (Leonard et al. 1992). Intact fluvial processes of flooding, sediment deposition, lateral channel migration, and scouring effects on bars and terraces are a natural cyclic process of riparian ecosystem development to which most riparian species are adapted. This cyclic process of building up sites and then removing them has been referred to as "site progression" by Leonard et al. (1992) and is thought to be a critical process in the maintenance, growth and reproduction of riparian/wetland plant communities (Muldavin, Sims and Johnson 1993, Durkin et al. 1994).

Schematic, conceptual models of site progression dynamics portray stages of riparian landform development, and the successive changes in plant composition and dominance due to sediment accumulation, lateral cutting of the channel, or downcutting of the channel over time. The temporal inferences of the models are drawn from data of the spatial relationships among plant communities in relation to soil type and flooding recurrence intervals. At any progression stage, beaver herbivory and other animal disturbances may accelerate or delay the progression of the site. The models become more complex and have different potential outcomes depending on whether streamflows are regulated, if there are major alterations of the channel and floodplain (i.e., diversions, riprapping, and jetty jacking), or if the vegetation has been altered or destroyed (i.e., encroachment of exotics), agricultural activities and urbanization in the floodplain.

Based on the survey data gathered, we have developed four preliminary conceptual models of different scenarios of site progression in the upper and middle Rio Grande basin. In each model we present the modal structure for a particular type of stream channel and geographic location. These models pertain primarily to unconfined stream types where depositional floodplains can potentially develop (we address confined reach dynamics in passing as special cases of unconfined conditions). Model 1 (Figure 24) depicts what we perceive were the dynamics of some of the historically dominant plant communities of the Rio Grande. The model portrays the spatial and temporal relationship to one another in the floodplain prior to high density human settlements, development of the floodplain, and the control of flooding. Model 2 (Figure 25) portrays the dynamics of site progression given the historical development of the middle Rio Grande to its present condition where flows are completely regulated and the channel has been highly modified, confined and stabilized. Model 3 (Figure 26) illustrates site progression dynamics of Rocky Mountain Montane plant communities of

PROGRESSION STAGE	LANDFORM	VEGETATION COMMUNITY	MODAL SOIL TYPE	FLOOD RETURN INTERVAL
→ 1 →	exposed river bar	non-vegetated/annual herbs	riverwash	annually
	abandoned channel	American Bulrush—Common Spikerush, or	ponded	annually
↓		Broadleaf Cattail/American Bulrush	Typic Fluvaquent	1-2 years
↑			Mollic Fluvaquent	
sediment accumulation ↓				
↑ 2 →	stabilized river bar	Coyote Willow/Smooth Horsetail, or	Aeric Fluvaquent	1-2 (5) years
	partially filled channels	Coyote Willow/Water Sedge	Typic Psammaquent	
		Coyote Willow/Yerba Mansa	"	
↓		Coyote Willow/False Quackgrass	Aquic Ustifluvent	
SCOUR sediment accumulation ↓				
↑ 3 →	aggregated floodplain	Rio Grande Cottonwood/Coyote Willow. or	Oxyaquic Ustifluvent	5-25 (3) years
	nearly filled channels	Rio Grande Cottonwood/Yerba Mansa	Aquic Torrifluvent	
↓ sediment accumulation				
lateral cutting/downcutting				
↑ ↓				
← 4 →	river terrace	Rio Grande Cottonwood/New Mexico Olive	Fluventic Ustochrept	25-100⁺ years
	filled channels		Typic Ustifluvent	

Figure 24. Schematic representation (Model 1) of hypothetical site progression dynamics of the riparian/wetland plant communities native to the middle Rio Grande floodplain prior to regulated streamflows and alteration of the channel and floodplain.

PROGRESSION STAGE	LANDFORM	VEGETATION COMMUNITY	MODAL SOIL TYPE	FLOOD RETURN INTERVAL
1 →	exposed river bar	non-vegetated/annual herbs	riverwash	annually
↓	abandoned channel	American Bulrush—Common Spikerush	periodically ponded Typic Fluvaquent	annually 1-2 years
sediment accumulation ↓				
2 →	stabilized (jetty jacked) river bar, confined by levee	Coyote Willow/Redtop Saltcedar/Coyote Willow	Aeric Fluvaquent Aquic Ustifluvent	2-5 years
↓ SCOUR sediment accumulation ↓				
3 →	aggregated (jetty jacked) floodplain, confined by levee	Rio Grande Cottonwood—Russian Olive, or Rio Grande Cottonwood—Saltcedar	Oxyaquic Ustifluvent Oxyaquic Ustipsamment Oxyaquic Torrifluvent	5-50 years
↓ sediment accumulation lateral cutting/downcutting ↓				
4 →	jetty jacked river terrace, confined by levee	Russian Olive—Saltcedar Saltcedar/Sparse	Oxyaquic Ustifluvent [Typic Ustifluvent] [Fluventic Ustochrepts]	50-100$^+$ years

Figure 25. Schematic representation (Model 2) of non-cyclic site progression characteristic riparian/wetland plant communities in the middle Rio Grande floodplain, in its present and future state following the introduction of exotics, the regulation of streamflows, and alteration of the channel and floodplain. Soil types in brackets are potentially present, but unconfirmed.

PROGRESSION STAGE	LANDFORM	VEGETATION COMMUNITY	MODAL SOIL TYPE	FLOOD RETURN INTERVAL
→ 1 →	exposed river bar	non-vegetated/annual herbs	riverwash	annually
↑ ↓ sediment accumulation ↓	abandoned channel	Broadleaf Cattail/American Bulrush	periodically ponded	annually
↑ 2 →	stabilized river bar	Coyote Willow/Smooth Horsetail, or Bluestem Willow—Coyote Willow	Typic Fluvaquent	1-2 years
SCOUR ↓ sediment accumulation ↓				
↑ 3 →	aggregated river bar	Narrowleaf Cottonwood/Coyote Willow, or Narrowleaf Cottonwood—Thinleaf Alder	Aeric Fluvaquent Oxyaquic Udifluvent	3-25 years
↓ ediment accumulation lateral cutting/downcutting ↑ ↓				
← 4 →	river terrace	Narrowleaf Cottonwood/Kentucky Bluegrass Narrowleaf Cottonwood—Rocky Mtn. Juniper	Mollic Udifluvent Aquic Ustifluvent	25-100+ years

Figure 26. Schematic representation (Model 3) of site progression dynamics of Rocky Mountain Montane riparian/wetland plant communities of the Rio Grande watershed. The schematic is typical of smaller nonregulated tributary basins of northern New Mexico.

relatively intact tributary basins in northern New Mexico. Finally, Model 4 (Figure 27) depicts a similar structure, but for Southwest Lowland plant communities of the smaller, non-regulated tributary basins in southern New Mexico, such as Las Animas Creek.

In Model 1 spring runoff produces floods across the middle Rio Grande floodplain, delivering large quantities of water and sediments. Dramatic changes in the channel location and the number of channels in the floodplain can occur. The first stage of this model is the development of unconsolidated bars formed from high sediment loads during these spring runoff events. In the first few years, either they remain non-vegetated or are dominated by herbaceous annual species. With repeated flooding and deposition at least at one- and two-year intervals, the mid-channel and side bars become vegetated with perennial emergent herbaceous communities such as the American Bulrush—Common Spikerush Community Type. As flooding continues, sediments collect in the vegetation, and the bars increase in height. Soils begin to develop from the riverwash as Typic and Mollic Fluvaquents. Perennial vegetation continues to become established. Ensuing floods may carry coarse woody debris, dissecting and scouring some bars, while the debris lodges in the channel or accumulates on the bars. If the floods coincide with cottonwood seed set (a normal occurrence during spring runoff), the bars essentially become nurseries for cottonwoods and willows (Brady, Patton and Paxson 1985; Siegel and Brock 1990; Stromberg, Patten and Richter 1991).

During any given high discharge flood event of significant duration, the channel may abandon its primary course and cut and meander laterally across the floodplain. Moist, nutrient rich soil is left behind in abandoned channels, providing a site for perennial herbaceous communities such as American bulrush—common spikerush or broadleaf cattail/American bulrush to develop.

During Stage 2 the bars stabilize further as willows and cottonwoods act to catch sediments over the next three to five years. In abandoned channels the communities are periodically ponded early in the growing season, receiving water from overflow by the main channel. Shrubby willows tend to predominate, and the Coyote Willow/Water Sedge, American Bulrush, Yerba Mansa or False Quackgrass dominated Community Types commonly occupy the sites (today, we commonly see only remnants of these communities). Cottonwoods are still establishing, or are present from the previous Stage 1, but they are not yet dominant in most cases. Soils are somewhat drier and represented by Aeric Fluvaquents, Typic Psammaquents, and Aquic Ustifluvents.

In the third stage, continued sediment accumulation occurs as the bars are elevated out of the active channel into the three-to-twenty-five-year floodplain. Soils become deeper. As the soil surface gets further from the water table, aeration increases (i.e., Aquic or Oxyaquic Ustifluvents, or Oxyaquic Torrifluvents). Increased aeration can lead to increased productivity, but most cottonwood and willow reproduction is limited by the dry surface soils. Stratified layers of vegetation develop, diversity of species

PROGRESSION STAGE	LANDFORM	VEGETATION COMMUNITY	MODAL SOIL TYPE	FLOOD RETURN INTERVAL
→ 1 →	exposed river bar	non-vegetated/annual herbs, or Seepwillow/Prairie Wedgescale	riverwash	annually
↑ ↓ →	abandoned channel	Broadleaf Cattail/American Bulrush	periodically ponded [Typic Fluvaquents]	annually
sediment accumulation				
↑ 2 →	stabilized river bar	Coyote Willow—Seepwillow	Typic Psammaquent [Aeric Fluvaquent] [Aquic Ustifluvent]	1-2 years
↓ SCOUR sediment accumulation ↓				
↑ 3 →	aggregated river bar	Fremont's Cottonwood—Goodding's Willow, or Arizona Sycamore/Sideoats Grama	Oxyaquic Torrifluvent Oxyaquic Ustifluvent	3-25 years
↓ sediment accumulation lateral cutting/downcutting ↑ ↓				
← 4 →	river terrace	Arizona Walnut/Sideoats Grama	Aquic Camborthid	$25\text{-}100^{+}$ years

Figure 27. Schematic representation (Model 4) of site progression dynamics of Southwest Lowland riparian/wetland plant communities of the Rio Grande watershed. The schematic is typical of smaller nonregulated tributary basins of southern New Mexico. Soil types in brackets are potentially present but not confirmed.

increases, and a diversified riparian forest, such as the Rio Grande Cottonwood/Coyote Willow or Rio Grande/Yerba Mansa Community Types, eventually takes hold of the site and matures.

In the final stage, additional sediment accumulation slows down and bar building reaches its limit. Lateral migration or downcutting of the channel may occur, and seldomly flooded terraces result with relatively dry soils (Oxyaquic Ustifluvents, Typic Ustifluvents and Ustochrepts). Tree reproduction completely ceases and trees mature and die, opening up the sub-canopy for facultative riparian shrubs, and meadow grasses and forbs. The Rio Grande Cottonwood/New Mexico Olive Community Type represents this fourth stage of site progression. These terraces are very rarely flooded (>25 years), but when they are, the force of the flow may cause some sites to be scoured and removed, resetting the progression back to Stage 1. This can occur at any stage, and is part of inherent disturbance parameters of these ecosystems. Also, some sites can slow down in development because the main channel has shifted a significant distance away, preventing further sediment accumulation and possibly lowering the water table. As a result sites may become quite a bit drier, willow and cottonwood growth rates will slow down, species diversity declines, and the Rio Grande Cottonwood/Sparse Community Type may prevail.

Under this model, the pre-historical vegetation of the Rio Grande floodplain was likely comprised of a more complex matrix of vegetation communities than currently exist. There were probably extensive emergent herbaceous wetlands (marshes); forest stands were probably smaller and more scattered with intervening shrub dominated wetlands. The degree of fragmentation would somewhat depend on the prevailing climatic regime and the resultant frequency of large flood events. The forests were likely removed continuously and regenerated as a consequence of the floodwaters.

The second model depicts the dynamics of a highly constrained hydrological regime such as that found in middle Rio Grande today. Flows are regulated, with discharges only incidentally matching the natural hydrograph, and not peaking nearly at the levels found before regulation. Hence, overbank flooding is uncommon, and high-energy, scouring floods are extremely unlikely. Flooding frequency also decreases upstream as Cochiti Dam is approached. This is because there are fewer uncontrolled inputs of both water and sediments, and because river channels typically degrade towards the dam, becoming incised and requiring even higher discharges to flood over the banks. Under this scenario the river channel is confined within a limited floodplain by levees, and is stabilized by jetty jacks and riprap, preventing the active channel from meandering through what remains of the floodplain. The landscape as a whole is no longer dynamic. It is physically locked in place by highly regulated stream flows.

Under these constrained hydrological conditions, Model 2 (Figure 25) portrays a declining forested wetland "bosque" that is being replaced by exotics trees and shrubs, and perhaps will be completely replaced within 50-100 years. The early stages of the model are somewhat similar to non-regulated reaches, but even here the impacts by exotics are beginning to be felt. Exotic herbaceous species may dominate the young bars and exotic trees such as saltcedar and Russian olive may co-dominate with willows as the bars stabilize and develop (e.g., the Coyote Willow/Redtop Community Type). The cottonwoods that do get established on these sites must compete with these exotics (and with mowing where it is used as a maintenance tool for water delivery). Because there is little migration of the channel and limited overbank flooding in a system that can be sediment starved, site progression may not move much further than Stage 2 along banks and in the channel.

Where jetty jacks were put in, new bars and terraces formed and the channel stabilized as planned (in the middle Rio Grande this process began in the 1950's {BOR 1995}). Jetty jack bars and terraces represent a one-time, non-cyclic event of Stages 1 through 4 of the model, since no scouring floods or channel migration occurs to re-initiate the system. Willows and cottonwoods become established on the young jetty jack bars during Stages 1 and 2. At about Stage 3, cottonwood and willow regeneration more or less ceases, and mature Rio Grande cottonwood forests develop. But because of river controls, exotic Russian olive, saltcedar and Siberian elm are maintained in the understory. Soils also tend become drier at an earlier stage, perhaps because of channel incision; there may even be a disconnection between surface and ground waters (Crawford et al. 1994). The lack of flooding slows production as decomposition slows and nutrient cycling becomes hindered by the dry conditions (Crawford et al. 1994). Ultimately, in Stage 4 the non-reproducing Cottonwood communities degenerate as the cottonwoods die, and self-regenerating Russian olive—saltcedar woodland communities are all that remain.

The Rio Grande cottonwood—Russian olive community is presently the most common floodplain community of the Rio Grande, but indications of decline have already been detected (Howe and Knopf 1991). Increases in uncontrolled fires and excessive disturbances from off-road vehicles further accelerates the destruction of the bosque. Fires open a niche for invasion by exotics while damage from off-road vehicles compacts the soil and fragments the forest.

Model 3 represents Rocky Mountain Montane riparian/wetland vegetation development that commonly occurs along perennial streams of northern portions of the basin (Figure 26). The communities that develop at the different stages reflect the climate and hydrology of the region. In the higher elevations of the mountains, the climate is cold temperate with frigid winters and cool summers, and communities tend to be dominated by the more cold tolerant bluestem willow, thinleaf alder and narrowleaf cottonwood. Soils reflect the more equitable distribution of moisture through the year, and at the later progression stages are commonly Udifluvents (as opposed to the drier Ustifluvents of lower elevations). The gradients on these mountain streams are usually steeper than the lowland rivers, and hence they have coarser channel substrates leading to very gravelly and cobbly riparian soils. The floodplains are also narrower, resulting in limited floodplain or community development. Channels are commonly confined within steep canyon sideslopes and lack depositional floodplain development that corresponds to the one presented in the model. Under these conditions there is little or no site progression. Rather, the riparian zone is dominated by communities such as the thinleaf alder/bluestem willow community, which are perpetually reproducing among the cobbles and boulders.

As with the lowland counterparts, Stage 1 is dominated by emergent herbaceous vegetation represented by the Broadleaf Cattail/American Bulrush Community Type. These are also nursery sites for narrowleaf cottonwood and thinleaf alder. Stage 2 communities are flooded annually or every other year. Soils are commonly Typic Fluvaquents on stabilized river bars supporting the Bluestem Willow-Coyote Willow, Thinleaf Alder/Bluestem Willow, or occasionally the Coyote Willow/Smooth Horsetail Community Types. In Stage 3, river bars become further aggraded during flood events or elevated relative to the active channel as the channel cuts and meanders. Bars are less frequently flooded and drier Aeric Fluvaquents or Oxyaquic Udifluvent soils develop. Narrowleaf Cottonwood/Coyote Willow or Narrowleaf Cottonwood-Thinleaf Alder communities develop and mature into closed canopy gallery forests. Dry terraces supporting relatively dry soils such as Mollic Udifluvents develop as aggradation slows, or the channel continues to downcut. As with Model 1, narrowleaf cottonwood and other obligate riparian species reproduction ceases. Mature, open-canopied forests develop represented by the Narrowleaf Cottonwood/Kentucky Bluegrass, or Narrowleaf Cottonwood/Rocky Mountain Juniper Community Types. As with the lowland communities, re-initiation of the cycle requires floods to be forceful enough to scour the terraces, thereby removing the vegetation and return the site back to the first stage of the cycle.

Southwest Lowland riparian/wetland vegetation community development is represented in Model 4 (Figure 27). This model is similar to Model 1, but pertains to the smaller perennial and intermittent stream segments of the central to southern parts of the basin. Here, the winters are milder and the summers are hotter and drier, and the vegetation communities are dominated by Southwestern species with affinities to the west in California and to the south into Mexico, as opposed to Rocky Mountain or Great Plains elements. Hence, in the first two stages, as bars aggrade, communities are commonly co-dominated by seepwillow along with coyote willow and American bulrush. As with the first model, these are also the nursery sites for tree species that will later be dominants in the progression cycle. In the third stage on the higher and drier bars and terraces, the Fremont's cottonwood—Goodding's willow Community Type, (Fremont's cottonwood is the Southwestern variant of Rio Grande cottonwood), or the Arizona Sycamore/Sideoats Grama Community Types have developed and matured to dominate the sites. Co-dominants may also include Arizona walnut and netleaf hackberry. In the final stage, the Arizona Walnut/sideoats grama community is representative of the type of community that can occur on what are now dry terraces that are high above, and usually some distance away from the active channel, at the edge of the floodplain. This model is based on limited data, and will be expanded with subsequent data from the Gila River watershed and other Southwestern watersheds in following year's work on the project.

We stress that these models are preliminary and simplified. In all of the models, the correlations between plant community type, soil type and flooding recurrence interval are not perfect. There is overlap of soil types with different community types. This may be, in part, a function of relying on the soil taxonomy (Soil Survey Staff 1992) for categorization of the soils. The soil taxonomy emphasizes the analysis of more developed soils than the very young ones commonly found in riparian zones. Ultimately, more direct and precise measures of soil hydric characteristics would be desirable, beyond those gathered in this reconnaissance survey. In addition, many of the plant community types concepts are based on still limited reconnaissance data, and need further refinement. With respect to recurrence interval, a wide range of values can result depending on the method of calculation. Those intervals calculated on the basis of direct stream measurements in the context of a long-term stream record are the best. In this study this means those cross-sections that were located near stream gauges that were used by BOR (1995) to calculate flows at the cross sections are the best. For those sites lacking stream gauges, discharges are based on estates such as Waltemeyer (1986), which often result in only crude approximations of stream flow at a given stage height. Refining the models will require more detailed direct stream measurements that will allow higher precision modeling of stage/discharge relationships. Although much of the complexity in these systems remains to be worked out, we hope these models in their current form help stimulate questions on the dynamics and structure of these complex ecosystems, and help in future experimental design, sampling and inventory work.

Status of Riparian/Wetlands in the Rio Grande

There is a definite need to implement riparian/wetland ecosystem protection planning in New Mexico. Of the 109 sites evaluated in the study area, only 18 (16%) were assessed as high quality, lacking significant impacts of hydrological modification and land use. Further, the best sites were in the higher elevations of more remote tributaries where hydrological modifications were limited. Although this survey was selective for reaches previously known to have extant riparian vegetation, it points toward a general downward trend of the condition of riparian communities in New Mexico.

Our models indicate that as a consequence of hydrological controls, much of the lowland native riparian vegetation will be replaced by communities dominated by aggressive exotic trees, shrubs and herbs. Similarly, Crawford et al. (1993) suggest that as cottonwoods die and hydrological controls prevent natural regeneration, much of the upper end of the middle Rio Grande will become dominated by Russian olive and Siberian elm, and much of the lower end by saltcedar. They have shown a 46.2% decline in the cottonwood forest and associated shrublands between 1918 and 1989; an estimated 7,084 ha (17,498 acres) were lost. During the same time period 7,220 ha (17,833 acres) of exotic saltcedar were gained. This supports Howe and Knopf's (1991) conclusions that the cottonwoods of the Rio Grande are in decline. The downward trend is compounded by extensive over-utilization of riparian resources for livestock, fuelwood, and even recreation. Without changes in management, the middle Rio Grande may look in 50 years much like the lower reach below Elephant Butte Reservoir to the Texas border, where, after 80 years of hydrological controls, only a few small, remnant groves of cottonwood remain.

The shrinking and fragmentation of the territory of native riparian vegetation also amplifies the impacts of herbivory by beaver and other native animals, which ultimately feeds back into their own population decline. Many species of amphibians, reptiles, arthropods, mammals and birds that are dependent on riparian resources are experiencing decline (Hink and Ohmart 1984; Crawford et al 1993; Federal Register 1995). But through careful wetlands protection planning and implementation, the so called "train wrecks" over issues such as rare and endangered species, and water pollution possibly may be avoided.

Because riparian ecosystems on the whole are highly productive and resilient, restoration and enhancement are possible. Although only a small percentage of our sites were ranked high, many sites in the "medium" category are restorable in areas where the hydrological regime remains somewhat intact or can be enhanced to some degree. Hydrological enhancement primarily involves maintaining overbank flooding, either naturally or on controlled streams, in a way that mimics the natural hydrograph. Flooding is important in nutrient cycling, as well as in creating seedbeds for reproduction of native riparian species (Brady, Patton and Paxson 1985; Fenner, Brady and Patton 1985; Asplund and Gooch 1988; Siegel and Brock 1990; Stromberg, Patten and Richter 1991; Crawford et al. 1993). Sufficient sediment loads are also necessary. along with a certain degree of fluvial dynamism where the active channel is allowed to migrate across the floodplain. These hydrological enhancements are particularly important for the long term maintenance of the Bosque of the middle Rio Grande (Crawford et al. 1993), as well as on the Rio Chama.

The control of exotics is also linked to a healthy native riparian ecosystem. Although exotics will never be eliminated from these ecosystems, a halfway intact hydrological regime may prevent their dominance. Saltcedar removal, followed by flooding that mimics the natural hydrograph, has proven to be successful in reestablishing cottonwoods in the lower part of the middle Rio Grande (John Taylor pers. comm. Bosque del Apache National Wildlife Refuge).

The natural and restorable riparian/wetland ecosystems of New Mexico are an invaluable resource for the State. Their protection enhances not only biological diversity, but also economic stability and environmental quality. With planning, these highly productive ecosystems can be managed in a natural, cost efficient way that can be compatible with many uses such as livestock grazing, recreation, and even agriculture and urbanization, and still maintain their overall biological diversity. Such an effort will require a systematic, comprehensive inventory based on the classification system and site quality evaluation criteria developed here, along with a program of ongoing research and monitoring to ensure the long-term sustainability of these vital resources.

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APPENDIX A. RIPARIAN/WETLAND COMMUNITY CHARACTERIZATION ABSTRACTS FOR THE UPPER AND MIDDLE RIO GRANDE WATERSHED.

Below are described the riparian plant communities of the upper and middle Rio Grande in New Mexico. Community Types are described in terms of the existing plant species composition and the physical characteristics within that community. The community characterization abstracts (CCA's) provide a preliminary classification scheme and include: 1) the most recent scientific and common names of the diagnostic plant species along with their six- or seven-letter acronym; 2) the geographical distribution of the plant community as it occurs throughout the basin; 3) a detailed description of the vegetation or associated taxa; 4) a description of the environmental setting, including soils, important geomorphic features and the hydrological setting; 5) a description of the adjacent vegetation (upland and riparian); 6) a brief discussion of community structure and dynamics; and 7) documentation of synonymous or similar Community Types from the literature in New Mexico and elsewhere in the Rocky Mountain and Southwest regions of the United States. Some Community Types have been described in New Mexico or the surrounding regions, while others are apparently new dominance types for New Mexico. As additional data is accumulated throughout other major basins of the state some new types may be expanded or rejected. Additionally, the distribution of some dominants, particularly of the woody exotic species (e.g., saltcedar and Russian olive), may cross several regional biomes.

Community Types are based on dominant or co-dominant plant species of each canopy stratum. A slash separates canopy strata (i.e., tree, shrub, graminoid and forb layers), while a dash indicates co-dominance within a given canopy layer. The following descriptors are used to characterize vegetative cover values in the CCA's:

Absent: cannot be found in stand (opp = present);
Accidental: individuals very infrequent, occasional, or limited to special microsites;
Abundant: canopy coverage >25%;
Common: canopy coverage >1% (opp = scarce);
Dominant: density or cover is as great as, or greater than, any other species of the same life form (two or more species can be dominant, i.e. codominant);
Luxuriant: canopy coverage >50%;
Poorly represented: canopy coverage <5% (opp = well represented);
Present: individuals can be found in the stand (opp = absent);
Regeneratation: understory trees as established seedlings, saplings, or small poles (dbh <10 in.);
Scarce: canopy coverage <1% (opp = common);
Well-represented: canopy coverage >5% (opp = poorly represented).

PALUSTRINE SYSTEM -- RIPARIAN/WETLAND VEGETATION

I. FORESTED WETLANDS CLASS -- FORESTS AND WOODLANDS

II. COLD TEMPERATE RIPARIAN/WETLANDS
III. ROCKY MOUNTAIN MONTANE FORESTED WETLANDS
IV. NEEDLE-LEAVED EVERGREEN SERIES GROUP

Blue spruce is the dominant species in this group. It occurs along lower slopes and down along the channel edges. Other conifers such as white fir, Douglas fir and ponderosa pine may be persistently present or remain completely out of the floodplain. Common deciduous species present are thinleaf alder and several willow shrubs including bluestem, yellow and Bebb willow. These are generally concentrated along the banks adjacent to the active channel. Diversity of species is high in these communities. Channel migration and sediment deposition play a key role in regeneration of these coniferous-dominated communities. Accumulation of sediment and debris elevate the bars over time and terraces develop. As the terraces build, soils become drier, tree canopies open and the coniferous species are still able to regenerate while the deciduous species remain closer to the channel. Over time, diversity of obligate riparian species decreases and understories become predominantly grassy. A common component of these terraces is Kentucky bluegrass. Hence, the coniferous riparian forests represent some of the most stable plant communities in the riparian zone.

V. Blue Spruce (*Picea pungens*) Series

1. Blue Spruce—Thinleaf Alder Community Type
***Picea pungens*; PICPUN—ALNINCT)**

Distribution. - The Blue Spruce—Thinleaf Alder Community Type is widely distributed in the upper montane reaches of the Rio Grande basin of northern New Mexico at elevations ranging from 2292-2403 meters (7520-7884 ft). It is also known from the upper Pecos basin draining the east side of the Sangre de Cristo Mountains.

Vegetation. - Blue spruce *(Picea pungens)* dominates the tree canopy while other conifers, such as white fir (*Abies concolor*), Douglas fir *(Pseudotsuga menziesii)* and ponderosa pine (*Pinus ponderosa*) are commonly well represented. Thinleaf alder *(Alnus incana* ssp. *tenuifolia)* dominates the shrub layer and forms thick bands lining and overhanging the river. Redosier dogwood *(Cornus sericea* ssp. *sericea),* bearberry honeysuckle *(Lonicera involucrata)* and several willows, bluestem willow *(Salix irrorata),* yellow willow *(Salix lutea)* and Bebb willow *(S. bebbiana)* are present. The forb layer is species rich and abundant in cover. Cowparsnip *(Heracleum lanatum)* is common. Cutleaf coneflower *(Rudbeckia laciniata)* and field horsetail *(Equisetum arvense)* are always present, while Columbia monkshood *(Aconitum columbianum)* and northern bog orchid *(Habenaria hyperborea)* are present, but scarce.

Environmental Setting. - The community occurs in narrow and confined channels where development of large bars and floodplains is limited. Aggradation and downcutting continues to occur. Development of small island bars may occur, but is uncommon. Banks are often armored with cobbles and stones. The river can be classified as a B1 stream type of Rosgen (1992). Sinuosity of the channel is limited and the gradient is relatively steep (1- 2%). Adjacent canyon hillslopes are steep. Lower positioned sites may be flooded every four to five years while the older, higher sites are flooded about every 25 years. Soils are classified as loamy-skeletal Aeric Fluvaquents where the matrix may be comprised of up to 80% coarse gravels, cobbles and stones.

Adjacent Vegetation. - Adjacent north-facing hillslopes are dominated by mixed coniferous forests. South-facing hillslopes include ponderosa pine forests and juniper woodlands. Adjacent riparian vegetation includes thinleaf alder/redosier dogwood shrublands on bars and blue spruce/Kentucky bluegrass communities on higher and drier terraces.

Discussion. - The Blue Spruce—Thinleaf Alder CT occurs towards the lower range of mixed coniferous forests and the upper range of narrowleaf cottonwood communities. This community is generally located along narrow depositional floodplains, with riparian vegetation developing among boulders and cobbles along the river channel. Stands are usually densely shaded and mesic. Diversity of species is high (50^+ species). This type is able to sustain seasonal flooding for short periods and appears to be relatively stable.

Documentation. - This description is based on plots 94PD026, 94PD027 and 94PD028. Our type has not been documented elsewhere for New Mexico; however, it is closely related to the *Picea pungens—Alnus tenuifolia*/MG-F documented by Dick-Peddie (1993) that occurs in montane regions of New Mexico. Szaro (1989) reports independent community types in New Mexico of *Picea pungens* and *Alnus tenuifolia*, but contends that these types remain separate. Similar blue spruce—alder types are classified in the White River Basin of Colorado (Kittel 1993), the Yampa and San Miguel/Dolores River Basins of Colorado (Kittel and Lederer 1993). These types are analogous to the type reported by Dick-Peddie (1993).

IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

This group is represented by the thinleaf alder and narrowleaf cottonwood Series. The thinleaf alder Series is distributed in the central and northern mountains of New Mexico. Two community types are classified within the thinleaf alder Series, while seven community types are classified within the narrowleaf cottonwood Series. These communities occur primarily on alluvial side bars or on low floodplains adjacent to the channel. Hydrological conditions are similar to that of the needle-leaved evergreen series group, yet the communities within this group generally occur at slightly lower elevations. Common shrubs in this group may occur in other riparian communities and include coyote willow and Wood's rose. Likewise, common forbs and grasses include cutleaf coneflower, field horsetail, Canada wildrye and meadow fescue.

V. Thinleaf Alder *(Alnus incana)* Series

1. Thinleaf Alder/Bluestem Willow Community Type
Alnus incana/Salix irrorata; **ALNINCT/SALIRR)**

Distribution. - The Thinleaf Alder/Bluestem Willow Community Type occurs along the upper montane reaches of the Rio Grande draining the west side of the Sangre de Cristo Mountains in northern New Mexico at elevation ranges from 2292-2536 meters (7520-8320 ft). It is also known from the east side of the Sangre de Cristos in the Pecos basin.

Vegetation. - The community is dominated by the small tree thinleaf alder *(Alnus incana* ssp. *tenuifolia)* in the upper canopy, while bluestem willow *(Salix irrorata)* is a sub-canopy dominant in the shrub layer. Additionally, several other willows: yellow willow *(S. lutea),* blue willow *(S. subcoerulea)*, Bebb willow *(S. bebbiana)*, and pacific willow *(S. lutea)* are commonly present, as well as redosier dogwood *(Cornus sericea* ssp. *sericea)* and bearberry honeysuckle *(Lonicera involucrata)*. Sapling-sized narrowleaf cottonwood *(Populus angustifolia)* may also be present. The understory is distinctively mesic, luxuriant, and species rich. Sedges, commonly smallwing sedge *(Carex microptera),* western sedge *(C. occidentalis)*, owlfruit sedge *(C. stipata)*; and rushes, Rocky Mountain rush *(Juncus saximontanus)* and Baltic rush *(J. balticus)* are well represented. Grasses are well represented and include reed canarygrass *(Phalaris arundinacea),* tufted hairgrass *(Deschampsia caespitosa)* and fowl mannagrass *(Glyceria striata)*. Forbs present include field horsetail *(Equisetum arvense),* cutleaf coneflower *(Rudbeckia laciniata)* and starry false solomonseal *(Smilacina stellata)*.

Environmental Setting. - The Thinleaf Alder/Bluestem Willow CT occurs on young depositional side or mid channel bars. The river can be classified as a B2 stream type of Rosgen (1992). There may be some entrenchment and confinement of the stream channel, but aggradation of sediments still occurs leading to stabilization of the bars. Hydraulic modeling indicates that the lowest bars are flooded repeatedly during the year while the return interval for flooding of the older terraces may occur every other year. Flows between 120-500 cfs will flood these sites. Soils are classified as loamy-skeletal or sandy-skeletal Typic Fluvaquents, Typic Endoaquents and Aquic Dystrochrepts. Occasionally, Aeric Fluvaquents can be associated with this community type, which occur under somewhat drier conditions and can have sandy or loamy surface horizons overlaying a cobbly matrix of the original channel bottom. The water table may be within at least 50 cm of the surface sometime during the year and evidence of prolonged reduced conditions (gley) are present.

Adjacent Vegetation. - Adjacent canyon hillslopes are steep and dominated by mixed-coniferous forests. Adjacent riparian vegetation includes blue spruce/Kentucky bluegrass on higher and drier terraces.

Discussion. - The Thinleaf Alder/Bluestem Willow CT appears to be a mid- to late-progressional stage riparian shrubland. Debris from flooding combined with vegetation enhances sediment aggradation and leads to stabilization of the bars with progression towards more mature communities. Evidence of oxygen poor, reduced conditions at lower depths within the soil profile is an indication of the close proximity and fluctuation of the water table. Soils are shallow and not well developed due to frequent scouring of the channel. The dominant vegetation of these sites is well adapted to frequent flooding and stem breakage. Consequently, they are extremely effective in stabilizing streambanks. The flooding regime may maintain the shrubby aspect of the community as willows and alders resprout on a continuous basis from the root crown. Under less frequent destructive flooding, an overstory tree canopy may develop.

Documentation. - This description is based on plots 92RW007, 92RW008, 92RW010, 92RW017, 92RW018, 92EM018 and 92EM024. Classifications in New Mexico and surrounding Rocky Mountain region states have not reported this community type, however, Kittel and Lederer (1993) describe other alder/willow types which may be ecologically similar to ours. In New Mexico and Arizona, Szaro (1989) documents a closely related *Salix irrorata*/mixed deciduous community type.

V. Narrowleaf Cottonwood (*Populus angustifolia*) Series

1. Narrowleaf Cottonwood—Thinleaf Alder Community Type
***Populus angustifolia—Alnus incana;* POPANG—ALNINCT)**

Distribution. - The Narrowleaf Cottonwood—Thinleaf Alder Community Type occurs on lower montane reaches of the upper Rio Grande in northern New Mexico at elevation ranges from 2158-2411 meters (7080-7910 ft). It is also known from the Pecos basin draining the east side of the Sangre de Cristo Mountains.

Vegetation. - Narrowleaf cottonwood *(Populus angustifolia)* dominates this moderately open to very open-canopied community in the tree layer. The understory is dominated by thinleaf alder *(Alnus incana* ssp. *tenuifolia),* which typically forms dense thickets as a sub-canopy tree along the river banks and often overhangs the banks. Narrowleaf cottonwood displays some advanced stages of regeneration and is present in the lower canopy of the shrub layer. The understory is characteristically shrubby. Bearberry honeysuckle (*Lonicera involucrata*) and redosier dogwood (*Cornus sericea* ssp. *sericea*) are commonly dominant. In the lowest reaches where the community occurs boxelder (*Acer negundo*) can be well represented in either of the tree or shrub layers. The forb layer can be luxuriant and very diverse. Common forbs present include cutleaf coneflower (*Rudbeckia laciniata*), cowparsnip (*Heracleum lanatum*), and field horsetail (*Equisetum arvense*). Common grasses include Kentucky bluegrass (*Poa pratensis*) and meadow fescue (*Festuca pratensis*).

Environmental Setting. - The Narrowleaf Cottonwood–Thinleaf Alder CT occurs on low to moderately elevated island bars and side bars associated with Rosgen's Type B2 and C2 channel morphology. The channel is moderately entrenched, moderately confined by the valley, and has a stream gradient between 1.5 and 2.5%. Banks are often well armored. Channel materials consist of large cobbles, small boulders, coarse gravels, and small- to medium-sized debris that affects less than 10% of the channel. Cross sectional hydraulic analyses indicate a flooding regime of every three to five years for the lower positioned sites. The flow required for these ranges from 350 cfs to 700 cfs. Higher position sites may be flooded every 20 years. Aggradation of sediments and/or limited downcutting has occurred to elevate the surface significantly above the water table to allow some aeration of the soil. This coincides with the classification of soils as Aeric Fluvaquents and Aeric Endoaquepts, which have hydric conditions at depths greater than 50 cm.

Adjacent Vegetation. - Adjacent north-facing hillslopes are steep and are typically mixed coniferous forests. Ponderosa pine forests commonly occupy the south-facing hillslopes. Adjacent riparian vegetation includes blue spruce/Kentucky bluegrass communities on drier terraces.

Discussion. - The Narrowleaf Cottonwood–Thinleaf Alder CT appears to be late progressional. It commonly occurs on lower positioned side bars and overflow channels positioned within the two- to five-year floodplain. Stratified layers of vegetation are well developed and species rich. Diversity of species is high. These communities are mesic and densely shaded. Beaver activity in these communities may be common, especially among the cottonwoods. More information regarding narrowleaf cottonwood communities is needed. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse.

Documentation. - This description is based on plots 93PD011, 93PD018, 94PD032, 94PD033, 94PD083, 94PD085 and 94PD086. This community type appears to be common throughout New Mexico. Dick-Peddie (1993) documents an analogous type *Populus angustifolia–Alnus oblongifolia*/MS/MG-F. Szaro (1989) reports independent *Populus angustifolia* and *Alnus oblongifolia* types in New Mexico. Edwards et al. (1987) report of a *Populus angustifolia–Picea pungens/Alnus oblongifolia* type to occur in the Carson National Forest of New Mexico. Analogous types have been reported in surrounding Rocky Mountain states as well. In Colorado, Baker (1989) reports a

Populus angustifolia–Alnus incana ssp. *tenuifolia* type in the Upper Colorado River Basin. Kittel and Lederer (1993) similarly document this type in the Yampa River Basin. In the San Miguel/Dolores River Basins their type intergrades with *Picea pungens* and *Cornus sericea* ssp. *sericea*. Kittel (1993) also reports a *Populus angustifolia–Picea pungens–Alnus incana* ssp. *tenuifolia/Cornus sericea* ssp. *sericea* type for the White River Basin in Colorado. Our stands had no *Picea pungens* or *Cornus sericea* ssp. *sericea* present. In our stands *Alnus oblongifolia* replaces *Alnus incana* ssp. *tenuifolia* in the southwestern regions of the state. Our type may be ecologically similar to the *Populus angustifolia–Betula occidentalis* type defined by Padgett et al. (1989) in Utah with *Betula occidentalis* replacing *Alnus oblongifolia*.

2. Narrowleaf Cottonwood–Arizona Alder Community Type
***Populus angustifolia–Alnus oblongifolia;* POPANG–ALNOBL)**

Distribution. - The Narrowleaf Cottonwood–Arizona Alder Community Type occurs in the upper reaches of Palomas, North Seco, and Las Animas Creeks which drain east side of the Black Range of southcentral New Mexico near the Gila National Forest. The community occurs in narrow valleys at elevations typically around 1890 meters (6200 ft).

Vegetation. - Narrowleaf cottonwood (*Populus angustifolia*) and Arizona alder (*Alnus oblongifolia*) co-dominate these forests. These forests are typically positioned adjacent to the active channel. The closely spaced alders border the channel and tend to slightly overhang the banks, while the larger cottonwood trees are set several feet further back away from the channel and are widely spaced. Narrowleaf cottonwood canopies provide additional shade over the creek, helping to lower water temperatures and prevent the growth of unwanted algae or weedy aquatic vegetation. As a tall forest, tree canopy heights can reach 18 to 20 meters (60-65 ft). With a total canopy cover of approximately 30%, these are not densely forested communities. The forest is neither deeply shaded nor excessively sunny. Growing adjacent to the stream channel are the reproducing saplings (<5 m in height and 2.5 to 5 cm diameter) of the dominants. Other trees present may be boxelder (*Acer negundo*), junipers (*Juniperus* spp.), and ponderosa pines (*Pinus ponderosa*).

These forests have a fairly diverse herbaceous understory dominated by grasses with few forbs, and a sparse and short shrub layer. Total canopy cover of the shrub layer is 15% and heights rarely exceed 1.5 meters (about 4.5 ft). Shrubs include California brickellbush (*Brickellia californica*) and the woody vine, canyon grape/Arizona grape (*Vitis arizonica*). Graminoids dominate the herbaceous layer with a total canopy cover of 50%, while forbs are sparse with less than 5% total cover. The perennial native grasses, sideoats grama (*Bouteloua curtipendula*), silver bluestem (*Bothriochloa saccharoides*) and blue grama (*Bouteloua gracilis*) are well represented. The dominant forbs include the exotic species, horehound (*Marrubium vulgare*) of the mint family and the tall, biennial, mullein (*Verbascum thapsus*) of the figwort family. Other forbs present include the purple flowering pineywoods geranium (*Geranium caespitosum* var. *caespitosum*), the reddish-orange Fendler's globemallow (*Sphaeralcea fendleri*), and the bright-yellow, hairy evening primrose (*Oenothera villosa* ssp. *strigosa*).

Environmental Setting. - It occurs along side bars that are adjacent to the active channel within the two- to five-year floodplain. It is situated less than two meters (1-6 ft) above the active channel and up to 10 meters (30 ft) distant. Overbank flooding occurs as evidenced by woody debris strewn over the banks, but the entire community may not be inundated very often. Banks are stabilized by stones, cobbles, and the roots of creekside alders. The river can be classified as a B2 stream type of Rosgen (1992) where the stream meanders only slightly across the floodplain and the gradients seldom exceed 2%. Channel materials typically consist of small- to medium-sized cobbles, gravels, and a few stones. Soils are shallow, recently deposited coarse-textured alluvium. The presence of three strongly contrasting texture layers in the profile. A 15-centimeter (6 in) cobbly layer occurs at the surface, which is then underlain by a sandy layer of 15 to 20 centimeters (6-8 in). Below this is a 30 centimeter (12 in) thick gravelly layer.

Adjacent Vegetation. - The adjacent riparian communities consist of the Arizona walnut/sideoats grama riparian forests positioned on terraces at higher and drier sites furthest away from the stream channel, or Arizona sycamore—Arizona alder forests near the active channel. Juniper—oak woodlands occupy the lowest hillslopes and gradate into ponderosa pine forests. Additionally, the mesa sideslopes are dominated by grama grasslands.

Discussion. - These riparian forests occur in small, discontinuous patches. They are restricted to the upper elevations and appear to be a stable community. More information regarding narrowleaf cottonwood communities is needed. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse.

Documentation. - This community type is based on plots 94PD004 and 94PD020. It is not known to be documented elsewhere in New Mexico or the surrounding Southwest or Rocky Mountain regions.

3. Narrowleaf Cottonwood—Rocky Mountain Juniper Community Type
***Populus angustifolia—Juniperus scopulorum;* POPANG—JUNSCO)**

Distribution. - The Narrowleaf Cottonwood—Rocky Mountain Juniper Community Type is known to occur in the upper basin along the main stem Rio Grande at mid-elevations near 2066 meters (6780 ft).

Vegetation. - The community is characterized by mature forests dominated by narrowleaf cottonwood (*P. angustifolia*) and co-dominated by Rocky Mountain juniper (*J.*

scopulorum) as a subcanopy tree. Total tree canopy is somewhat open (25-40 % cover). Oneseed juniper (*J. monosperma*) may be common in these stands. Narrowleaf cottonwood is usually represented by individuals of the same size and age class, with reproduction limited to root sprouts. Many trees have reached maturity, are dead or senescent and have junipers growing up under them. The shrub layer can be well represented with pale wolfberry (*Lycium pallidum*) and the saplings of junipers. The herbaceous layer tends to be grassy (20-30% cover) and dominated by Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), and wheatgrasses (*Pascopyrum smithii, Elymus trachycaulus* or *Elymus* x *pseudorepens*). The dominant forbs are dandelion (*Taraxacum officinale*), American vetch (*Vicia americana*), trailing fleabane (*Erigeron flagellaris*) and sweetclover (*Melilotus officinalis*).

Environmental Setting. - This community type occupies the higher terraces in the floodplain and is commonly above the current high-water mark and several feet above the active channel. The river can be characterized as a C3 stream type of Rosgen (1992) -- moderately entrenched and slightly confined with a stable coarse gravel/small cobble channel of low gradient and moderate sinuosity. Bankfull width ranges between 30-50 feet. Stands are somewhat removed laterally from the main channel or any overflow channels. Given their position in the landscape a minimum of 300 cfs would be necessary to flood these communities. Soils are primarily Aquic Ustifluvents with sandy-skeletal textures. They are nonacidic and moderately dry, showing no indication of reduced or hydric conditions.

Adjacent Vegetation. - Adjacent riparian communities are typically coyote willow scrub-shrublands which occupy alluvial bars closer to the active channel. Commonly coyote willow—rubber rabbitbrush or coyote willow/redtop are the dominant communities. The surrounding upland communities are characteristically dominated by pinyon pine—juniper woodlands.

Discussion. - The community is a late progressional riparian community. Lack of sexual regeneration indicates that no recent flooding events (required to sustain the community) have occurred. More information regarding narrowleaf cottonwood communities is needed. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse.

Documentation. - This community type is based on plot 92EM025. It is not known to be documented elsewhere in New Mexico or the surrounding Southwest and Rocky Mountain regions.

4. Narrowleaf Cottonwood/New Mexico Olive Community Type
***Populus angustifolia/Forestiera;* POPANG/FORPUBP)**

Distribution. - The Narrowleaf Cottonwood/New Mexico Olive Community Type occurs in the upper Rio Grande of northern New Mexico. It is known to occur along the Chama River in small fragmented stands at 1920 meters (6300 ft).

Vegetation. - The community is dominated by pole-sized narrowleaf cottonwood (*P. angustifolia*). The stand is even-aged and abundant. Beaver herbivory is apparent and reproduction succeeds asexually by root suckering. The community is distinctively shrubby and diverse. Junipers (*Juniperus monosperma* and *J. scopulorum*), rabbitbrush (*Chrysothamnus nauseosus*), sagebrush (*Artemisia tridentata* and *A. frigida*) and skunkbush sumac (*Rhus trilobata*) are well represented. The herbaceous layer is very well represented, diverse and dominated by grasses and various forbs that are predominantly upland in character. Grasses are well represented and commonly include Hairy grama (*Bouteloua hirsuta*), alkali sacaton (*Sporobolus airoides*), western wheatgrass (*Pascopyrum smithii*) and Kentucky bluegrass (*Poa pratensis*). The composition of forbs also reflects the drier conditions. They are represented by paintbrushes (*Castilleja linariifolia*), flaxflowered gilia (*Ipomopsis longiflora*), goldenasters (*Heterotheca villosa*), beardlip penstemon (*Penstemon barbatus*), American licorice (*Glycirrhiza lepidota*), woolly paperflower (*Psilostrophe tagetina*), Fendler's globemallow (*Sphaeralcea fendleri*), the ubiquitous sweetclover (*Melilotus officinalis*) and smooth horsetail (*Equisetum laevigatum*) in more mesic locales.

Environmental Setting. - The river can be characterized as a C3 stream type of Rosgen (1992) -- moderately entrenched and slightly confined with a stable coarse gravel/small cobble channel of low gradient and moderate sinuosity. Bankfull width ranges between 30-50 feet. Streamflows are perennial and highly regulated. Cross sectional hydraulic analyses indicates that flow extremes of 6475 cfs would be required to flood the community. Based on Waltmeyer (1986) equations, long duration floods at these levels are estimated to occur every ten years. Soils are classified as Oxyaquic Ustifluvents with a wetness ranking of 8 with very low salinity levels and slightly calcareous. Texture is coarse-loamy and mottles are few, fine and distinct at 51 cm.

Adjacent Vegetation. - Adjacent riparian vegetation commonly consists of Rio Grande cottonwood—oneseed juniper on adjacent terraces and coyote willow—rubber rabbitbrush on bars positioned along the lowest sites in the floodplain. Adjacent upland vegetation on hillslopes include ponderosa pine forests and pinyon pine—juniper woodlands.

Discussion. - The community is typically found in intermediate positions within the riparian landscape. At this stage the community appears to be stable. The flood regime and herbivory from beavers has created and maintained the community. No sexual reproduction of cottonwoods is apparent, yet the cottonwoods are still successful and able to resprout following herbivory. Floods carrying heavy bedloads and debris could disturb the existing community or destroy it. Accumulation of debris from beavers can also affect flows, changing channel configurations, blocking secondary channels and providing additional sites for new establishment of the cottonwoods and willows. More information regarding narrowleaf cottonwood communities is needed. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse. More information regarding narrowleaf cottonwood communities may be needed.

Documentation. - This community type is based on plots 94PD087. It has not been documented elsewhere in New Mexico or the surrounding Southwest and Rocky Mountain regions.

5. Narrowleaf Cottonwood/Coyote Willow Community Type
***Populus angustifolia/Salix exigua;* POPANG/SALEXI)**

Distribution. - The Narrowleaf Cottonwood/Coyote Willow Community Type is common along lower montane reaches of the upper Rio Grande in northern New Mexico at elevations of 1905-2359 meters (6250-7740 ft). It is known to occur along the lower reach of the Rio Truchas, an unregulated intermediate-sized stream which originates high in the Sangre de Cristo Mountains and flows west-southwest into the Rio Grande. It is also known to occur along the Pecos and Gallinas Rivers which drain the east side of the Sangre de Cristos.

Vegetation. - Narrowleaf cottonwood (*Populus angustifolia*) dominates the tree canopy in this forest with other important obligate riparian trees commonly present, including Rio Grande cottonwood *(P. deltoides)*, black chokecherry *(Prunus virginiana* var. *melanocarpa)* and boxelder *(Acer negundo)*. Understories are distinctively shrubby and dominated by coyote willow (*Salix exigua*), which is well represented to luxuriant. Other shrub associates are diverse and include bluestem willow (*S. irrorata*) and sapling-sized cottonwoods on wetter aspects. Apacheplume (*Fallugia paradoxa*), rubber rabbitbrush (*Chrysothamnus nauseosus*), skunkbush sumac (*Rhus trilobata*) and Wood's rose (*Rosa woodsii*) are present in drier aspects of the community. The herbaceous layer is diverse, but without significant dominants. Several rushes are present and include (*Juncus bufonius*, *J. tenuis*, *J. balticus*, *J. torreyi* and *J. saximontanus*). Other graminoids present include water sedge (*Carex aquatilis*), American bulrush (*Scirpus* bulrush), alkali muhly (*Muhlenbergia asperifolia*) and common spikerush (*Eleocharis palustris*). The predominant grasses, however, are the exotic redtops or bentgrasses (*Agrostis stolonifera* and *A. gigantea*).

Environmental Setting. - The river can be characterized as a C3 stream type of Rosgen (1992) -- moderately entrenched and slightly confined with a stable coarse gravel/small cobble channel of low gradient and moderate sinuosity. Flows are ephemeral on the Rio Truchas and perennial on the Pecos and Gallinas. Cross-sectional hydraulic analyses indicates that flow extremes between 50 and 500 cfs would be required to flood the communities, with an average near 125 cfs. Based on Waltmeyer (1986) equations, long duration floods at these levels are estimated to occur every two to ten years. Hence, younger communities closer to the channel are frequently flooded, while older, higher sites are infrequently flooded. Soils are classified as Aeric Fluvaquents, Oxyaquic Udifluvents and Typic Fluvaquents with wetness rankings ranging from 2 to 7. Textures are sandy-skeletal. The soils are nonacidic, shallow and structureless with variously fine mottles. No diagnostic horizons occur. Soils are often saturated at shallow depths. The water table is often within one meter of the surface.

Adjacent Vegetation. - Adjacent upland vegetation on hillslopes include ponderosa pine forests and juniper woodlands. Terraces adjacent to the floodplain are commonly used for pasture.

Discussion. - The community is typically found in intermediate positions within the riparian landscape. At this stage the community appears to be stable. The flood regime has created environments for successful sexual reproduction of the obligate riparian species. Floods carrying heavy bedloads and debris could disturb or destroy the existing community. Accumulation of debris from beaver herbivory can also affect flows, changing channel configurations, blocking secondary channels and providing additional sites for new establishment of the cottonwoods and willows. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse. More information regarding narrowleaf cottonwood communities may be needed.

Documentation. - This description is based on plots 92RW023, 92RW024, 92RW026, 93PD019 and 94PD084. This type is analogous to other classified types in New Mexico and Colorado (Baker 1984; Kittel and Lederer 1993; and Kittel 1993). Muldavin et al. (1993b) reports this type to occur on the Upper Rio Grande River Basin of New Mexico, and Dick-Peddie (1993) classifies a *Populus angustifolia/Salix exigua*/MG-F as being common to montane riparian regions of New Mexico. The Colorado types are widespread and analogous to our types.

6. Narrowleaf Cottonwood/Bluestem Willow Community Type
***Populus angustifolia/Salix irrorata;* POPANG/SALIRR)**

Distribution. - The Narrowleaf Cottonwood/Bluestem Willow Community Type occurs in the upper Rio Grande in northern New Mexico. It is known to occur in the lower reaches of Agua Caliente, a small unregulated mountain stream draining the west side of the Sangre de Cristo Mountains at approximately 2082 meters (6830 feet).

Vegetation. - Narrowleaf cottonwood (*P. angustifolia*) dominates the tree canopy of this community and overtopping a shrubby understory dominated by bluestem willow (*S. irrorata*). Ponderosa pine (*Pinus ponderosa*) canopies occasionally extend from the upper hillslopes into the stand. Shrubs may include gooseberries (*Ribes cereum, R. americanum, R. inerme,* or *R. leptanthum*), apacheplume (*Fallugia paradoxa*) and Wood's rose (*Rosa* *woodsii*) as common associates. Herbaceous diversity is high, but cover is low-to-moderate and dominated by mesic graminoids. Present are owlfruit sedge (*Carex stipata*), Baltic rush (*Juncus balticus*), Rocky Mountain rush (*J. saximontanus*), fowl mannagrass (*Glyceria striata*) and redtop (*Agrostis gigantea*). Forbs commonly include exotics such as sweetclover (*Melilotus officinalis*), Canadian horseweed (*Conyza canadensis*) and various clovers (*Trifolium pratense* and *T. repens*).

Environmental Setting. - The stream can be characterized as an A3 stream type of Rosgen (1992) -- very deeply entrenched and well confined with a coarse cobbly-gravel channel of moderate to steep gradient and little sinuosity. Highest annual flows are expected during spring runoff. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analysis, flows are expected to peak during May. A ten-year return interval would carry a flow of 560 cfs to this stream and be strong enough to inundate the community. Soils are classified as Typic Fluvaquent with sandy skeletal textures. They are sub-irrigated, shallow and nonacidic. Substrates are abundantly rocky (of basaltic origin).

Adjacent Vegetation. - The adjacent riparian vegetation is typically dominated by coyote willow/sparse shrublands which occur alongside riverwash and the active channel. Bordering the community between the upland ponderosa pine forests are arroyo riparian shrublands dominated by either apacheplume or rubber rabbitbrush.

Discussion. - Aggradation during flooding in association with vegetation has aided the development of this community to levels several feet above the active channel. The community is considered late progressional and is infrequently flooded. In narrow mountain canyons where this community is encountered it is often fragmented by upland landslides. Sexual recruitment by obligate riparian tree species is restricted. Most regeneration is asexual from root systems in contact with the water table. If resprouting fails, then the community is opened up for facultative riparian species from the upland. In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse. More information regarding narrowleaf cottonwood communities may be needed.

Documentation. - This description is based on plot 92RW016. It is not known to be documented from elsewhere in New Mexico or the surrounding Southwest and Rocky Mountain regions.

7. Narrowleaf Cottonwood/Kentucky Bluegrass Community Type
***Populus angustifolia/Poa pratensis;* POPANG/POAPRA)**

Distribution. - The Narrowleaf Cottonwood/Kentucky Bluegrass Community Type occurs along the lower montane reaches of the Rio Grande in northern New Mexico at elevations of 2231 meters (6800 ft). It is also known to occur in the upper Pecos of northern New Mexico.

Vegetation. - Narrowleaf cottonwood *(Populus angustifolia)*, dominates this closed-canopied to moderately open and mature community in the tree layer. Trees are similar in age and regeneration is absent. These communities are well shaded and species diversity is relatively low. The understory is predominantly grassy. Kentucky bluegrass *(Poa pratensis)* dominates this layer. Meadow fescue *(Festuca pratensis)* and timothy *(Phleum pratense)* are common. The shrub and forb layers have few species. Wood's rose *(Rosa woodsii)* is common while common chokecherry *(Prunus virginiana)* and whitestem currant *(Ribes inerme)* are present. Western virginsbower *(Clematis ligusticifolia)* and pineywoods geranium *(Geranium caespitosum* var. *caespitosum)* are present.

Environmental Setting. - The *Populus angustifolia/Poa pratensis* CT occurs on older, high elevation island and side bars. It is associated with the Rosgen's Type B2 channel morphology. The channel is moderately entrenched and moderately confined by the valley. Channel material consists of large cobbles, small boulders, coarse gravels, and small- to medium-sized debris that affects less than 10% of the channel. Hydraulic analysis indicates that this community may be flooded every 25 years with an estimated flow of 2200 cfs to inundate this community. Alluvial terraces are coarse textured, relatively stable and adjacent to steep upland slopes. Soils are classified as a sandy-skeletal Mollic Udifluvents having a frigid temperature regime and moderate moisture regime.

Adjacent Vegetation. - Adjacent canyon hillslopes are south-facing and occupied by ponderosa pine forests. Adjacent riparian vegetation includes thinleaf alder/bluestem willow shrublands on lower bars and bordering the streambank.

Discussion. - The Narrowleaf Cottonwood/Kentucky Bluegrass CT appears to be a late-progressional stage. Tree canopies are open. Diversity of species is generally low. Aggradation of sediments and flood debris contributes to lateral channel migration. A wetland adjacent to this community appears to be located in an abandoned channel that became isolated with the migration of the channel. This community is reported as a disturbance-induced type in other states (Utah and Montana). In general, they appear to be fast-growing and short-lived communities sensitive to impacts from external sources or overuse. More information regarding narrowleaf cottonwood communities may be needed.

Documentation. - This description is based on plots 92EM026 and 93PD009. This type may be ecologically similar to our upper montane *Picea pungens/Poa pratensis* which occupies older, infrequently flooded terraces. Our type is similar to Dick-Peddie's (1993) *Populus angustifolia*/MS/MG-F which occurs in montane riparian regions of New Mexico.

Our type is analogous to the type described by Padgett and others (1989) which is widespread in Utah, and Hansen and others (1990) of Montana.

III. SOUTHWEST MONTANE FORESTED WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

Southwest montane forested wetlands are dominated by Arizona alder. In New Mexico, these forests are generally distributed from south central New Mexico to southern New Mexico. Commonly, they are closed forests bordering narrow floodplains along perennial segments of low gradient, intermittent streams.

V. Arizona Alder (*Alnua oblongifolia*) Series

1. Arizona Alder—Goodding's Willow Community Type
***Alnua oblongifolia—Salix gooddingii;* ALNOBL—SALGOO)**

Distribution. - The Arizona Alder—Goodding's Willow Community Type is known to occur along Las Animas, Seco and Palomas Creeks, three tributaries that drain the east side of the Black Range of south central New Mexico. The community occurs at elevations ranging approximately between 1520-1830 meters (5000-6000 ft).

Vegetation. - The Arizona Alder—Goodding's Willow community is co-dominated by the broad-leaved deciduous trees Arizona alder (*A. oblongifolia*) and Goodding's willow (*S. gooddingii*). Combined canopy cover is 70%. This medium-statured riparian forest represents a closed-canopy, densely shaded forest. Alders are numerous within the stand with the typical tree measuring 20 to 25 centimeters (8-10 in) in diameter (about 1.5 meters above the ground surface) and reaching heights of up to 14 meters (45 ft). Arizona alder grows in linear rows along the banks of the creek where they mature and reproduce, while Goodding's willow is generally not positioned directly adjacent to the channel edge, yet its canopy may still overhang the channel. On average these trees contribute to 10-25% of the total canopy cover within these forests. These medium-sized trees rarely form dense forest stands of their own in New Mexico.

Diversity of plant species within this community is fairly high but moderately sparse due to frequent scouring of the underlayer and intense shading by the tree layer. Total canopy cover of the shrub, graminoid and forb layers is seldom more than 15%. Among the obligate woody riparian species, Fremont's cottonwood (*Populus fremontii*), usually reaches and exceeds the canopy heights of both of the dominants, but does not co-dominate. Reproducing near the creekside are juvenile-sized (1-cm stem diameter at a height of <1 m) tree species, boxelder (*Acer negundo*) and velvet ash (*Fraxinus velutina*), while the woody vine, canyon/Arizona grape (*Vitis arizonica*) is scattered throughout the community.

The total canopy cover of the herbaceous layer is 10%. Graminoids are represented by the grasses Kentucky bluegrass (*Poa pratensis*), bottlebrush squirreltail (*Elymus elymoides*), fringed brome (*Bromus ciliatus*), creeping bentgrass (*Agrostis stolonifera*), and plains lovegrass (*Eragrostis intermedia*). Forbs include willowleaf aster (*Aster praealtus*), cottonbatting (*Gnaphalium stramineum*), and trailing fleabane (*Erigeron divergens*) all belonging to the aster family. The scarlet red cardinalflower (*Lobelia cardinalis* ssp. *graminea*) of the bellflower family, purple pineywoods geranium (*Geranium caespitosum* var. *caespitosum*) and the introduced white-flowering sweet clover (*Melilotus officinalis*) of the legume family are also common here. This ubiquitous species is often one of the first herbs to colonize cobble bars in riparian areas of New Mexico.

Environmental Setting. - This riparian forest community occurs immediately adjacent to the active channel, but can be situated about one meter (3 ft) above it. The river can be classified as a B2 stream type of Rosgen (1992) where the valleys are narrow to moderately wide and the active channel meanders only slightly across the floodplain. At bankfull stages, the channel may be 1.5 to 10 meters (5-30 ft) wide. Stream gradients may be moderate to steep (1 to 2.5%) and overbank flooding occurs at one- to two-year intervals. Banks are typically well armored. Channel materials consist mostly of medium and large cobbles, a few stones, and small gravels. In the narrowest canyons, large boulders and riverworn bedrock may be exposed. Where pools occur, they may be several feet deep and are on average between five and ten feet long or wide.

Adjacent Vegetation. - Adjacent riparian communities include Arizona sycamore/sideoats grama positioned on slightly higher terraces with Arizona walnut—netleaf hackberry and/or juniper—oak woodlands located on the outer floodplain and partway up the adjoining hillslopes. Uplands are dominated by grama grasslands bordered by a thin fringe of honey mesquite shrublands.

Discussion. - These riparian forests are very tolerant to frequent, scouring floods. The rocky nature of the banks along with the thick and widespread root system of bankside alders make this community one of the most important stabilizers of streambanks. The deep shade and cover provided by these forests not only helps improve the water quality of the creek by lowering stream temperatures and helping to inhibit the growth of algae or other aquatic vegetation, but also provides important habitat for the native fauna. These are young forests that can only reach climax stages should the active stream channel alter its course and meander away from the forest. Relatively frequent flooding events inhibit the development of a true soil. Sands, silts and clays are washed out of the system and the resulting alluvial "soil" that is left behind is comprised of coarse materials such as cobbles and gravel (which are particles too large to be classified as soil).

Documentation. - This description is based on plots 94PD019 and 94PD106. It is not known to be documented from elsewhere in New Mexico or the surrounding Southwest and Rocky Mountain regions.

2. Arizona Alder/Seepwillow Community Type
***Alnus oblongifolia/Bacharis salicifolia;* ALNOBL/BACSAL)**

Distribution. - The Arizona Alder/Seepwillow Community Type is known to occur along the upper and middle reaches of Las Animas Creek in southcentral New Mexico at elevations ranging approximately between 1520 to 1830 meters (5000-6000 ft).

Vegetation. - With a combined tree canopy cover of at least 60%, Arizona alder (*A. oblongifolia*) dominates the forest canopy. The understory is dominated by seepwillow (*B. salicifolia*), a shrub of the aster family. It is well developed, tall, and averages between 25 to 35% cover. Despite the dense canopy, additional trees such as ashes (*Fraxinus velutina*) are able to break through the canopy, mature, and diversify the community, while Goodding's willow (*Salix gooddingii*) remains fairly well represented. Overall, this is a low-statured forest where the tallest tree seldom exceeds 7 to 8 meters (25 ft) in height. Trees are pole-sized, averaging 10 to 15 centimeters (4-6 in) in diameter at breast height (about 1.5 m above the ground surface). Most of the obligate riparian tree species also occur as juveniles (<1 m in height and 1 cm diameter) or saplings (<5 m in height and 2.5 to 5 cm diameter). Desert indigobush (*Amorpha fruticosa*), Arizona walnut (*Juglans major*), boxelder (*Acer negundo*), and the woody vine, canyon/Arizona grape (*Vitis arizonica*) are common woody associates.

There is also an abundant and diverse herbaceous layer. Though fewer species of grasses occur here than do forbs, total canopy cover of each is nearly equal (25-30%). Of the grasses, little barley (*Hordeum pusillum*), muttongrass (*Poa fendleriana*), and smooth brome (*Bromus inermis*) are well represented. The dominant forb, Fendler's meadowrue (*Thalictrum fendleri*) is an inconspicuously flowering perennial of the buttercup family. Five members of the aster family are present and include three native species: the tall cutleaf coneflower (*Rudbeckia laciniata*), as well as, Canada goldenrod (*Solidago canadensis* var. *canadensis*) with arching clusters of minute yellow flowers, and cottonbatting plant (*Gnaphalium stramineum*) with white, cottonlike flower clusters. Exotic species present include spiny sowthistle (*Sonchus asper*) which has yellow flowers and thistlelike leaves, and the ubiquitous Canadian horseweed (*Conyza canadensis*).

Environmental Setting. - The Arizona Alder/Seepwillow Community Type occurs on broader floodplains and in open and sunny stands. This riparian forest community develops on low, relatively flat and cobbly bars. It occurs where the active channel meanders slightly across the floodplain and secondary or overflow channels are common. The active channel is on average 15 to 20 centimeters (6-8 in) deep and 3 to 5 meters (10-15 ft) wide with alternating riffles and pools. Stream gradients are moderate, ranging from 1 to 1.5%. Channel materials consist mostly of medium and large cobbles, a few stones, and aquatic vegetation. Banks are typically well-armored. Cobbles, stones, and the exposed roots of bankside alders protect the banks from erosion and anchor these trees during flooding. Soils are recently deposited, coarse-textured, alluvial sands and gravels. They are typically shallow soils which can have one or more alternating and strongly contrasting texture layers. This is indicative of an actively meandering channel which moves laterally across the floodplain.

Adjacent Vegetation. - Adjacent riparian communities generally include younger Arizona sycamore—Arizona alder forests bordering the creek, Fremont's cottonwood—Goodding's willow communities on side bars, and a combination of Arizona walnut/netleaf hackberry and juniper—oak woodlands situated at slightly higher elevations towards the outer floodplain. Adjacent uplands are dominated by grama grasslands.

Discussion. - These riparian forests are very tolerant to frequent, scouring floods. The rocky nature of the banks along with the thick and widespread root system of bankside alders make this community one of the most important stabilizers of streambanks. The deep shade and cover provided by these forests not only helps improve the water quality of the creek by lowering stream temperatures and aiding to inhibit the growth of algae or other aquatic vegetation, but also provides important habitat for the native fauna. These are young forests that can only reach climax stages should the active stream channel alter its course and meander away from the forest. Relatively frequent flooding events inhibits the development of a true soil. Sands, silts, and clays are washed out of the system and the resulting alluvial "soil" that is left behind is comprised of coarse materials such as cobbles and gravel (which are particles too large to be classified as soil).

Documentation. - This description is based on plot 94PD014. It is not known to be documented from elsewhere in New Mexico or the surrounding Southwest and Rocky Mountain regions.

III. RIO GRANDE/GREAT PLAINS FORESTED WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

Intact fluvial processes are essential for the establishment, growth, maintenance, and long-term survival of these forests. Terraces are often situated well above the active channel where natural surficial fluvial processes are no longer or very rarely active. The majority of these forests occur on the main stem of the Rio Grande where water flows are highly regulated. Long-term survival of these forests is threatened by many impacts from urbanization, fire, recreation, grazing and encroachment or replacement by exotic species that have become naturalized in New Mexico. Many of the stands consist of even-aged and mature trees. Regeneration is largely due to root suckering or asexual cloning. Sexual reproduction is typically rare.

Taxonomic treatments of the broadleaf cottonwood taxa in New Mexico needs further critical review and analysis. The majority of the main stem of the Rio Grande in New Mexico we feel is likely dominated by the Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*) which remains the dominant tree of its extensive floodplains. We regard Fremont's cottonwood (*P. fremontii*) to be the true southwestern broadleaf cottonwood species that occurs in much of the Rio Grande basin as well as the lower Pecos basin of eastern New Mexico. It is also expected to be the dominant cottonwood in the Gila watershed of southwestern New Mexico. We also consider the Plains cottonwood (*P. deltoides* ssp. *monilifera*) to be the dominant cottonwood along the creeks and rivers of eastern New Mexico.

V. Rio Grande Cottonwood(*Populus deltoides*) Series

1. Rio Grande Cottonwood—Russian Olive Community Type
***Populus deltoides—Elaeagnus angustifolia;* POPDELW—ELAANG)**

Distribution. - The Rio Grande Cottonwood—Russian Olive Community Type is widely distributed in both the upper and middle Rio Grande of central New Mexico. It is the most common forest type in the middle basin and occurs along the main stem of the Rio Grande, as well as in several smaller tributary basins at elevations ranging from 1457-1792 meters (4780- 5880 ft).

Vegetation. - This community is characterized by an overstory of Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over a dense thicket of Russian olive (*E. angustifolia*) with a sparse to poorly represented herbaceous layer. In some stands the exotic tree Siberian elm (*Ulmus pumila*) is abundant. Sexual reproduction of cottonwoods is rare to nonexistent and occurs only by root sprouting after herbivory by beavers. Overall diversity of species is poor and often grass dominated. The dropseeds (*Sporobolus cryptandrus* and *S. airoides*) are common as are alkali muhly (*Muhlenbergia asperifolia*), purple three-awn grass (*Aristida purpurea*) and saltgrass (*Distichlis spicata*). Forbs are commonly represented by Canada goldenrod (*Solidago canadensis*), American licorice (*Glycyrrhiza lepidota*), Russian thistle (*Salsola kali*), annual ragweed (*Ambrosia artemisiifolia*) and the ubiquitous European exotic sweetclover (*Melilotus officinalis*).

Environmental Setting. - The community commonly occupies low to intermediate positions along the riverbank as well as interior positions across the floodplain. Where the community occurs along tributary basins the stream type can be classified as a C3 stream type of Rosgen (1992), moderately entrenched and slightly confined with low gradient and sinuosity. Banks are unstable and have unconsolidated and noncohesive soils. The channel consists of a predominantly gravel bed mixed with small cobbles and sand. Along the main stem the river can be characterized as a C4 stream type. It differs from the C3 type in that the channel consists of an unarmored, unstable shifting sand bed with a mixture of suspended silt/clay and some small gravel. Side bars and mid-channel bars are mixed through the channel. Bankfull widths vary from 15-1000 feet. Streamflows are perennial and regulated. Though difficult to assess under these conditions, based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 6954 cfs would inundate the community at a mean recurrence interval of 16 years. Soils are of mixed mineralogies and can be classified as Aeric Fluvaquents, Oxyaquic Ustifluvents, Fluventic Ustochrepts and Aquic Ustipsamments with wetness rankings ranging from somewhat moist (3) to very dry (12). Salinity levels are widely variable from very low (.17mS) to high (7.59). Texture classes are commonly sandy, but may also be coarse-loamy, coarse-silt over sand, or fine-loam.

Adjacent Vegetation. - Adjacent riparian vegetation may consist of Rio Grande cottonwood/New Mexico olive forests at slightly higher positions and coyote willow/American bulrush shrubland communities on the lower bars. Adjacent upland vegetation has commonly been converted for agriculture, residential or commercial purposes.

Discussion. - The community is most readily evident along river and streambanks where Russian olive overhangs the banks and forms dense, nearly impenetrable thickets, almost to the exclusion of other species. It may also occur within the interior floodplain. Russian olive is an extremely aggressive and prolific weed that has the potential to and often does displace native riparian/wetland vegetation after disturbances, such as fire. Its roots have the ability to fix nitrogen in nutrient poor soils, such as floodplain soils. Their roots may also have the ability to tap into the water table. They are common deep within the soil profile, whereas cottonwood roots tend to be shallow and closer to the surface. Russian olive appears to tolerate deep shade under cottonwood canopies, but is better adapted to open, sunny areas, hence its dominance along the riverbank. Once established it is difficult, costly and nearly impossible to eradicate. It is highly adapted to and resistant to control efforts and has consequently become a management concern for landowners.

Documentation. - This community type is based on plots 92RW020, 94PD046, 94PD048, 94PD054, 94PD056, 94PD066 and 94PD075. This community type is well documented in New Mexico (Campbell and Dick-Peddie 1964; Freehling 1982; Hink and Ohmart 1984; Sivinski et al. 1990 and Crawford et al 1993). It is not known to be documented in New Mexico the surrounding Southwestern and Rocky Mountain regions.

2. Rio Grande Cottonwood—Oneseed Juniper Community Type
***Populus deltoides—Juniperus monosperma;* POPDELW—JUNMON)**

Distribution. - The Rio Grande Cottonwood—Oneseed Juniper Community Type occurs along the main stem of the middle Rio Grande basin of central New Mexico at elevations near 1574 meters (5165 feet). It is also known from the Pecos basin of eastern New Mexico.

Vegetation. - This community is characterized by an open overstory of mature (2-3 ft. dbh) Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over an open sub-canopy of oneseed juniper (*J. monosperma*). Reproduction of cottonwood is absent. The sub-shrub snakeweed (*Gutierrezia sarothrae*) is scarce and scattered. The herbaceous layer is well represented, though not diverse and is characteristically grassy with scattered forbs. Saltgrass (*Distichlis spicata*) is the dominant grass, while forbs are upland in character and typically represented by gumweed (*Grindelia squarrosa*), annual ragweed (*Ambrosia artemisiifolia*), russian thistle (*Salsola kali*), cocklebur (*Xanthium strumarium*), American licorice (*Glycyrrhiza lepidota*) and whorled milkweed (*Asclepias subverticillata*).

Environmental Setting. - The community is positioned atop the highest and driest terraces on the floodplain. Where banks are severely downcut, the community is commonly directly adjacent to the river and one to several meters above it. Stream types are variable and can be classified as Rosgen's (1992) C3 and C4. The C3 stream types are slightly confined and moderately entrenched with low gradients and sinuosity and have a gravel bed with mixtures of small cobble and sand. The C4 stream type is similar to the C3 stream type, although the C4 type consists of an unarmored, shifting sand bed with a mixture of suspended silt/clay and some small gravel. Bankfull widths vary from 150-500 feet. Streamflows are perennial and regulated. Though difficult to assess under these conditions, based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 8500 cfs would inundate the community at a mean recurrence interval of 26 years. Soils are of mixed mineralogies and can be classified as Oxyaquic Ustifluvents and Fluventic Ustochrepts with wetness rankings ranging from 8 to 12. These are dry, slightly calcareous soils of mixed mineralogies very low salinity levels (<1 mS).

Adjacent Vegetation. - Adjacent riparian vegetation is typically distant, but may include coyote willow/American bulrush shrublands on side and mid channel bars. The adjacent upland vegetation is used for agricultural purposes (i.e., ranchland or farmland), while juniper—oak woodlands dominate the hillslopes.

Discussion. - The community occupies the highest and driest positions within the floodplain and is often directly adjacent to, but one to several meters above the river. This could potentially occur naturally as the channel moves laterally across the floodplain, but more often is a function of management where the floodplain is artificially terraced after channelization and bank stabilization (i.e., riprapping) practices. Consequently, the community may no longer lie within the hundred-year floodplain. Hence, cottonwood (*P. deltoides*) trees mature and become senescent. Reproduction is rare to nonexistent.

Documentation. - This community type is based on plots 93PD043 and 94PD096. The community was first documented in New Mexico by Hink and Ohmart (1984). It is not known to be documented in New Mexico the surrounding Southwestern and Rocky Mountain regions.

3. Rio Grande Cottonwood—Saltcedar Community Type
***Populus deltoides—Tamarix chinensis;* POPDELW—TAMCHI)**

Distribution. - The Rio Grande Cottonwood—Saltcedar Community Type is widely distributed in the upper and middle Rio Grande basin at elevations ranging between 1111-1568 meters (3645 to 5145 ft). It is also known from the Pecos basin of eastern New Mexico.

Vegetation. - This community is characterized by an open to closed overstory of Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over an open to dense thicket of saltcedar (*T. chinensis*). Overall diversity of species is characteristically low. The exotic tree Russian olive (*Elaeagnus angustifolia*) is almost always present. The understory is typically sparse and grassy or absent. Where the understory is able to develop, grasses include saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), sand dropseed (*S. cryptandrus*), giant sacaton (*S. wrightii*), Indian ricegrass (*Oryzopsis hymenoides*), vine mesquite (*Panicum obtusum*), witchgrass (*Panicum capillare*), western wheatgrass (*Pascopyrum smithii*) and burrograss (*Scleropogon brevifolius*). Forbs are upland in character and include Rocky Mountain beeplant (*Cleome serrulata*), Russian thistle (*Salsola kali*), velvetweed (*Gaura parviflora*), prairie coneflower (*Ratibida tagetes*), spotted sandmat (*Chamaesyce maculata*), touristplant (*Dimorphocarpa wislizenii*), American licorice (*Glycyrrhiza lepidota*), cocklebur (*Xanthium strumarium*) and the European exotics, sweetclover (*Melilotus officinalis*) and silverleaf nightshade (*Solanum elaeagnifolium*)

Environmental Setting. - The community occurs along the floodplain of large, broad floodplain rivers. Stream types of Rosgen (1992) are highly variable and can be characterized as C1, C3 and C4. The C1 stream type is moderately confined, moderately entrenched and of low gradients and moderate sinuosity. The channel bed is predominantly cobble with mixtures of small boulders and coarse gravel. C3 stream types are slightly confined and moderately entrenched of moderate gradient and sinuosity and have a gravel bed with mixtures of small cobble and sand. The C4 stream type is similar to the C3 stream type, although the C4 type consists of a shifting sand bed with a mixture of suspended silt/clay and some small gravel. Bankfull width varies from 100-1000 feet. Streamflows are perennial and regulated. Though difficult to assess under these conditions, based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 10,154 cfs would inundate the community at a mean recurrence interval of 12 years. Soils are of mixed mineralogies and can be classified as Typic Ustifluvents, Oxyaquic Ustifluvents, Oxyaquic Torrifluvents, Typic Fluvaquents, Typic Psammaquents and Fluventic Ustochrepts. Typic Psammaquents have a wetness ranking of 2.5, but generally these soils are dry with wetness rankings ranging between 8 to12. Textures vary and range from coarse-loamy over clayey to sandy skeletal. They are slightly calcareous, variously mottled and variously saline. Salinity levels are highly variable, as low as .24 mS and up to 7.48 mS.

Adjacent Vegetation. - Adjacent riparian vegetation consists of Rio Grande cottonwood–Russian olive forests on the floodplain or cottonwood–oneseed juniper forests on higher terraces and coyote willow–seepwillow or coyote willow–rubber rabbitbrush shrublands on low side and mid channel bars. Adjacent uplands have been converted for agricultural (i.e., rangeland or farmland), residential or commercial use.

Discussion. - The community may be located on the outermost portion of the floodplain, within the interior forest or along the riverbank. Cottonwood still dominates the tree canopy, but trees are generally mature (2-3 ft dbh) and senescent. The community is infrequently flooded. Reproduction is rare or absent. If reproduction occurs, it occurs asexually by root suckering upon herbivory by beavers. Saltcedar is an extremely aggressive and prolific weed that has the potential to displace native riparian vegetation. Once established saltcedar is difficult, costly and nearly impossible to eradicate. It is highly adapted to and resistant to control efforts and has consequently become a management concern for landowners.

Documentation. - This community type is based on plots 93PD027, 93PD029, 93PD030, 93PD032, 93PD040, 93PD041, 93PD049, 93PD052, 94PD051, 94PD069, 94PD076, 94PD081, 94PD0091, 94PD092, 94PD093, 94PD095 and 94PD098. This type was first described by Campbell and Dick-Peddie (1964) and was also documented by King (1976) in southern New Mexico, as well as by Freehling (1982) and Hink and Ohmart (1984) for the middle Rio Grande basin.

4. Rio Grande Cottonwood/New Mexico Olive Community Type
***Populus deltoides/Forestiera pubescens;* POPDELW/FORPUBP)**

Distribution. - The Rio Grande Cottonwood/New Mexico Olive Community Type is distributed along the larger tributary basins of the upper Rio Grande in northern New Mexico and along the main stem in the middle Rio Grande in central New Mexico at elevations ranging between 1524-1719 meters (5000-5640 feet). It is known from the Jemez and Pojoaque Rivers in the upper basin.

Vegetation. - The community is characterized by a broad overstory of mature (2-3 ft. dbh) Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over a shrub layer dominated by New Mexico olive (*Forestiera pubescens* var. *pubescens*). Other trees may be common, but with no significant dominant. These include oneseed juniper (*Juniperus monosperma*), Goodding's willow (*Salix gooddingii*) and the exotics, Russian olive (*Elaeagnus angustifolia*), Siberian elm (*Ulmus pumila*) or white mulberry (*Morus alba*). The shrub layer is fairly diverse and includes coyote willow (*S. exigua*), skunkbush sumac (*Rhus trilobata*), rubber rabbitbrush (*Chrysothamnus nauseosus*), desert indigobush (*Amorpha fruticosa*), Wood's rose (*Rosa woodsii*), American black currant (*Ribes americanum*), tulip pricklypear (*Opuntia phaeacantha*) and the woody vines, Virginia creeper (*Parthenocissus quinquefolia* var. *quinquefolia*) and western white clematis (*Clematis ligusticifolia*).

The herbaceous layer is well represented with an even mix of grasses and forbs. Common grasses are Kentucky bluegrass (*Poa pratensis*), alkali sacaton (*Sporobolus airoides*), saltgrass (*Distichlis spicata*), Canada wildrye (*Elymus canadensis*), little barley (*Hordeum pusillum*), Indian ricegrass (*Oryzopsis hymenoides*) and the exotics, redtop (*Agrostis gigantea*), tall fescue (*Festuca pratensis*), japanese brome (*Bromus japonicus*) and cheatgrass (*B. tectorum*). Forbs are typically scarce, but represented by annual ragweed (*Artemisia artemisiifolia*), Canada goldenrod (*Solidago canadensis*), American licorice (*Glycyrrhiza lepidota*), Missouri gourd (*Cucurbita foetidissima*) and the European exotics, sweetclover (*Melilotus officinalis*) and curly dock (*Rumex crispus*).

Environmental Setting. - Stream types of Rosgen (1992) are somewhat variable and can be characterized as C3 and C4. The C3 stream type is slightly confined and moderately entrenched with moderate gradient and sinuosity and have a gravel bed with mixtures of small cobble and sand. C4 stream types are similar to the C3 stream type, although the C4 type consists of an unarmored and unstable shifting sand bed with a mixture of suspended silt/clay and some small gravel. Bankfull width varies from 50-1000 feet. Streamflows are perennial and regulated. Though difficult to assess under these conditions, cross sectional hydraulic analyses and Waltmeyer's (1986) equations indicate flows of 8684 cfs would inundate the community at a mean recurrence interval of 7.5 years. Soils are of mixed mineralogies and can be classified as Fluventic Ustochrepts, Aeric Fluvaquents, Typic Ustifluvents and Oxyaquic Ustifluvents that are commonly dry with the exception of Aeric Fluvaquents, which have a wetness ranking of 3. The other soils are drier and have wetness rankings ranging between 8 to 12. The soils are variously mottled, slightly calcareous and variably saline with levels ranging between low (.26 mS) to moderate (3.6 mS). Textures are generally coarse; either coarse-loamy over sandy, coarse-loamy, or coarse-silty over sandy.

Adjacent Vegetation. - Adjacent riparian vegetation consists of Rio Grande cottonwood—Russian olive forests or coyote willow/redtop shrublands, while upland vegetation is dominated by pinyon pine—juniper woodlands.

Discussion. - The community occupies the highest and driest positions within the floodplain and at times is adjacent to, but slightly higher (one to meters) than the active channel. Consequently, flooding is infrequent. Cottonwoods are typically mature with broad canopies. The community is considered to be a remnant native community of the Rio Grande that historically was more prevalent. Its decline may be attributed to the coincidal introduction and encroachment by exotics along with the regulation of streamflows.

Documentation. - This community type is based on plots 94PD044, 94PD050, 94PD059, 94PD061, 94PD062, 94PD068 and 94PD079. The community type was first documented in the middle Rio Grande basin of central New Mexico by Hink and Ohmart (1984). It is not known from the adjacent Southwestern or Rocky Mountain regions.

5. Rio Grande Cottonwood/Coyote Willow Community Type
***Populus deltoides/Salix exigua;* POPDELW/SALEXI)**

Distribution. - The Rio Grande Cottonwood/Coyote Willow Community Type widely distributed in the upper and middle Rio Grande basin of northern and central New Mexico at elevation ranges from 1786-1926 meters (5860-6320 ft). It is also known to occur in the Pecos basin on the east side of the Sangre de Cristo Mountains.

Vegetation. - This community is characterized by an overstory of Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over a dense thicket of coyote willow (*Salix exigua*) in the shrub layer. Sapling-sized trees of other willows, such as peachleaf (*S. amygdaloides*) and Goodding's willow (*S. gooddingii*), as well as boxelder (*Acer negundo*) and Russian olive (*Elaeagnus angustifolia*) may also be well represented. The herbaceous layer is well represented and characteristically mesic. Among the associates are stalky berula (*Berula erecta*), Canada goldenrod (*Solidago canadensis*), hardstem bulrush (*Scirpus acutus*), American bulrush (*Scirpus americanus*), alkali muhly (*Muhlenbergia asperifolia*) and the ubiquitous European exotic sweetclover (*Melilotus officinalis*).

Environmental Setting. - The *Populus deltoides/Salix exigua* CT occurs on stable bars at mid elevations in the floodplain and develops on recently deposited alluvium. This community is associated with Rosgen's Types B2, C1, and C3 channel morphologies. In the C morphology types, the channel is moderately entrenched and slightly to moderately confined by the valley. Channel materials consist of sand, coarse gravels, small cobbles, and large debris. Moderately developed depositional features are common. In the B2 channel morphology type, the channel is moderately entrenched and moderately confined by the valley. Terraces and banks are stable and steep canyon walls border the floodplain. Hydraulic modeling indicates that these communities are inundated at 25-year intervals. Soils are classified as calcareous, sandy-skeletal Typic Ustifluvents; calcareous, coarse-loamy over sandy-skeletal Oxyaquic Ustifluvents, and calcareous, fine-loamy over sandy-skeletal Typic Endoaquents. Ustifluvents are floodplain soils that have a mesic temperature regime and a moderate moisture regime. Oxyaquic Ustifluvents have aquic conditions above a depth of 100 cm. Typic Endoaquents have aquic conditions between 40-50 cm from the soil surface.

Adjacent Vegetation. - Adjacent upland vegetation varies from the northern reaches to the southern and can include pinyon pine—juniper woodlands with ponderosa pine and Gambel's oak, or mesquite shrublands and alkali sacaton grasslands. Adjacent riparian vegetation can include vast stands of saltcedar woodlands as well as Rio Grande cottonwood—Russian olive forests.

Discussion. - The Rio Grande Cottonwood/Coyote Willow CT is considered a mid-progressional stage and is an important plains riparian forest community. Signs of beaver herbivory were observed on the cottonwoods. The distribution of cottonwoods may be threatened by manmade impoundments (dams, irrigation channels, and levees). Below the dams, entrenchment of the channel increases and channel evulsion is restrained. Flood flows, which are required for the growth, maintenance and reproduction of this community, are restricted below Santa Rosa Lake and Ft. Sumner Dam. Saltcedar may be limiting the distribution of this type. In the middle reaches (primarily in the Ft. Sumner region) Russian olive is also encroaching and positioned on the banks directly adjacent to saltcedar.

Documentation. - This community type is based on plots 93PD015, 93PD026, 94PD017, 94PD031, 94PD039, 94PD042, 94PD049, 94PD057, 94PD097 and 94PD102. This type has previously been documented by Hink and Ohmart (1984). It corresponds with Dick-Peddie's (1993) *Populus fremontii/Salix exigua*/MG-F and the *Populus fremontii/Salix exigua* community type reported in the Santa Fe National Forest (Miller et al. 1993).

6. Rio Grande Cottonwood/Water Sedge Community Type
***Populus deltoides/Carex aquatilis;* POPDELW/CARAQU)**

Distribution. - The Rio Grande Cottonwood/Water Sedge Community Type occurs along the main stem of the upper Rio Grande basin in northern New Mexico at an elevation of 1786 meters (5860 ft).

Vegetation. - This community is characterized by a broad overstory of Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over an herbaceous-dominated understory with water sedge (*C. aquatilis*) being a significant dominant. Other trees may be present as saplings and include peachleaf willow (*Salix amygdaloides*), narrowleaf cottonwood (*P. angustifolia*), and oneseed juniper (*Juniperus monosperma*). Shrubs present include coyote willow (*S. exigua*), New Mexico olive (*Forestiera pubescens* var. *pubescens*) and the woody vines, Arizona grape (*Vitis arizonica*) and Virginia creeper (*Parthenocissus quinquefolia* var. *quinquefolia*). The herbaceous layer is grass dominated, although forbs may also be very well represented, with smooth horsetail (*Equisetum laevigatum*) being a significant dominant. Grasses are represented by Canada wildrye (*Elymus canadensis*), saltgrass (*Distichlis spicata*), slender wheatgrass (*Elymus trachycaulus* ssp. *trachycaulus*), Kentucky bluegrass (*Poa pratensis*) and the European exotics, orchardgrass (*Dactylis glomerata*), smooth brome (*Bromus inermis*) and tall fescue (*Festuca pratensis*).

Environmental Setting. - The stream can be classified as a C2 stream type of Rosgen (1992) -- moderately entrenched and well confined with moderate gradients and sinuosity. The channel consists of a large cobble bed with mixtures of small boulders and coarse gravel. Point bars and mid channel bars are common depositional features. Bankfull width ranges between 150-250 feet and streamflows are perennial. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 3540 cfs would inundate the community at a mean recurrence interval of two years. Soils are of mixed mineralogies and can be classified as Oxyaquic Ustifluvents with a wetness ranking of 8. They are slightly calcareous and nonsaline. Texture is sandy over loamy and mottling is common and distinct between 31 to 71 cm. from the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is commonly dominated by coyote willow/sparse shrublands on point bars and mid channel bars, narrow strands of American bulrush/smooth horsetail herbaceous communities and small fragmented stands of Rio Grande cottonwood/New Mexico olive on narrow terraces. Upland vegetation is dominated by big sagebrush shrublands on the flats and juniper woodlands on the hillslopes.

Discussion. - The community is distinctively mesic and occurs just below the confluence of a major tributary (Embudo Creek) to the Rio Grande. It borders the active channel and is situated about one meter above the active channel. Community dynamics may be dependent upon subsurface fluctuations of the water table.

Documentation. - This community type is based on plot 94PD036. The community type is not known to be documented from the surrounding Southwestern or Rocky Mountain regions.

7. Rio Grande Cottonwood/Smooth Horsetail Community Type
***Populus deltoides/Equisetum laevigatum;* POPDELW/EQULAE)**

Distribution. - The Rio Grande Cottonwood/Smooth Horsetail Community Type occurs in the upper Rio Grande basin of northern New Mexico. It is known from the main stem, as well as from large tributary (Rio Chama) basins at elevations ranging between 1774-1920 meters (5820-6300 ft).

Vegetation. - This community is characterized by an overstory of Rio Grande cottonwood (*P. deltoides* ssp. *wislizenii*) over an herbaceous understory dominated by smooth horsetail (*E. laevigatum*). Trees are numerous and comprised of several age-classes. Narrowleaf cottonwood (*P. angustifolia*) may be present. The shrub layer is generally rather sparse, with no significant dominant though coyote willow (*Salix exigua*) and young seedling-sized boxelder (*Acer negundo*) may also be present. The herbaceous layer is well represented and grassy, but does not contain any other significant dominant. European exotics tend to be better represented than native species. These include redtop (*Agrostis gigantea*), creeping bentgrass (*A. stolonifera*), tall fescue (*Festuca pratensis*), smooth brome (*Bromus inermis*) and orchardgrass (*Dactylis glomerata*), while the natives are represented by alkali sacaton (*Sporobolus airoides*), Kentucky bluegrass (*Poa pratensis*), muttongrass (*P. fendleriana*), Canada wildrye (*Elymus canadensis*) and little barley (*Hordeum pusillum*). The exotic forbs include the clovers (*Melilotus* *officinalis, Trifolium repens, T. pratense*), mullein (*Verbascum thapsus*), curly dock (*Rumex crispus*), oxeyed daisy (*Leucanthemum vulgare*), Fuller's teasel (*Dipsacus fullonum* ssp. *sylvestris*) and broadleaf plantain (*Plantago major*), while the natives are represented by swamp milkweed (*Asclepias incarnata*), annual ragweed (*Ambrosia artemisiifolia*), Canada horseweed (*Conyza canadensis*) and American licorice (*Glycyrrhiza lepidota*).

Environmental Setting. - The river can be characterized as C2 and C3 stream types of Rosgen (1992). The C2 stream type is moderately entrenched and well confined with moderate gradients and sinuosity. The channel consists of a predominantly large cobble bed with mixtures of small boulders and coarse gravel. C3 stream types are slightly confined and moderately entrenched with moderate gradients and sinuosity and have a gravel bed with mixtures of small cobble and sand. Side and mid channel bars are common depositional features. Bankfull widths range between 75 and 150 feet. Streamflows are perennial. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 3698 cfs would inundate the community at a mean recurrence interval of four years. Soils are of mixed mineralogies and can be classified as Aeric Fluvaquents and Oxyaquic Ustifluvents with wetness rankings ranging between 3 to 8. They are slightly calcareous and nonsaline. Textures are sandy, sandy-skeletal or coarse-loamy over sandy-skeletal with common, fine and distinct mottling typically within 30 cm of the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is commonly dominated by coyote willow/sparse shrublands on side and mid channel bars and small fragmented stands of Rio Grande cottonwood/New Mexico olive on narrow terraces. Upland vegetation is dominated by big sagebrush shrublands on the flats and juniper—oak woodlands on the hillslopes.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water table heights. The community is located on the lowest bars within the five-year floodplain and is flooded fairly frequently as evidenced by the different ages and size classes of trees. The community requires fluctuations of the groundwater so that the water table is at or near the surface during the growing season. Flooding created the environments for the cottonwoods and maintenance of these species is dependent on their ability to tap into the groundwater. They may still resprout by root suckering, upon herbivory by beaver and persist until they either mature and senesce or the stand is destroyed by scouring floods and a new stand is created.

Documentation. - This community type is based on plots 94PD041, 94PD043 and 94PD088. The community type is not known to be documented from the surrounding Southwestern or Rocky Mountain regions.

8. Rio Grande Cottonwood/Kentucky Bluegrass Community Type
***Populus deltoides/Poa pratensis;* POPDELW/POAPRA)**

Distribution. - The Rio Grande Cottonwood/Kentucky Bluegrass Community Type is distributed along intermediate-sized tributaries of the upper Rio Grande basin in northern New Mexico. It is known from Cienega Creek and from the Jemez River at elevations ranging from 1708-1792 meters (5605-5880 ft).

Vegetation. - This community is characterized by an overstory canopy of Rio Grande cottonwood (*P. deltoides* ssp. *wilizenii*) over a grassy meadowlike understory dominated by Kentucky bluegrass (*P. pratensis*). Trees are numerous and the community is well shaded. Sapling-sized peachleaf willow (*Salix amygdaloides*) can be present, but is typically solitary. Shrubs may be very well represented, but do not have a significant dominant throughout the community. Skunkbush sumac (*Rhus trilobata*), New Mexico olive (*Forestiera pubescens* var. *pubescens*), coyote willow (*S. exigua*), tulip pricklypear (*Opuntia phaeacantha*) and the woody vines, Virginia creeper (*Parthenocissus quinquefolia* var. *quinquefolia*) and western white clematis (*Clematis ligusticifolia*) may be common, but scattered. Other grasses present include Canada wildrye (*Elymus canadensis*), little barley (*Hordeum pusillum*), quackgrass (*Elytrigia repens* var. *repens*) and the exotics, japanese brome (*Bromus japonicus*), cheatgrass (*B. tectorum*) and tall fescue (*Festuca pratensis*). Forbs are very scarce or solitary and represented by Fendler's globemallow (*Sphaeralcea fendleri*) and the exotic, prickly lettuce (*Lactuca serriola).*

Environmental Setting. - The community is positioned in intermediate positions within the riparian landscape. The river can be classified as C3 stream type of Rosgen (1992) -- slightly confined and moderately entrenched with moderate gradients and sinuosity and having a gravel bed with mixtures of small cobble and sand. Bankfull width varies from 15-150 feet. Streamflows are perennial and not highly regulated. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 1916 cfs would inundate the community at a mean recurrence interval of 3.5 years. Soils are of mixed mineralogies and can be classified as Fluventic Ustochrepts and Oxyaquic Ustifluvents with wetness rankings ranging between 8 to 12. Soils are slightly calcareous and nonsaline. Textures are coarse-loamy over sandy-skeletal. They are generally well drained soils with a low available water-holding capacity and water tables may fluctuate enough for distinct mottles to form.

Adjacent Vegetation. - Adjacent riparian vegetation is commonly dominated by Rio Grande cottonwood—Russian olive along the streambanks and coyote willow/redtop along cobble side bars. Upland vegetation is dominated by juniper woodlands.

Discussion. - The community occurs along low lying alluvial terraces of streams and rivers. Stands are broad and extensive and dominated by many trees or several mature and senescing trees. Sites are well shaded. Hence, reproductive capabilities of the cottonwoods are limited unless the stand is rejuvenated by new scouring floods. The distribution of trees commonly occurs in distinct linear or arcuate banding patterns with each band being even-aged and indicates where a former flood created the present forest.

Documentation. - This community type is based on plots 94PD064 and 94PD103. It is not known to be previously documented in New Mexico. It has been documented in Montana by Hansen et al. 1990 where it is described as being grazing induced.

9. Rio Grande Cottonwood/Sparse Community Type
***Populus deltoides*/sparse; POPDELW/SPARSE)**

Distribution. - The Rio Grande Cottonwood/Sparse Community Type occurs along the middle Rio Grande basin of central New Mexico at an elevation of 1585 meters (5200 ft). It is also known from the Pecos basin in eastcentral New Mexico.

Vegetation. - Rio Grande cottonwood *(Populus deltoides)* dominates the tree layer, providing a closed-canopy shady site. Regeneration of cottonwood is not evident. Oneseed juniper *(Juniperus monosperma)* is well represented as a sub-canopy tree along with the exotic Russian olive *(Elaeagnus angustifolia)*. Vegetative ground cover is sparse and mostly herbaceous. Graminoids and forbs present include oneflower flatsedge *(Cyperus uniflorus)*, alkali muhly *(Muhlenbergia asperifolia)*, field mint *(Mentha arvensis)*, and white sweetclover *(Melilotus alba)*.

Environmental Setting - This community type occurs on moderate elevation bars or terraces positioned out of the floodplain. It is associated with Rosgen's Type C3 channel morphology. The channel is moderately entrenched and slightly confined by the valley. Stream gradient is between 0.5 and 1%. Channel materials consist of a mixture of silt, sand, fine gravels, and small cobbles. Bars and terraces appear to be moderately stable. Debris from flooding is common. Cross sectional hydraulic analysis indicates that flooding occurs at 10- to 25-year intervals. Soils are classified as calcareous Oxyaquic Ustipsamments with a mesic temperature regime. They are predominantly sandy soils with aquic conditions occurring above 85 cm. They are generally well-drained soils with a low available water-holding capacity and water tables may fluctuate enough for distinct mottles to form.

Adjacent Vegetation. - Adjacent upland slopes are sparsely vegetated with mesquite shrubland communities. Adjacent riparian vegetation is typically dominated by the herbaceous American bulrush—common spikerush community.

Discussion. - Mature communities of this type occupy a narrow band on floodplains that are commonly delimited by downcutting of the river channel and farmed terraces. The sparse ground cover may be attributed to previous scouring floods that carried large debris and heavy bedloads. There is some potential for sexual reproduction of cottonwoods, but shading may limit the success. The lack of regeneration may also be due to herbivory.

Documentation. - This description is based on plots 94PD037 and 94PD047. No other synonymous types have been reported elsewhere for New Mexico. A similar community type was identified by Hansen and others (1990) for central and eastern Montana. Generally, Fremont's cottonwood community types in New Mexico have been broadly classified to the series level (Dick-Peddie 1993).

V. Russian olive (*Elaeagnus angustifolia*) Series

1. Russian Olive—Saltcedar Community Type
***Elaeagnus angustifolia—Tamarix chinesis;* ELAANG—TAMCHI)**

Distribution. - The Russian Olive—Saltcedar Community Type occurs along the floodplains of the middle Rio Grande basin in central New Mexico. It is known from the Jarales reach at elevations near 1457 meters (4780 ft).

Vegetation. - The community is characterized by dense, nearly impenetrable thickets co-dominated by the exotic trees, Russian olive (*E. angustifolia*) and saltcedar (*T. chinensis*). Stands are well-shaded and diversity of species is poor. The shrub layer is sparse, represented only by very scattered coyote willow and sapling-sized trees that have escaped from cultivation. These include white mulberry (*Morus alba*) and Southern catalpa (*Catalpa bignonioides*). The herbaceous layer is absent.

Environmental Setting. - Streamflows are perennial and regulated. Though difficult to assess under these conditions, cross sectional hydraulic analyses and Waltmeyer's (1986) equations indicate that flows of 3000 cfs would inundate the community at a mean recurrence interval of two years. Soils are of mixed mineralogies and can be classified as Oxyaquic Ustifluvents with a wetness ranking of 8. They are slightly calcareous and nonsaline. Texture is coarse-loamy over sandy. These are generally well-drained soils with a low available water-holding capacity and water tables may fluctuate enough for distinct mottles to form throughout the profile.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by Rio Grande cottonwood—Russian olive while adjacent uplands have been converted for agricultural purposes.

Discussion. - The community is a disturbance-induced community that has become highly adapted to the current flood regime. It is extremely successful along the Rio Grande floodplain in central New Mexico and commonly replaces the natives after disturbances such as fire, where the native cottonwoods are not successfullyl regenerated. Russian olive and saltcedar are extremely aggressive and prolific exotics that commonly displace the native riparian vegetation especially after disturbances, such as fire. Once established Russian olive and saltcedar are difficult, costly and nearly impossible to eradicate. They are highly adapted to and resistant to control efforts and have consequently become a management concerns for landowners. The roots of Russian olive have the ability to fix nitrogen in nutrient poor soils, such as in floodplain soils. They may also have the ability to tap into the water table. They are common deep within the soil profile.

Documentation. - This community type is based on plot 94PD071. The community type was first documented in New Mexico by Hink and Ohmart (1984) for the middle Rio Grande basin.

IV. NEEDLE-LEAVED DECIDUOUS SERIES GROUP

Needle-leaved deciduous shrublands are represented by the exotic saltcedar Series. These communities are simple assemblages of plant species where diversity of species is extremely low. They are disturbance-induced communities that form extensive and, at times, impenetrable stands along the floodplains of the Rio Grande.

V. Saltcedar (*Tamarix chinensis*) Series

1. Saltcedar/Coyote Willow Community Type
***Tamarix chinensis/Salix exigua;* TAMCHI/SALEXI)**

Distribution. - The Saltcedar/Coyote Willow Community Type occurs in the upper Rio Grande basin in northern New Mexico. It is known from the Orilla Verde reach along the main stem and from Agua Caliente, a smaller tributary basin, at elevations ranging from 1843-1942 meters (6045-6370 ft).

Vegetation. - The vegetation is dominated by the exotic tree, saltcedar (*T. chinensis*) with scattered coyoted willow (*S. exigua*) over a grassy understory. The invasive saltcedar (*T. chinensis*) forms dense thickets so that the community maintains shrub-like qualities. Sapling-sized boxelder (*Acer negundo*) or Rio Grande cottonwood (*Populus deltoides*) are very widely scattered as are mature netleaf hackberry (*Celtis laevigata* var. *reticulata*). The herbaceous understory is grass dominated and weedy. The European exotics, cheatgrass (*Bromus tectorum*) and redtop (*Agrostis gigantea*) are typically more abundant than the natives, such as Canada wildrye (*Elymus canadensis*), little barley (*Hordeum pulillum*) and alkali muhly (*Muhlenbergia asperifolia*). Common native forbs include dogbane (*Apocynum androsaemifolium*), leafybract aster (*Aster foliaceous* var. *apricus*), Canada horseweed (*Conyza canadensis*), sneezeweed (*Helenium autumnale* var. *montanum*), cocklebur (*Xanthium strumarium*), fetid goosefoot (*Chenopodium graveolens*) and field horsetail (*Equisetum arvense*), while exotics are commonly represented by broadleaved pepperweed (*Lepidium latifolium*), sweetclover (*Melilotus officinalis*) and broadleaf plantain (*Plantago major*).

Environmental Setting. - The stream can be characterized as an A3 and B2 stream type of Rosgen (1992). The A3 stream type is very deeply entrenched and well confined with a coarse cobbly-gravel channel of moderate to steep gradients and little sinuosity. Sideslopes are steep and coarse textured. Debris avalanches are prominent. The B2 stream type is moderately confined and moderately entrenched with moderate gradients and sinuosity. The channel has a stable large cobble bed mixed with small boulders and coarse gravel. Associated alluvial terraces are stable and sideslopes are moderately steep. Bankfull width ranges between 30-50 feet. Highest annual flows are expected during spring runoff. Streamflows are perennial. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, flows of 4443 cfs would inundate the community at a mean recurrence interval of 11 years. Soils are of mixed mineralogies and can be classified as Aquic Ustifluvents and Typic Fluvaquents with wetness rankings ranging between 2-5. Textures are generally coarse-loamy, loamy-skeletal, sandy-skeletal or fine-loamy. They are generally well-drained soils with a low available water-holding capacity and water tables may fluctuate enough for aquic conditions to be present for some time during the year.

Adjacent Vegetation. - Adjacent riparian vegetation is sparse, while upland vegetation is dominated by big sagebrush/Indiangrass shrublands and juniper woodlands.

Discussion. - The community dominates mid channel bars and intermediate positioned alluvial terraces bordered by steep canyon walls comprised of boulders and talus fields of basaltic origins. Saltcedar is an extremely aggressive and prolific exotic that has the potential to displace native riparian vegetation. Once established saltcedar is difficult, costly and nearly impossible to eradicate. It is highly adapted to and resistant to control efforts and has consequently become a management concern for landowners. Sites are considered degraded and of poor quality.

Documentation. - This community type is based on plots 92EM017, 92EM022, 92RW030, 92RW032, 92RW038 and 92RW039. The community is not known to be documented in New Mexico or the surrounding Southwestern and Rocky Mountain regions.

2. Saltcedar/Sparse Community Type
***Tamarix chinensis*/Sparse; TAMCHI/SPARSE)**

Distribution. - The Saltcedar/Sparse Community Type is widely distributed across floodplains of the Rio Grande in central New Mexico at lower elevations near 1003 meters (3290 ft). It is also known from middle and lower segments of the Pecos River in DeBaca, Chaves and Eddy Counties. It is particularly extensive from Artesia south to the Texas border.

Vegetation. - The exotic shrub saltcedar *(T. chinensis)* dominates this community, forming closed canopied, dense stands along the banks and across the floodplain. Herbaceous cover is distinctively scarce and low in diversity. White sweetclover *(Melilotus officinalis)*, Russian thistle *(Salsola kali)* and silverleaf nightshade *(Solanum elaeagnifolium)* are common forbs. Alkali sacaton *(Sporobolus airoides)* and tall bristlegrass *(Setaria leucopila)* are the only native graminoids present (<5% cover).

Environmental Setting. - The community occurs on high elevation side bars and terraces that are out of the active floodplain. The river can be classified as a C6 stream type of Rosgen (1992) where the channel is deeply entrenched and slightly confined by the valley with very low stream gradients of approximately 0.1%. No armoring of the channel occurs. Channel materials consist of a sand bed with a mixture of silt. Banks are unstable and downcutting is severe. Channel evulsion is usually absent, and the river channel commonly resembles a canal. Soils are classified as very fine, calcareous Typic Torrifluvents. Conductivity is 1.68 mS. The pH ranges from 7.71 to 7.78.

Adjacent Vegetation. - Adjacent upland vegetation commonly associated with this type include mesquite and plains-mesa grasslands. Adjacent native riparian vegetation is scarce or absent.

Discussion. - This community is most readily evident along the outer floodplain where saltcedar forms dense, nearly impenetrable thickets almost to the exclusion of other species. It is also known to border river and ditch banks. This type occurs prolifically across the floodplains of the main stem from Bernardo and south to Elephant Butte in the middle basin and on bars in the Pilar reach of the upper basin. Saltcedar is an extremely aggressive and prolific weed that has the potential to displace native riparian vegetation. Once established saltcedar is difficult, costly and nearly impossible to eradicate. It is highly adapted to and resistant to control efforts and has consequently become a management concern for landowners.

Documentation. - This description is based on plots 92RW033, 92RW037, 93PD056 and 94PD022. *Tamarix chinensis* plant associations have been classified as disclimax types in New Mexico by Hildebrandt and Ohmart (1982), Szaro (1989), and Dick-Peddie (1993).

II. WARM TEMPERATE RIPARIAN/WETLANDS
III. SOUTHWEST LOWLAND FORESTED WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

Several series dominate this group in New Mexico and include netleaf hackberry, Arizona walnut, Arizona sycamore, as well as Fremont's cottonwood. The distribution of the community types in the group is generally limited to smaller tributary basins in the lower reaches of the Rio Grande basin and can be expected to occur where surface flows are intermittent or ephemeral, and streams are not stabilized by a storage reservoir.

Plant communities are dominated by broad-leaved and deciduous forests or woodlands with major components generally restricted to the southwest montane regions of the United States.

V. Netleaf Hackberry (*Celtis laevigata*) Series

1. Netleaf Hackberry/Skunkbush Sumac Community Type
Celtis laevigata/Rhus trilobata; CELLAER/RHUTRIT)

Distribution. - The Netleaf Hackberry/Skunkbush Sumac Community Type is limited to smaller montane tributary basins in the southernmost segment of the middle Rio Grande basin at elevations near 1630 meters (5360 ft). It occurs along the lower reaches of Las Animas and Seco Creeks. It is also known to occur at Blue Spring, a tributary of the Black River in the Pecos basin of southeastern New Mexico.

Vegetation. - This riparian forest community is dominated by netleaf hackberry (*Celtis laevigata* var. *reticulata*) which forms an expansive stand and dominates the community. Total canopy cover approaches 75%. Typically small trees, this native relative to the exotic Siberian elm (*Ulmus pumila*) is easily recognizable by the prominent reticulate leaf venation, and, its small, crabapple-like, yellowish-red fruits which tend to persist on the trees through the winter months. The underlayer consists only of a sparse shrub layer dominated by skunkbush sumac (*Rhus trilobata* var. *trilobata*), a non-poisonous relative of poison ivy. Total canopy cover is less than 5%. Other shrubs include the ill-smelling California brickellbush (*Brickellia californica*) of the aster family and the spiny, honey mesquite (*Prosopis glandulosa*) of the legume family. Due to the deep shade of the canopy, the forest floor lacks herbaceous development; instead, leaf litter, woody debris and stones dominate the ground surface.

Environmental Setting. - The *Celtis laevigata/Rhus trilobata* Community Type is typically situated on terraces well above the active channel and towards the outer floodplain where it rarely or no longer is flooded by the active channel. It may be adjacent to the channel but where banks are severely downcut and approximately 3 meters (10 ft) high and up to 40 meters (130-150 ft) distant. Soils are deep, dry sandy loams underlain by a cobbly coarse sand layer and the water table is beyond one meter (>3 ft) depth.

Adjacent Vegetation. - The adjacent riparian communities may consist of seepwillow/prairie wedgescale riparian scrub-shrub adjacent to the active channel, Fremont's cottonwood—Goodding's willow forests on side bars or arroyo riparian dominated communities, such as those dominated by burrobush/apacheplume/rubber rabbitbrush. Uplands may consist of steep canyon walls or rolling hills dominated by the suffrutescent shrubs, ocotillo, yucca, and prickly pear or cholla, and grama grasslands on the higher hillslopes.

Discussion. - The community is generally positioned towards the outer floodplain, at the highest position in the floodplain and commonly far from the active or primary channel. It can however occupy downcut terraces directly adjacent to the channel. Mature forests generall have a sparse understory due to the dense canopy and shade. This community appears to be approaching maturity and appears to be stable.

Documentation. - This description is based on plot 94PD007. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

V. Arizona Walnut (*Juglans major*) Series

1. Arizona Walnut/Sideoats Grama Community Type
***Juglans major/Bouteloua curtipendula;* JUGMAJ/BOUCUR)**

Distribution. - The Arizona Walnut/Sideoats Grama Community Type is limited to smaller montane tributary basins in the southernmost segment of the middle Rio Grande basin at elevations between 1520-1830 meters (5000-6500 ft). This type is common on the outermost terraces of Las Animas, Seco and Palomas Creeks. It is also known to occur at Blue Spring, a tributary of the Black River in the Pecos basin of southeastern New Mexico.

Vegetation. - Arizona walnut (*Juglans major*), native to the southwestern United States and northern Mexico, dominates these dry terraces. A few large trees comprise 25% of the total canopy cover and include the junipers, Rocky Mountain juniper (*Juniperus scopulorum*) and alligator juniper (*J. deppeana*), which tend to creep down from the upland hillslopes. The understory is dominated by perennial grasses with a total canopy cover of 40%. Sideoats grama (*Bouteloua curtipendula*) co-dominates the community, contributing nearly 30% of the forest floor cover. Other grasses include two other native species, silver bluestem (*Bothriochloa saccharioides*) and bottlebrush squirreltail (*Elymus elymoides*). One exotic species, bermudagrass (*Cynodon dactylon*), introduced from Africa, is well represented. This sod-forming grass is increasingly common in riparian areas of the Southwest that are somewhat disturbed from grazing. The shrub layer is not well represented and contributes less than 15% of the canopy cover. Boxelder (*Acer negundo*) and narrowleaf cottonwood (*Populus angustifolia*) occur as saplings (< 5 m in height and 2.5 to 5 cm diameter). The forb layer is sparse, with less than 5% cover.

Environmental Setting. - This riparian forest community occurs in open and short-statured forests are ordinarily situated farthest from the active channel on gently to steeply sloping alluvial terraces adjacent to the upland hillslope. They occur on the fringes of the floodplain, adjacent to the upland hillslope, and far removed from the influences of the active channel. They can be situated up to 5 meters (15 ft) above the high water level and 30 meters (60 ft) away from the active channel. Boulders fallen from the upland hillslopes are commonly scattered on the surface. Soils are deep and well developed consisting of coarse textured alluvial deposits comprised primarily of a sandy loam layer overlying a coarser gravelly layer. Depth to the water table may be several meters.

Adjacent Vegetation. - Adjacent riparian communities consist of narrowleaf cottonwood–Arizona alder riparian forests on alternating side bars and seepwillow/prairie wedgescale shrublands situated adjacent to the active channel. Adjacent hillslopes are dominated by juniper–oak woodlands on the toe slopes and grama grasslands higher upslope.

Discussion. - Like netleaf hackberry forests, the community is typically positioned towards the outer floodplain, at the highest positions along the floodplain and generally far from the active or primary channel. However, it may also dominate downcut terraces adjacent to the channel. Unlike netleaf hackberry forests, as Arizona walnut forests mature, their broad canopies result in trees being widely spaced and grasses move in beneath the understory. These are mature forests and appear to be stable.

Documentation. - This description is based on plot 94PD005. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

V. Arizona Sycamore (*Platanus wrightii*) Series

1. Arizona Sycamore–Arizona Alder Community Type
***Platanus wrightii–Alnus oblongifolia*; PLAWRI–ALNOBL)**

Distribution. - The Arizona Sycamore–Arizona Alder Community Type is limited to smaller montane tributary basins in the southernmost segment of the middle Rio Grande basin. It occurs at elevations between approximately 1520 to 1830 meters (5000-6000 ft). It occurs along Las Animas Creek draining the Black Range of southcentral New Mexico.

Vegetation. - Total tree canopy cover averages 25%, yet this forest is extremely dense and composed of numerous saplings (<5 m in height and 2.5 to 5 cm diameter). Sapling-sized trees contribute to >50% of the total canopy cover. Arizona sycamore (*Platanus wrightii*) dominates the community while Arizona alder (*Alnus oblongifolia*) codominates. Both of these species are native to the southwestern United States and northern Mexico. Height of the canopy is approximately 3 to 5 meters (10-15 ft). Goodding's willow, Fremont's cottonwood, and velvet ash may also extend up into the tree canopy. Other trees include juvenile-sized (< 1 m in height and 1 cm diameter) Arizona walnut (*Juglans major*), boxelder (*Acer negundo*) and desert indigobush

(*Amorpha fruticosa*). Shrub species further diversify the community and include seepwillow (*Baccharis salicifolia*), bluestem willow (*Salix irrorata*), California brickellbush (*Brickellia californica*), and the woody vine, canyon grape/Arizona grape (*Vitis arizonica*). The herbaceous understory is not well represented, as the total canopy cover seldom exceeds 10%. Still, the grasses include two native species, muttongrass (*Poa fendleriana*) and little barley (*Hordeum pusillum*), as well as two introduced species, the sod-forming bermudagrass (*Cynodon dactylon*), and rescuegrass (*Bromus catharticus*). Forbs include, the tall cutleaf coneflower (*Rudbeckia laciniata*) and the purple-flowering pineywoods geranium (*Geranium caespitosum* var. *caespitosum*).

Environmental Setting. - This riparian forest community occurs in early successional stands adjacent to the active channel. Channel migration and meander movements result in the community being typically situated within 1 to 1.5 meters (3-4 ft) above the active channel and up to 5 meters (15 ft) distant. Valleys are typically narrow, but not extremely confined. Stream gradients are moderate, ranging between 1 to 1.5%. Channel materials consist of a mixture of cobbles, small- to medium-sized gravels, and sand with alternating riffles and small pools that seldom exceed 20 to 25 centimeters (8-10 in) in depth and 1 to 2 meters (3-6 ft) long or wide. Soils are cobbly, and coarse, alluvial sands and small gravels deposited in one or more strongly contrasting texture layers. They are loose, unconsolidated and dry soils.

Adjacent Vegetation. - The adjacent riparian communities consist of Arizona alder—Goodding's willow forests on alternating bars in narrow bands and Arizona walnut—netleaf hackberry towards the outer floodplains, and creeping up the adjacent hillslopes. Several species of aquatic vegetation grow out into the channel, and include cutleaf waterparsnip of the carrot family, watercress of the mustard family, and American speedwell of the figwort family. Adjacent uplands are dominated by juniper/grama woodlands bordered by a thin fringe of honey mesquite, viscid acacia, skunkbush sumac, and Wright's silktassel.

Discussion. - The community is a young forest probably established within the last five years. It is situated in the lowest position within the floodplain, several feet away and above the active channel. A study by Bock and Bock (1985) coincides with our findings. They found that sexual reproduction of Arizona sycamore usually fails due to drought or flash flooding and seedlings and saplings require moist conditions with permanent water and little flooding. Reproduction is always away from the mature tree canopy and in the stream channel.

Documentation. - This description is based on plot 94PD018. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

2. Arizona Sycamore/Seepwillow Community Type
***Platanus wrightii/Baccharis salicifolia;* PLAWRI/BACSAL)**

Distribution. - The Arizona Sycamore/Seepwillow Community Type is limited to a nonregulated small montane tributary basin of the middle Rio Grande in southcentral New Mexico. It is known to occur at 1433 meters (4700 ft) and only from Las Animas Creek, which drains the east side of the Black Range.

Vegetation. - Arizona sycamore (*P. wrightii*) co-dominates this young community with the shrub seepwillow (*B. salicifolia*). Sycamore regeneration is prominent and overtops the dense shrub layer. Regeneration of other obligate woody species is common and includes velvet ash (*Fraxinus velutina*), Fremont's cottowood (*Populus fremontii*), Arizona alder (*Alnus oblongifolia*) and Arizona walnut (*Juglans major*). The shrub layer is very luxuriant well developed and undisturbed. The density of the shrub layer keeps the underlayer well shaded and sparse. No grasses are present, only the ubiquitous sweetclover (*Melilotus officinalis*) is common, with scattered cover.

Environmental Setting. - The stream can be characterized as a B2 stream type of Rosgen (1992) -- moderate confinement and entrenchment with a stable cobble/coarse gravel and partially exposed bedrock channel of moderate gradient and sinuosity. Bankfull width ranges between 30-50 feet. Streamflows are intermittent and nonregulated. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analysis, a two-year return interval would carry a flow of 449 cfs and be strong enough to inundate the community. Soils are undeveloped riverwash with a wetness ranking of 7. Texture is sandy-skeletal.

Adjacent Vegetation. - Adjacent riparian communities include the Arizona alder—Goodding's willow riparian forests bordering the creek in long, narrow strands and Arizona walnut—netleaf hackberry, as well as juniper—oak woodlands that are located towards the outermost segment of the floodplain and often creep partway up the adjoining hillslope. A thin fringe of honey mesquite shrublands borders the riparian zone on the toe slopes, while grama grasslands dominate the higher slopes and mesa tops.

Discussion. - The community is positioned along the lowest positions within the riparian landscape directly adjacent to the channel where it is frequently flooded. Shading of the creek is commonly provided by the overstory tree canopy. A study by Bock and Bock (1985) coincides with our findings. They found that sexual reproduction of Arizona sycamore usually fails due to drought or flash flooding and seedlings and saplings require moist conditions with permanent water and little flooding. Reproduction is always away from the mature tree canopy and in the stream channel.

Documentation. - This description is based on plot 94PD011. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

3. Arizona Sycamore/Sideoats Grama Community Type
***Platanus wrightii/Bouteloua;* PLAWRI/BOUCUR)**

Distribution. - The distribution of this type is limited to smaller montane tributary basins in the southernmost segment of the middle Rio Grande basin. It is known to occur along the middle reaches of Las Animas Creek that drains east side of the Black Range in southcentral New Mexico at elevations between approximately 1520 to 1830 meters (5000-6000 ft).

Vegetation. - This is a mature forest with trees having broad, sprawling canopies and a grass-dominated understory. Total tree canopy cover is 60%. The flat, alluvial terraces that this Community Type dominates are typically broad with many large and majestic trees. Arizona sycamore (*Platanus wrightii*), with a characteristically thin, brown outer bark layer that flakes off over a white inner bark, has huge, arching branches that are at times nearly parallel the ground surface. It has enormous maple-like leaves and dense globose fruits. It attains diameters exceeding 50 centimeters (20 in) at breast height (approximately 1.5 m above the ground surface) and heights reaching 15 to 18 meters (60 ft). Fremont's cottonwood (*Populus fremontii*), often associated with this community is also an important obligate riparian tree species, and is also capable of reaching similar proportions as the sycamores.

Co-dominating this riparian forest is the native grass, sideoats grama (*Bouteloua curtipendula*). It is abundant and lush contributing to nearly 25% of the herbaceous cover. Total canopy cover of the herbaceous layer is 40%. Overall, the grasses are varied and dominated by mostly perennial native species, including green sprangletop (*Leptochloa dubia*), fringed brome (*Bromus ciliatus*), plains lovegrass (*Eragrostis intermedia*), squirreltail bottlebrush (*Sitanion hystrix*), and the annual species, Grisebach's bristlegrass (*Setaria grisebachii*). Forbs are scarce and contribute only 5% of the total herbaceous cover.

The shrub layer is scarcely more abundant than the herbaceous layer and has a total canopy cover of 10%. Skunkbush sumac (*Rhus trilobata* var. *trilobata*), California brickellbush (*Brickellia californica*), and sapling-sized (< 5 m in height and 2.5 to 5 cm diameter) netleaf hackberry (*Celtis laevigata* var. *reticulata*), oneseed juniper (*Juniperus monosperma*), and Arizona walnut (*Juglans major*) contribute to the total shrub canopy. All are native species to North America.

Environmental Setting. - This riparian forest community occurs primarily in moderately narrow valleys on gently sloping, broad alluvial terraces situated about one- to three meters (3-6 ft) above the high water level and five to 30 meters (25 to 60 ft) away from the active channel. It is found on terraces between the upland hillslopes and lower side bars. Flooding occurs very rarely at intervals estimated between 50 to 100 years. Soils are dry, coarse-textured alluvial deposits comprised primarily of a shallow, sandy loam surface layer overlying a deeper, coarser gravelly, sandy layer.

Adjacent Vegetation. - Adjacent riparian communities include the Arizona alder—Goodding's willow riparian forests bordering the creek in long, narrow strands and Arizona walnut—netleaf hackberry, as well as juniper—oak woodlands that are located towards the outermost segment of the floodplain, and often creep partway up the adjoining hillslope. A thin fringe of honey mesquite shrublands borders the riparian zone on the toe slopes, while grama grasslands dominate the higher slopes and mesa tops.

Discussion. - The community is a mature and stable forest, in pristine condition and provides excellent habitat for the native fauna. Reproduction of the sycamores no longer occurs on terraces which these communities occupy. However, along adjacent secondary or overflow channels, sapling-sized (<5 m in height and 2.5 to 5 cm diameter) trees can often be found. A study by Bock and Bock (1985) coincides with our findings. They found that sexual reproduction of Arizona sycamore usually fails due to drought or flash flooding and seedlings and saplings require moist conditions with permanent water and little flooding. Reproduction is always away from the mature tree canopy and in the stream channel.

Documentation. - This description is based on plot 94PD105. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

4. Arizona Sycamore/Sparse Community Type
***Platanus wrightii*/sparse; PLAWRI/SPARSE)**

Distribution. - The distribution of this type is limited to smaller montane tributary basins in the southernmost segment of the middle Rio Grande basin. It occurs in fragmented stands along the lowest reaches of Las Animas Creek draining the east side of the Black Range in southcentral New Mexico at elevations near 1430 meters (4700 ft). It is also known to occur at Blue Spring, a tributary of the Black River in the Pecos basin.

Vegetation. - This is a closed-canopied forest with a sparse and open understory. Arizona sycamore (*Platanus wrightii*) dominates the stand. Total canopy cover is >60%. The tallest tree measures nearly 75 centimeters (30 in) in diameter. Heights of the canopy reach 15 to 18 meters (60 ft). Canopies are broad and the stand is well-shaded.

The species composition of the understory may be influenced by past disturbances from livestock activity resulting in a sparse herbaceous and shrubby understory and reducing the overall diversity of the stand. The total canopy cover of the shrub layer comprises only 10%. Netleaf hackberry dominates the shrub layer but contibutes a scant

5% cover. Other shrubs present include broom snakeweed (*Gutierrezia sarothrae*), California brickellbush (*Brickellia californica*) and sapling-sized (<5 m in height and 2.5 to 5 cm diameter) boxelder. The herbaceous layer also is sparse with <5% total cover. All species are introduced and include the sod-forming bermudagrass (*Cynodon dactylon*), horehound (*Marrubium vulgare*) of the mint family, and common mullein (*Verbascum thapsus*) of the figwort family.

Environmental Setting. - This riparian forest community occurs on gently sloping terraces of moderately wide valleys. It occurs on the outside of meander bends and is situated well above the high water level (3 to 6m), adjacent to steeply downcut banks, and approximately 20 to 30 meters distant from the active channel. Thus, the community occurs far from the influences of the active channnel and flooding of the community probably no longer occurs or only on very rare occasions. Soils are deep and well developed, recently deposited fine-textured alluvium consisting of three strongly contrasting texture layers within the top meter. A 40 centimeter (16 in) thick sandy layer at the surface is underlain by a finer silt-loam layer 55 cm (22 in) thick. Below this is a coarser gravelly, cobbly, sandy layer. The three layers are evidence of three major flood events in the past and indicates lateral channel migration across the floodplain.

Adjacent Vegetation. - Adjacent riparian communities include a seepwillow—rubber rabbitbrush shrublands on drier cobble bars, and Fremont's cottonwood—Goodding's willow riparian forests on side bars. The outermost floodplain is dominated by Arizona walnut—netleaf hackberry (*Juglans major—Celtis laevigata*) forests and juniper—oak (*Juniperus monosperma/J. deppeana—Quercus grisea*) woodlands. Uplands are dominated by grama (*Bouteloua* spp.) grasslands.

Discussion. - The Arizona Sycamore/Sparse Community Type is a mature forest and appears to be stable. Reproduction of the sycamores no longer occurs on terraces which these communities occupy. However, along adjacent secondary or overflow channels, sapling-sized (<5 m in height and 2.5 to 5 cm diameter) trees can often be found. A study by Bock and Bock (1985) coincides with our findings. They found that sexual reproduction of Arizona sycamore usually fails due to drought or flash flooding and seedlings and saplings require moist conditions with permanent water and little flooding. Reproduction is always away from the mature tree canopy and in the stream channel.

Documentation. - This description is based on plot 94PD010. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

V. Fremont's Cottonwood (*Populus fremontii*) Series

1. Fremont's Cottonwood—Velvet Ash Community Type
***Populus fremontii—Fraxinus velutina*; POPFRE—FRAVEL)**

Distribution. - The Fremont's Cottonwood—Velvet Ash Community Type occurs along smaller montane tributary basins that drain the east side of the Black Range in south central New Mexico at elevations near 1524 meters (5000 ft) elevations along Las Animas Creek.

Vegetation. - Young Fremont's cottonwood (*P. fremontii*) mixed with the hybrid lanceleaf cottonwood (*P.* x *acuminata*) co-dominates this even-aged stand with velvet ash (*F. velutina*). The understory is predominantly shrubby and mixed with a diverse assemblage of obligate, facultative and upland species. Most of the obligates are very young sapling trees less than two meters tall and include Arizona alder (*Alnus oblongifolia*) and Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*). Shrubs are typically represented by California brickellbush (*Brickellia californica*), desert indigobush (*Amorpha fruticosa*), coyote willow (*Salix exigua*), skunkbush sumac (*Rhus trilobata* var. *trilobata*), seepwillow (*Baccharis salicifolia*) and ocotillo (*Fouquieria splendens*). Much of the substrate is as much as 25% rock from upland rockfalls or 30% cobble. The herbaceous understory is not well developed, but is somewhat diverse. Typically present, but with insignificant cover are pineywoods geranium (*Geranium caespitosum* var. *caespitosum*), roving sailor (*Maurandella antirrhiniflora*), skickywilly (*Galium aparine*), monkeyflower (*Mimulus guttatus*) and the exotics, horehound (*Marrubium vulgare*), mullein (*Verbascum thapsus*) and the ubiquitous sweetclover (*Melilotus officinalis*). The graminoid layer is grass dominated and consists of deergrass (*Muhlenbergia rigens*), prairie wedgescale (*Sphenopholis obtusata*), little barley (*Hordeum pusillum*) and the exotic rescuegrass (*Bromus catharticus*).

Environmental Setting. - The stream can be characterized as a B2 stream type of Rosgen (1992) -- moderate confinement and entrenchment with a stable cobble/coarse gravel and partially exposed bedrock channel of moderate gradient and sinuosity. Bankfull width ranges between 30-50 feet. Streamflows are intermittent and nonregulated. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analysis, a two-year return interval would carry a flow of 580 cfs and be strong enough to inundate the community. Soils are classified as Typic Torrifluvents and undeveloped riverwash with wetness rankings ranging between 2-12. Salinity levels are very low (<1 mS) and soils are slightly calcareous with prominent mottling. Textures are predominantly coarse-loamy over fragmental or sandy-skeletal.

Adjacent Vegetation. - Adjacent riparian communities include a seepwillow—rubber rabbitbrush shrublands on drier cobble bars, and Fremont's cottonwood—Goodding's willow riparian forests on side bars. The outermost floodplain is dominated by Arizona walnut—netleaf hackberry forests and juniper—oak woodlands. Uplands are dominated by grama grasslands.

Discussion. - The community occupies the lowest sites within the riparian landscape, directly adjacent to the channel where it is frequently flooded. The dynamics of the community are driven by hydrological processes, such as flooding, as well as geomorphology. The channel cuts through narrow canyons and is somewhat controlled by the exposed bedrock. Depositional floodplains are long, narrow and interrupted by large boulders. Much of the substrate consists of rock from upland rockfalls or is cobbly and gravelly. The development of a dense herbaceous layer is prohibited by the substrate and frequent flooding. Episodic floods created the community. Maintenance and growth of the community is benefited by periodic floods.

Documentation. - This description is based on plots 94PD008 and 94PD009. The community type has not previously been documented in New Mexico or the surrounding Southwest and Rocky Mountain regions.

2. Fremont's Cottonwood—Goodding's Willow Community Type
***Populus fremontii—Salix gooddingii;* POPFRE—SALGOO)**

Distribution. - The Fremont's Cottonwood—Goodding's Willow Community Type occurs in the southernmost reaches of the main stem in the middle Rio Grande basin near San Marcial and along smaller montane tributary basins that drain the east side of the Black Range. Elevation ranges from 987-1622 meters (3240-5320 ft). It is also known from three tributaries (Rio Ruidoso, Rio Hondo, and Black River) of the lower Pecos basin in southeastern New Mexico.

Vegetation. - Fremont's cottonwood *(Populus fremontii)* dominates the overstory while Goodding's willow *(Salix gooddingii)* codominates as a sub-canopy tree. Fremont's cottonwood is typically positioned adjacent to the river banks and often overhangs the banks. Other trees may be present and include boxelder *(Acer negundo),* Arizona walnut *(Juglans major)* and New Mexico locust *(Robinia neomexicana)*, as well as the exotics saltcedar *(Tamarix chinensis)* and Russian olive *(Elaeagnus angustifolia).* Fremont's cottonwood and Goodding's willow may also be present in the shrub layer in advanced stages of regeneration. Common shrubs include coyote willow *(Salix exigua)* and seepwillow *(Baccharis salicifolia)*. The herbaceous understory is distinctively mesic and often graminoid-dominated. Deergrass *(Muhlenbergia rigens)* is typically abundant. Alkali muhly *(Muhlenbergia asperifolia),* Baltic rush *(Juncus balticus)* and the exotic bermudagrass *(Cynodon dactylon)* are often well represented.

Environmental Setting. - The *Populus fremontii—Salix gooddingii* CT occurs on mid-elevation, well-developed side bars. It is associated with Rosgen's Type C3 channel morphology. Channel entrenchment is moderate, while valley confinement is slight, with stream gradients between 0.5 and 1%. Channel materials are commonly sand, coarse gravels and small cobbles. Multiple terraces or low vegetated bars are common features. Hydraulic analysis indicates a flow of approximately 1900 cfs would scour some lower positioned sites at five-year intervals, while 50-350 cfs would likely flood the sites every two to five years. Soils are classified as calcareous Aeric Fluvaquents, Oxyaquic Ustifluvents, and Typic Fluvaquents. Particle classes range from sandy-skeletal to coarse-loamy. Aquic conditions can occur between 100-40 cm of the soil surface. Conductivity ranges from 0.64 to 9.02 mS. The pH ranges from 7.65 to 8.09.

Adjacent Vegetation. - Adjacent riparian communities include a seepwillow—rubber rabbitbrush shrublands on drier cobble bars, and Arizona alder—Goodding's willow riparian forests on side bars. The outermost floodplain is dominated by Arizona walnut—netleaf hackberry forests and juniper—oak woodlands. Uplands are dominated by grama grasslands.

Discussion. - The Fremont's Cottonwood—Goodding's Willow CT appears to be stable. Tree canopies are moderately open and individuals are widely spaced. Deergrass is a large tussock-forming grass. As it occurs it commonly forms dense stands along riparian woodland streambanks, which effectively stabilizes them against erosion. These communities are typically species rich. Other obligate woody riparian species such as velvet ash, Arizona walnut and Arizona alder are commonly present in the understory as sapling-sized or mature trees.

Documentation. - This description is based on plots 93PD053, 93PD054, 93PD05, 93PD062, 93PD066, 94PD006, 94PD012, 94PD015, 94PD074, 94PD080, 94PD099 and 94PD100. The *Populus fremontii—Salix gooddingii* plant association is well documented in California, Arizona, and New Mexico. Holland and Roye (1988) refer to this type as a "Great Valley Cottonwood Riparian Forest Subtheme" occurring in California. In Arizona, it has been documented by Stromberg et al. (1991), Szaro (1989), Reichenbacher (1984), and Laurenzi et al. (1983). In New Mexico, the community was first documented by Hink and Ohmart (1984). It is also described by Dick-Peddie et al. (1987), Szaro (1989) and again by Dick-Peddie (1993).

3. Fremont's Cottonwood/Yerba Mansa Community Type
***Populus fremontii/Anemopsis;* POPFRE/ANECAL)**

Distribution. - The Fremont's Cottonwood/Yerba Mansa Community Type is known to occur in the middle Rio Grande in small, fragmented stands from the confluence of the Jemez River south to Jarales at elevations ranging from 1457-1548 meters (4780 to 5080 ft).

Vegetation. - Fremont's cottonwood (*P. fremontii*) is very abundant and canopies are nearly closed. The cottonwood stand is mature and even-aged. The herbaceous layer is distinctly dominated by the forb yerba mansa (*A. californica*). Graminoids are very scattered to well represented (1-10% cover). Common associates are saltgrass (*Distichlis spicata*) and alkali sacaton (*Sporobolus airoides*). The shrub layer is absent. Bordering the community are shrub forms of the exotics saltcedar (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*).

Environmental Setting. - The community typically occupies former channels situated in the lowest position of the floodplain and within the surrounding cottonwood-dominated forest. The river can be classified as a C4 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of moderate sinuosity, with an unstable sand bed, unarmored and mixed silt/clay. Bankfull width is variable, ranging from 350 to 500 feet in the Jarales reach and 150 to 250 feet in the Santa Ana reach just south of the mouth of the Jemez River. The channel may have mixed side and mid-channel depositional bars. Streamflows are perennial and regulated by Cochiti Dam and irrigation withdrawals. Highest annual flows are during the spring snowmelt, typically peaking in May. However, assessing streamflows under natural/nonregulated conditions is difficult. Flows may peak again during summer thunderstorms, particularly south of the confluences of the nonregulated tributary streams (Rio Puerco and Rio Salado). Soils are Oxyaquic Ustifluvents having a high wetness rank (8), low salinities and are calcareous. Texture is predominantly clayey over coarse-loamy with common and distinct mottling within 10 cm of the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by mature Rio Grande cottonwood—Russian olive and cottonwood—saltcedar forests. Adjacent uplands are dominated either by mesquite and creosote shrublands or have been converted for agricultural purposes.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water table heights. The position of the water table is important in maintaining the community. The combination of episodic floods and a historically high water table created this community. Flooding created environments for the coyote willow and adjacent cottonwoods. Maintenance of the community, particularly yerba mansa, the hydric codominant, requires fluctuations of the groundwater so that the water table is at or near the surface at some point during the growing season. The obligate woody riparian species (i.e., willows and cottonwoods) may still resprout by asexual suckering if roots remain in contact with the water table. Based on historical accounts of the middle Rio Grande floodplain, prior to impoundment (see Introduction), we believe this community to be an important remnant community type that is highly threatened by regulated streamflows and exotic encroachment by saltcedar, Russian olive and Siberian elm.

Documentation. - This description is based on plots 94PD072 and 94PD077. This community type has not previously been documented in New Mexico or the surrounding Southwestern and Rocky Mountain regions.

I. SCRUB-SHRUB WETLANDS CLASS - SHRUBLANDS

II. COLD TEMPERATE RIPARIAN/WETLANDS
III. RIO GRANDE/GREAT PLAINS SCRUB-SHRUB WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

The riparian, deciduous shrublands of the Rio Grande/Great Plains are dominated by the Coyote willow Series. These communities occur from low- to mid- elevations. They are tolerant of flooding and are one of the first pioneering shrubland communities to become established on freshly deposited coarse-textured sandy alluvium. Hence, they are effective streambank stabilizers of these lowland reaches. Ten community types are described below.

V. Coyote Willow (*Salix exigua*) Series

1. Coyote Willow—Rubber Rabbitbrush Community Type
Salix exigua—Chrysothamnus nauseosus; **SALEXI—CHRNAU)**

Distribution. - The Coyote Willow—Rubber Rabbitbrush Community Type is widely distributed throughout the upper and middle Rio Grande basin yet commonly occurs along the smaller tributary reaches at lower elevations near 1524 meters (5000 ft). This description is based on a community sampled on the lower reaches of the Rio Puerco.

Vegetation. - The community is characterized by an open stand co-dominated by coyote willow (*S. exigua*) and rubber rabbitbrush (*C. nauseosus*). The sub-shrub broom snakeweed (*Gutierrezia sarothrae*) may be well represented. The herbaceous layer is dominated by upland grasses primarily belonging to the gramagrass and dropseed groups. Blue grama (*Bouteloua gracilis*) and sand dropseed (*Sporobolus cryptandrus*) are common, along with Kentucky bluegrass (*Poa pratensis*). The forbs are also predominantly upland in character and represented by paintbrushes (*Castilleja linariifolia, C. minor, C. rhexifolia*), flaxflowered gilia (*Ipomopsis longiflora*), goldenasters (*Heterotheca canescens, H. villosa, H. viscida*), beardlip penstemon (*Penstemon barbatus*), sunflowers (*Helianthus annuus*), blanket flowers (*Gaillardia pulchella*) and sneezeweeds (*Helenium autumnale* var. *montanum*).

Environmental Setting. - This community occupies elevated terraces several feet above the active channel and above the current high-water mark. The river can be classified as a C1 stream type of Rosgen (1992) where the channel is moderately confined, moderately entrenched and of low gradients and moderate sinuosity. The channel bed is predominantly cobble with mixtures of small boulders and coarse gravel. Soils are Oxyaquic Ustifluvents with a coarse-loamy texture. They are slightly calcareous and well drained. These are dry soils having a wetness ranking of 8 yet evidence of distinct mottles and reduced conditions occurs within 35 cm of the surface.

Adjacent Vegetation. - Adjacent riparian communities are dominated by narrowleaf cottonwood–Rocky Mountain juniper on higher terraces or narrowleaf cottonwood/Kentucky bluegrass. Adjacent upland vegetation is dominated by pinyon pine–juniper woodlands.

Discussion. - This community appears to be a mid- to late-progressional riparian shrubland. The community commonly occupies cobble and high and dry sand bars mixed with cobble bordering perennial rivers and intermittent streams. The position of the community in the landscape is within the one- to two-year floodplain where 1000 cfs would completely inundate the community. However, given the composition of the vegetation and the soil characteristics, flooding of the community probably occurs every one to five years.

Documentation. - This description is based on plot 94PD070. This type has been documented for the Pecos National Historic Park in the Pecos basin (Muldavin 1991).

2. Coyote Willow/Redtop Community Type
***Salix exigua/Agrostis gigantea;* SALEXI/AGRGIG)**

Distribution. - The Coyote Willow/Redtop Community Type is widely distributed in the upper and middle Rio Grande of New Mexico. It is known from the main stem and along smaller tributary basins at elevations ranging between 1707-2030 meters (5600-6660 ft). It is also known from the Pecos basin.

Vegetation. - Coyote willow (*S. exigua*) characteristically forms dense undisturbed thickets and dominates the shrub canopy. Trees are not present, although there may be some recruitment of sapling-sized Rio Grande cottonwood (*Populus deltoides*), saltcedar (*Tamarix chinensis*), Russian olive (*Elaeagnus angustifolia*) or thinleaf alder (*Alnus incana* ssp. *tenuifolia*). Other shrubs may be present, but the understory is characteristically lush and herbaceous dominated. The grass redtop (*A. gigantea*) co-dominates the community. This ubiquitous European exotic has successfully naturalized along streambanks and is indicative of mesic habitats. Common herb associates include water sedge (*Carex aquatilis*), Canada wildrye (*Elymus canadensis*), prairie wedgescale (*Sphenopholis obtusata*), little barley (*Hordeum pusillum*), smooth horsetail (*Equisetum laevigatum*), cinquefoils (*Potentilla rivalis* var. *rivalis*, *P. pulcherima* and *Argentina anserina*), knotweeds (*Polygonum persicaria* and *P. lapathifolium*), American licorice (*Glycyrrhiza lepidota*), cocklebur (*Xanthium strumarium*) and the ubiquitous exotic sweetclover (*Melilotus officinalis*).

Environmental Setting. - The community occurs along small intermediate-sized mountain tributaries that may be narrowly or moderately confined canyons, as well as along large, broad floodplain rivers. Stream types of Rosgen (1992) are highly variable and can be characterized as a B1, B2, C3 and C4. B1 stream types are moderately entrenched and well confined, of moderate to high gradients and moderate sinuosity. They are bedrock-controlled channels having a predominantly boulder and large cobble-sized bed. B2 stream types are moderately confined and moderately entrenched, of moderate gradient and sinuosity and have a stable cobble/coarse gravel bed. C3 stream types are slightly confined and moderately entrenched with moderate gradients and sinuosity and have a gravel bed with mixtures of small cobble and sand. The C4 stream type is similar to the C3 stream type, although the C4 type consists of a shifting sand bed with a mixture of suspended silt/clay and some small gravel. Bankfull widths vary from 30-250 feet. Soils are classified as Aeric Fluvaquents, Aquic Ustifluvents, Typic Fluvaquents, Oxyaquic Ustifluvents and undeveloped riverwash with wetness rankings ranging from 3-8. Textures are predominantly coarse loamy, sandy-skeletal and fragmental. They are typically nonacidic but may be slightly calcareous and are variously mottled. Streamflows are perennial and the community is frequently flooded and typically found within the one- to two-year floodplain.

Adjacent Vegetation. - Adjacent riparian vegetation may consist of mature Rio Grande cottonwood—Russian olive at lower elevations or narrowleaf cottonwood—thinleaf alder forests at higher elevations. Upland vegetation is variable, depending on elevation. At lower elevations it typically has been converted for agricultural or residential/commericial use, while at higher elevations the upland vegetation may consist of big sagebrush flats and pinyon pine—juniper woodlands on the hillslopes.

Discussion. - Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. These communities typically occupy alluvial side and mid channel bars along both regulated and unregulated reaches. The high water mark is commonly found within the stand and inundation of the community may only be partial along the margins or complete. They depend upon periodic flooding (in many cases annually) for maintenance and development and they provide good sites for cottonwood regeneration, although survival is severely limited by frequent flooding which occurs every other year or on a yearly basis.

Documentation. - This description is based on plots 92EM031, 92EM035, 92RW002, 92RW003, 92RW005, 92RW012, 92RW013, 92RW034, 92RW036, 93PD012, 93PD023, 94PD024, 94PD035 and 94PD104. The community is not known to be documented from New Mexico or the surrounding Southwest and Rocky Mountain regions.

3. Coyote Willow/Water Sedge Community Type
***Salix exigua/Carex aquatilis;* SALEXI/CARAQU)**

Distribution. - The Coyote Willow/Water Sedge Community Type is widely distributed in the mountainous canyons of the upper Rio Grande of northern New Mexico and along broad floodplains of the middle basin in central New Mexico at elevations ranging between 1484-1762 meters (4870-5780 ft).

Vegetation. - Coyote willow (*S. exigua*) characteristically forms dense undisturbed thickets and dominates the shrub canopy. Mature trees are not present, although there may be some recruitment of sapling-sized Rio Grande cottonwood (*Populus deltoides*) or saltcedar (*Tamarix chinensis*). Other shrubs may be present, but the understory is characteristically lush and graminoid dominated.

Environmental Setting. - The community occurs along bars in narrowly confined canyons as well as along large, broad floodplain rivers. Stream types of Rosgen (1992) are variable and can be characterized as C1 and C4. The C1 stream type is moderately confined, moderately entrenched and of low gradient and moderate sinuosity. The channel bed is predominantly cobble with mixtures of small boulders and coarse gravel. The C4 stream type is moderately entrenched, slightly confined of moderate gradient and sinuosity and consists of a shifting sand bed with a mixture of suspended silt/clay and some small gravel. Side bars and mid-channel bars are mixed through the channel. Bankfull width varies from 100-1000 feet. Streamflows are perennial and regulated, but the community is generally positioned within the one- to two-year floodplain. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analysis, a two-year return interval would, on average, require flows of 3873 cfs to inundate the community. Soils are classified as Aeric Fluvaquents and Oxyaquic Ustifluvents with wetness rankings ranging from 3-8, low salinities and slightly calcareous. They have mixed mineralogies and textures may be coarse-loamy or sandy-skeletal.

Adjacent Vegetation. - Adjacent riparian vegetation may consist of mature Rio Grande cottonwood—saltcedar at lower elevations or narrowleaf cottonwood—thinleaf alder forests at higher elevations. Upland vegetation is variable depending on elevation. At lower elevations it typically has been converted for agricultural or residential/commericial use, while at higher elevations the upland vegetation may consist of big sagebrush flats and pinyon pine—juniper woodlands on the hillslopes.

Discussion. - The community occupies alluvial terraces and overflow channels along both regulated and unregulated reaches. It is found below the high water mark, and is thus subject to periodic flooding, in many cases annually. Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. The high-water mark is commonly found within the stand and inundation of the community may only be partial along the margins or complete. They depend upon periodic flooding (in many cases annually) for maintenance and development and they provide good sites for cottonwood regeneration, although survival is severely limited by frequent flooding which occurs every other year or on a yearly basis.

Documentation. - This description is based on plots 94PD040 and 94PD101. No analogous types have been documented for the surrounding Southwest and Rocky Mountain regions.

4. Coyote Willow/Woolly Sedge Community Type
***Salix exigua/Carex lanuginosa;* SALEXI/CARLAN)**

Distribution. - The Coyote Willow/Woolly Sedge Community Type occurs in linear communities along streambanks adjacent to the middle Rio Grande in central New Mexico at elevations near 1457 meters (4780 ft). It is also known to occur on river bars in the Rio Grande gorge in the upper Rio Grande of northern New Mexico.

Vegetation. - Coyote willow (*Salix exigua*) dominates this distinctively shrubby and mesic community. Woolly sedge (*Carex lanuginosa*), a rhizomatous sedge of moist habitats, forms a dense sod beneath the willows in the understory. Exotic sweetclovers (*Melilotus officinalis*) can be common. Other herbs are scarce, although young cottonwood regeneration can be present.

Environmental Setting. - The river can be classified as a C4 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of moderate sinuosity, with an unstable sand bed, unarmored and mixed with silt/clay. Bankfull width ranges from 350 to 500 feet and the channel may have mixed side and mid-channel depositional bars. Streamflows are perennial and regulated by Cochiti Dam and irrigational withdrawals. Highest annual flows are during the spring snowmelt, typically peaking in May. However assessing streamflows under natural/nonregulated conditions is difficult. Flows may peak again during summer storms. Soils are Oxyaquic Ustifluvents having a high wetness rank (8), low salinities and slightly calcareous. Texture is predominantly clayey over sandy and mottles are common and distinct at 70 cm.

Adjacent Vegetation. - Adjacent riparian vegetation includes small and fragmented stands of Rio Grande cottonwood—Goodding's willow, although the dominant community consists of Rio Grande cottonwood—Russian olive. Adjacent upland vegetation is typically converted for agricultural use.

Discussion. - Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. This community occupies narrow alluvial side bars slightly above the high-water mark and is subject to periodic overbank flooding, in many cases annually or every other year. Subsurface flows may maintain this mesic community during times of low flows particularly in the summer months when demands for water are high.

Documentation. - This description is based on plot 94PD073. No analogous types have been documented for the surrounding Southwest and Rocky Mountain regions.

5. Coyote Willow/Saltgrass Community Type
***Salix exigua/Distichlis spicata;* SALEXI/DISSPI)**

Distribution. - The Coyote Willow/Saltgrass Community Type occurs in the middle basin of the Rio Grande in central New Mexico at elevations near 1475 meters (4840 ft). It is known to occur near the Isleta marshes south of Albuquerque.

Vegetation. - Coyote willow (*S. exigua*) characteristically forms dense, undisturbed thickets and dominates the shrub canopy; overall diversity of species is low. Mature trees are not present and recruitment of cottonwood (*Populus deltoides*) is absent. Other shrubs (i.e., seepwillows) may be present, but the understory is characteristically lush and graminoid dominated. Saltgrass (*Distichlis spicata*) is luxuriant and dominates the herbaceous layer. Other herbs include the grass, vine mesquite (*Panicum obtusum*). Forbs are poorly represented. Yerba mansa (*Anemopsis californica*) and dogbane (*Apocynum cannabinum*) are present, but with insignificant cover.

Environmental Setting. - The river can be classified as a C4 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of moderate sinuosity, with an unstable sand bed, unarmored and mixed with silt/clay. Bankfull width ranges from 350 to 500 feet and the channel may have mixed side and mid-channel depositional bars. Streamflows are perennial and regulated by Cochiti Dam and irrigation withdrawals, but the community is generally positioned within the one- to two-year floodplain. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analysis, a two-year return interval would, on average, require flows of 2011 cfs to inundate the community. Soils are classified as Oxyaquic Ustifluvents having a high wetness rank (8), low salinities and slightly calcareous. Texture is sandy over clayey and mottles are common and distinct between 82 and 93 cm.

Adjacent Vegetation. - Adjacent riparian vegetation may consist of mature Rio Grande cottonwood—saltcedar forests. Upland vegetation has typically been converted for agricultural or residential/commericial use or may be bordered by mesquite or creosotebush shrublands.

Discussion. - Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. The community occupies narrow overflow channels and is subject to periodic flooding, in many cases annually or every other year. Subsurface flows may maintain this mesic community during times of low flows, particularly in the summer months when demands for water are high. The hydrologic regime is such that trees will rarely be able to become established and the community is deemed to be stable.

Documentation. - This description is based on plot 94PD052. No analogous types have been documented for the surrounding Southwest and Rocky Mountain regions.

6. Coyote Willow/Common Spikerush Community Type
***Salix exigua/Eleocharis palustris;* SALEXI/ELEPAL)**

Distribution. - The Coyote Willow/Common Spikerush Community Type occurs along mountainous canyon reaches of the main stem in the upper basin of northern New Mexico. It is known from Orilla Verde at elevations near 1853 meters (6080 ft).

Vegetation. - Coyote willow (*S. exigua*) dominates this shrubby community forming a dense thicket. Trees are rare. The composition of species is somewhat diverse in the underlayer and dominated by distinctively mesic species with graminoids dominating the underlayer. Co-dominating the community is common spikerush (*E. palustris*). Canopy cover is very abundant. No other species is significantly dominant. Diversifying the community in the graminoid layer are Bolander's sedge (*Carex bolanderi*), rice cutgrass (*Leersia oryzoides*) and foxtail barley (*Hordeum jubatum*), while the forbs are represented by sneezeweed (*Helenium autumnale*), wild mint (*Mentha arvensis*), cinquefoil (*Argentina anserina*), smooth horsetail (*Equisetum laevigatum*), dogbane (*Apocynum androsaemifolium*), western water hemlock (*Cicuta douglasii*), MacDougal verbena (*Verbena macdougalii*) and the European exotics, white clover (*Trifolium repens*) and curly dock (*Rumex crispus*).

Environmental Setting. - The river can be characterized as a B2 stream type of Rosgen (1992) -- moderate confinement and entrenchment with a stable cobble/coarse gravel and partially exposed bedrock channel of moderate gradient and sinuosity. Bankfull width ranges between 30-50 feet and the channel may have mixed side and mid channel bars. Streamflows are perennial. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analyses, the community is inundated annually with flows of 478 cfs. Soils are classified as Typic Fluvaquents with a wetness ranking of 2. Textures are loamy over loamy-skeletal. Soils are shallow with the water table lying within one-half meter (46 cm) of the surface and reduced conditions at 24 cm.

Adjacent Vegetation. - Adjacent riparian vegetation is sparse and uplands consist of steep rocky, unstable slopes with scattered big sagebrush and various grasses.

Discussion. - Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. This community occupies alluvial terraces and mid channel bars above and below the high-water mark, and is thus subject to periodic flooding, in many cases annually. The hydrologic regime is such that trees will rarely be able to become established and the community is deemed to be stable.

Documentation. - This description is based on plot 92EM023. No analogous types have been documented for the surrounding Southwest and Rocky Mountain regions.

7. Coyote Willow/False Quackgrass Community Type
***Salix exigua/Elymus* X *pseudorepens;* SALEXI/ELYPSE)**

Distribution. - The Coyote Willow/False Quackgrass Community Type occurs along depositional reaches of the upper Rio Grande in northern New Mexico through the Rio Grande gorge at Orilla Verde and from Taos Junction to Pilar. Elevations are mid-range, near 1838-1850 meters (6030-6070 ft).

Vegetation. - Coyote willow (*S. exigua*) dominates this shrubby community forming a dense thicket. Other shrubs present include apacheplume (*Fallugia paradoxa*), rubber rabbitbrush (*Chrysothamnus nauseosus*), as well as shrub-sized netleaf hackberry (*Celtis laevigata*) and boxelder (*Acer negundo*). The herbaceous understory is graminoid-dominated where false quackgrass (*E.* X *pseudorepens*) is significantly dominant and luxuriant. Other grasses include the exotics, redtop (*Agrostis gigantea*) and cheatgrass (*Bromus tectorum*). Total forb cover is well represented and includes horsetails (*Equisetum laevigatum, E. arvense*), sneezeweed (*Helenium autumnale*), dogbane (*Apocynum cannabinum*), as well as the exotic sweetclovers (*Melilotus officinalis*) and mullein (*Verbascum thapsus*). Mature cottonwoods are absent.

Environmental Setting. - The river can be characterized as a B2 stream type of Rosgen (1992) -- moderate confinement and entrenchment with a stable cobble/coarse gravel and partially exposed bedrock channel of moderate gradient and sinuosity. Bankfull width ranges between 30-50 feet and the channel may have mixed side and mid channel bars. Streamflows are perennial. Based on cross sectional hydraulic analysis and Waltmeyer's (1986) equations, the community could become inundated at five-year intervals with flows of 3550 cfs. Soils are classified as Aquic Ustifluvents, having a wetness ranking of 5. They have mixed mineralogies, coarse in texture (primarily sandy, coarse-loamy, and occasionally fine loamy. Moisture and mottling increases at lower depths within the profile.

Adjacent Vegetation. - The vegetation immediately bordering these communities are considered arroyo riparian species and include apacheplume and rubber rabbitbrush, while further up the adjacent hillslopes ponderosa pine forests are common, as are juniper and big sagebrush-dominated shrublands.

Discussion. - The community occurs on river bars in deep canyons (gorges) where there is moderate development of the floodplain and sideslopes are predominantly rocky and steep. Channels cut through bars and terraces leaving long narrow, linear areas that have been scoured down to the coarse, somewhat stable sediments. Flooding of the community is fairly frequent on these terraces. They occupy the highest alluvial landforms in the gorge. Still, they are unable to support trees and the community is deemed to be stable.

Documentation. - This description is based on plot 92EM015. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions. However, this type may closely related to plant associations documented in Colorado (Kittel 1993; Kittel et al. 1994), Montana (Hansen et al. 1990), Utah and Idaho (Padgett et al. 1989).

8. Coyote Willow/Smooth Horsetail Community Type
***Salix exigua/Equisetem laevigatum;* SALEXI/EQULAE)**

Distribution. - The Coyote Willow/Smooth Horsetail Community Type is widely distributed in the upper and middle Rio Grande of New Mexico. It is known from the mountainous canyons of the main stem and along smaller tributary basins at elevations ranging between 1707-2030 meters (5600-6660 ft). It is also known from the Pecos basin.

Vegetation. - Coyote willow (*S. exigua*) dominates this shrubby community, forming a dense thicket. Trees are rare, though sapling-sized Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix chinensis*) may be present. The understory is characteristically herbaceous and fairly diverse. Co-dominating the community is the forb smooth horsetail (*E. laevigatum*). Canopy cover is very abundant with no other significant dominants. Species composition is typically mesic. Grasses are well represented and include Canada wildrye (*Elymus canadensis*), witchgrass (*Panicum capillare*) and the European exotics, tall fescue (*Festuca pratensis*) and creeping bentgrass (*Agrostis stolonifera*). Several rushes are also common and include Torrey's rush (*Juncus torreyi*), Dudley's rush (*J. dudleyi*) and American spikerush (*Scirpus americanus*). Many herbs may be present. Both native and exotic species may be equally abundant. Common natives include the paintbrushes (*Castilleja linarifolia*), American licorice (*Glycyrrhiza lepidota*), annual ragweed (*Ambrosia artemisiifolia*), beautiful cinquefoil (*Potentilla pulcherima*), Canadian horseweed (*Conyza canadensis*) and heath aster (*Aster ericoides*). The exotics species are commonly European introductions and include the clovers (*Trifolium repens, T. pratense, Medicago lupulina,* and *Melilotus officinalis*) and broadleaf plantain (*Plantago major*).

Environmental Setting. - The community occurs along small- to intermediate-sized mountain tributaries that may be narrowly or moderately confined canyons. Stream types of Rosgen (1992) are highly variable and can be characterized as a B2, C1, C3 and C4. B2 stream types are moderately confined and moderately entrenched, of moderate gradient and sinuosity and have a stable cobble/coarse gravel bed. The C1 stream type is moderately confined, moderately entrenched and of low gradient and moderate sinuosity. The channel bed is predominantly cobble with mixtures of small boulders and coarse gravel. C3 stream types are slightly confined and moderately entrenched, of moderate gradient and sinuosity and have a gravel bed with mixtures of small cobble and sand. The C4 stream type is similar to the C3 stream type, although the C4 type consists of a shifting sand bed with a mixture of suspended silt/clay and some small gravel. Bankfull widths vary from 15-250 feet. Soils are classified as Aeric Fluvaquents, Typic Fluvaquents and Oxyaquic Ustifluvents with wetness rankings ranging from 3-8. Textures are predominantly coarse loamy over clayey, coarse loamy over sandy, coarse-loamy over sandy-skeletal, sandy-skeletal or coarse-loamy. They are typically nonacidic but may be slightly calcareous have low salinity levels. Standing water is at or near the surface and mottling and reduced conditions varies throughout the profile. Streamflows are perennial and they may be regulated. The community is frequently flooded and typically found within the one- to two-year floodplain.

Adjacent Vegetation. - Adjacent riparian vegetation may include Rio Grande cottonwood—Russian olive forests along streambanks, cottonwood/Kentucky bluegrass on terraces or low growing American bulrush—common spikerush herbaceous communities along the periphery of the channel. Uplands are typically dominated by pinyon pine—juniper woodlands or are steep and rocky, unstable hillslopes dominated by big sagebrush and various suffrutescent cacti.

Discussion. - Coyote-willow-dominated communities characteristically form dense thickets and are effective stabilizers of bars and streambanks. The community occupies alluvial terraces and mid channel bars above and below the high-water mark, and thus is subject to periodic flooding, in many cases annually. The hydrologic regime is such that trees will rarely be able to become established and the community is deemed to be stable.

Documentation. - This description is based on plots 92RW014, 93PD005, 93PD010, 93PD014, 94PD065, 94PD067 and 94PD090. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

9. Coyote Willow/Baltic Rush Community Type
***Salix exigua/Juncus balticus;* SALEXI/JUNBAL)**

Distribution. - The Coyote Willow/Baltic Rush Community Type occurs in mountain canyons along streambanks of small perennial streams. It is known to occur along the lower reaches of the Rio Truchas originating in and draining the west side of the Sangre de Cristo Mountain of northern New Mexico at elevations near 1743 meters (5720 ft).

Vegetation. - Coyote willow (*S. exigua*) dominates this shrubby riparian community. Total canopy of other shrubs may be well represented (5-10%) and include scattered bluestem willow (*S. irrorata*) and thinleaf alder (*Alnus tenuifolia*). The herbaceous understory is distinctively mesic where Baltic rush (*Juncus balticus*) is the significant dominant. Other herbs include water sedge (*Carex aquatilis*), sheep sorrel (*Rumex acetosella*), willowherb (*Epilobium ciliatum*), wild mint (*Mentha arvensis*), Canadian horseweed (*Conyza canadensis*) and the ubiquitous exotic sweetclover (*Melilotus officinalis*).

Environmental Setting. - The river can be characterized as a C3 stream type of Rosgen (1992) -- slight confinement and moderate entrenchment with a moderate gradient and sinuosity and having a gravel bed with mixtures of small cobble and sand. Highest annual flows are during spring runoff, typically peaking in May. Soils are classified as Typic Fluvaquents having a wetness ranking of 2. Textures are predominantly sandy-skeletal and moisture increases with depth. Roots are common to many throughout the profile.

Adjacent Vegetation. - Adjacent riparian vegetation is commonly narrowleaf cottonwood—thinleaf alder forests at intermediate positions and blue spruce/Kentucky bluegrass on higher and drier sites. Uplands are predominantly mixed coniferous forests.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water-table heights. The position of the water table is important in maintaining the community. The community predominantly occupies cobble and gravel side bars situated below the high-water mark, and is thus subject to frequent periodic flooding, in many cases annually. Under the present hydrological regime, most of the youngest tree seedlings are not able to withstand repeated flooding and are removed by floods. Hence, this community is deemed to be stable in its present condition.

Documentation. - This description is based on plot 92EM020. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

10. Coyote Willow/American Bulrush Community Type
***Salix exigua/Scirpus americanus;* SALEXI/SCIAME)**

Distribution. -The Coyote Willow/American Bulrush Community Type is widely distributed in the upper and middle Rio Grande basin of northern and central New Mexico at elevations ranging from 1079-2030 meters (3540-6660 ft). It is also known from the Pecos basin.

Vegetation. - Coyote willow (*S. exigua*) dominates this shrubby community, forming a dense thicket. Co-dominating the community is the graminoid American bulrush (*Scirpus americanus*). Trees are rare, though very young or sapling-sized peachleaf willow (*S. amygdaloides*), Goodding's willow (*S. gooddingii*), Rio Grande or Fremont's cottonwood (*P. deltoides* or *P. fremontii*) and the exotics, Russian olive (*Elaeagnus* *angustifolia*) and saltcedar (*Tamarix chinensis*) may be present. The understory, however, is characteristically herbaceous, lush and diverse. Graminoids are represented by Torrey's rush (*Juncus torreyi*), bearded flatsedge (*Cyperus squarrosus*), alkali muhly (*Muhlenbergia asperifolia*), rice cutgrass (*Leersia oryzoides*), little barley (*Hordeum pusillum*), prairie wedgescale (*Sphenopholis obtusata*), American sloughgrass (*Beckmannia syzigachne*), as well as several European exotics such as barnyard grass (*Echinochloa crus-galli*), annual rabbitsfoot grass (*Polypogon monspeliensis*), creeping bentgrass (*Agrostis stolonifera*), orchardgrass (*Dactylis glomerata*) and tall fescue (*Festuca pratensis*). Forbs commonly include cocklebur (*Xanthium strumarium*), Canadian horseweed (*Conyza canadensis*), annual ragweed (*Ambrosia artemisiifolia*), sneezeweed (*Helenium autumnale* var. *montanum*), cinquefoil (*Argentina anserina*), American water horehound (*Lycopus americanus*), wild mint (*Mentha arvensis*) and the common European exotics, such as sweetclover (*Melilotus officinalis*) and broadleaf plantain (*Plantago major*).

Environmental Setting. - The community occurs along small- to intermediate-sized mountain tributaries that may be narrowly or moderately confined canyons, as well as along large and broad floodplain rivers. Stream types of Rosgen (1992) are highly variable and can be characterized as a B2 and C4. The B2 stream types are moderately confined and moderately entrenched, of moderate gradient and sinuosity and have a stable cobble/coarse gravel bed. The C4 stream type is moderately entrenched, slightly confined, of low gradient and sinuosity and consists of an unstable, unarmored shifting sand bed with a mixture of suspended silt/clay and some small gravel. The channel may have mixed side and mid-channel depositional bars. Bankfull widths vary from 15-500 feet. Soils are classified as Aeric Fluvaquents, Typic Fluvaquents, Mollic Fluvaquents and Aquic Ustipsamments with wetness rankings ranging from 2-4.5. Textures vary from fine loamy to coarse-loamy over sandy-skeletal to sandy-skeletal. They are typically nonacidic, but may be slightly calcareous have low salinity levels. Soils are shallow and standing water remains at or near the surface. Mottling and reduced conditions is variable throughout the profile. Streamflows are perennial and they may be regulated. The community is frequently flooded and typically found within the one- to two-year floodplain.

Adjacent Vegetation. - Adjacent riparian vegetation may include Rio Grande cottonwood—Russian olive forests along streambanks, cottonwood/Kentucky bluegrass on terraces or low growing American bulrush—common spikerush herbaceous communities along the periphery of the channel. Uplands are typically dominated by pinyon pine—juniper woodlands or are steep and rocky, unstable hillslopes dominated by big sagebrush and various suffrutescent cacti.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water-table heights. The position of the water table is important in maintaining the community. The combination of episodic floods and a historically high water table created this community. Maintenance of the community for the hydric codominants and associates requires fluctuations of the groundwater so that the water table is at or near the surface at some point during the growing season, but also recedes, allowing the soil to dry. The community occupies alluvial terraces, side bars and dissected mid channel bars below the high-water mark, and is thus subject to frequent periodic flooding, in many cases annually. Under the present hydrological regime, most of the youngest cottonwood and willow seedlings, especially along regulated segments, may not be able to withstand repeated flooding. They are typically removed and destroyed by floodwaters. Hence, this community is deemed to be stable in its present condition.

Documentation. - This description is based on plots 92RW001, 92RW011, 93PD024, 93PD036, 94PD045 and 94PD078. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

III. ROCKY MOUNTAIN MONTANE SCRUB-SHRUB WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

Rocky Mountain montane scrub-shrub wetland communities are dominated by bluestem willow communities. They primarily occur on cobbly side bars or on low floodplains adjacent to the channel adjacent to intermediate-sized perennial streams. Common shrubs in this group may occur in other riparian communities and include coyote willow and Wood's rose. Likewise, common forbs and grasses include cutleaf coneflower, field horsetail, Canada wildrye and meadow fescue.

V. Bluestem Willow (*Salix irrorata*) Series

1. Bluestem Willow—Coyote Willow Community Type
***Salix irrorata—Salix exigua;* SALIRR—SALEXI)**

Distribution. - The Bluestem Willow—Coyote Willow Community Type along intermediate-sized tributary basin of the upper Rio Grande basin. It is known from the Rio Truchas and Rio Brazos in northern New Mexico at elevations ranging from 1890-2365 meters (6200-7760 ft).

Vegetation. - The community is distinctively shrubby and co-dominated by bluestem willow (*S. irrorata*) and coyote willow (*S. exigua*). Trees are commonly nearby and may occur as young seedlings. The herbaceous layer is typically sparse and dominated by non-graminoid species, although graminoids are present, but widely scattered. Commonly present are Canadian horseweed (*Conyza canadensis*), cocklebur (*Xanthium strumarium*), spreading fleabane (*Erigeron divergens*), field horsetail (*Equisetum arevense*), James' monkeyflower (*Mimulus glabratus* var. *jamesii*), hairy goldenaster (*Heterotheca villosa* var. *villosa*), as well as the European exotics, sweetclover (*Melilotus officinalis*), white clover (*Trifolium repens*), black medic (*Medicago lupulina*), broadleaf plantain (*Plantago major*) and mullein (*Verbascum thapsus*).

Environmental Setting. - The river can be characterized as a C1 and C3 stream type of Rosgen (1992). The C1 stream type is moderately confined, moderately entrenched and of low gradient and moderate sinuosity. The channel bed is predominantly cobble with mixtures of small boulders and coarse gravel. The C3 stream type is slightly confined and moderately entrenched with a moderate gradient and sinuosity and having a gravel bed with mixtures of small cobble and sand. Bankfull widths are between 50-75 feet. Streamflows are perennial with significant seasonal variation driven primarily by runoff from snowmelt. Highest annual flows typically peak in May. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, the community could become inundated at five-year intervals with flows of 282 cfs. Soils are classified as Typic Fluvaquents, Aeric Fluvaquents and undeveloped riverwash having a wetness rankings of 2-3, nonacidic and with low salinity levels. Textures are predominantly sandy-skeletal and moisture increases with depth.

Adjacent Vegetation. - Adjacent riparian vegetation consists of narrowleaf cottonwood—thinleaf alder forests on slightly higher bars and narrowleaf cottonwood/Kentucky bluegrass on the highest and driest terraces. Uplands may consist of big sagebrush flats and pinyon pine—juniper or ponderosa pine—Rocky Mountain juniper—Gambel's oak forests.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water table heights. Along higher elevation cobbly floodplains, these two species are typically the first to colonize and are well adapted to frequent flooding. The community predominantly occupies cobble and gravel side bars situated below the high water mark, and is thus subject to frequent periodic flooding, in many cases annually, or from two- to five-year intervals. Under the present hydrological regime, most of the youngest tree seedlings are not be able to withstand repeated flooding and are removed by floods. Hence, this community is deemed to be stable in its present condition.

Documentation. - This description is based on plots 92RW022, 92RW025, 92RW028 and 94PD082. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

2. Bluestem Willow/Sparse Community Type
***Salix irrorata*/Sparse; SALIRR/SPARSE)**

Distribution. - The Bluestem Willow/Sparse Community Type occurs in the upper Rio Grande basin of northern New Mexico. It is known to occur along Agua Caliente, a small tributary basin, at elevations near 1981 meters (6500 ft).

Vegetation. - The community is distinctively shrubby and dominated by an open, sparse canopy. Bluestem willow (*S. irrorata*) dominates all layers. The stand is fragmented, broken up by debris avalanches from the upland side slopes. The substrate is as much as 60% rock and 25% gravel. The herbaceous layer is characteristically sparse with no significant dominants. Present are field horsetail (*Equisetum arvense*), wild mint (*Mentha arvensis*), cutleaf coneflower (*Rudbeckia laciniata*), Norwegian cinquefoil (*Potentilla norvegica*), Canadian horseweed (*Conyza canadensis*), as well as the European exotics, sweetclover (*Melilotus officinalis*), white clover (*Trifolium repens*), black medic (*Medicago lupulina*), broadleaf plantain (*Plantago major*) and mullein (*Verbascum thapsus*). Total canopy cover is less than 10%.

Environmental Setting. - The stream can be characterized as an A3 stream type of Rosgen (1992) -- deeply entrenched and very well confined of high gradients and moderate to high sinuosity. The channel consists of small boulders, cobble, and coarse gravel. Sideslopes are steep,dominated by talus rock. Streamflows are perennial with significant seasonal variation driven primarily by runoff from snowmelt. Highest annual flows typically peak in May. Based on cross sectional hydraulic analyses and Waltmeyer's (1986) equations, the community is inundated annually with average flows of 93 cfs. Soils are classified as Typic Fluvaquents having a wetness ranking of 2. They are nonacidic and have low salinity levels. Texture is predominantly sandy-skeletal and moisture increases with depth.

Adjacent Vegetation. - Adjacent riparian vegetation consists of narrowleaf cottonwood—thinleaf alder forests on slightly higher bars and narrowleaf cottonwood/Kentucky bluegrass on the highest and driest terraces. Uplands may consist of big sagebrush flats and pinyon pine—juniper or ponderosa pine—Rocky Mountain juniper—Gambel's oak forests.

Discussion. - Community dynamics are driven by hydrological processes and geomorphology. The community occupies cobble and gravel side bars situated below the high-water mark, and thus is subject to frequent periodic flooding, typically annual scouring. Under the present hydrological regime, the youngest tree seedlings and much of the herbaceous layer is unable to withstand repeated flooding. Consequently, only those species that are extremely well adapted remain. Hence, this community is deemed to be stable in its present condition.

Documentation. - This description is based on plot 92RW009. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

III. SOUTHWEST LOWLAND SCRUB-SHRUB WETLANDS
IV. BROAD-LEAVED DECIDUOUS SERIES GROUP

Two series are classified in this group and include plant communities dominated by seepwillow or coyote willow. These plant communities are dominated by broad-leaved and deciduous shrub with components generally restricted to lower montane regions or low-lying valleys of the southwestern United States. Both communities are tolerant of flooding and are one of the first pioneering shrubland community types to become established in the middle Rio Grande. Hence, they are very effective streambank stabilizers. Coyote willow generally becomes established on freshly deposited coarse-textured sandy alluvium, while seepwillow communities are more common along cobbly tributary basins.

V. Seepwillow (*Baccharis salicifolia*) Series

1. Seepwillow/Prairie Wedgescale Community Type
***Baccharis salicifolia/Sphenopholis obtusata;* BACSAL/SPHOBT)**

Distribution. - The Seepwillow/Prairie Wedgescale Community Type occurs in the middle Rio Grande basin along the lower reaches of Palomas, Seco and Las Animas Creeks that drain the east side of the Black Range at elevations approaching 1520 meters (4980 ft) in southcentral New Mexico.

Vegetation. - This riparian shrubland community is dominated by the tall shrub seepwillow (*Baccharis salicifolia*). The community is mixed in its overall species composition and structure. Total canopy cover of the shrub layer can be widely variable, ranging from 10 to 80%. Canopies are open to closed, and may have a dense or sparse understory. Heights of the canopy range on average between 1 to 1.5 meters tall with occasional sapling-sized (<5 m in height and 2.5 to 5 cm diameter) tree species overtopping the shrub canopy. These include Arizona alder (*Alnus oblongifolia*), Arizona walnut (*Juglans major*), Fremont's cottonwood (*Populus fremontii*). Other shrubs present may include coyote willow (*Salix exigua*) and occasionally bluestem willow (*S. irrorata*).

The herbaceous layer may be sparse to dense, yet species composition is not exceptionally diverse. The native grass, prairie wedgescale (*Sphenopholis obtusata*) co-dominates the community. Important wetland species, such as rushes, are scattered in small clumps within the sub-canopy and tend to concentrate adjacent to the channel where the soils are frequently wetted by overbank flooding. Commonly, these include Rocky Mountain rush (*Juncus saximontanus*), irisleaf rush (*Juncus xiphoides*), common spikerush (*Eleocharis palustris*), and field horsetail (*Equisetum arvense*). However, introduced species are also well represented, and include rabbitsfootgrass (*Polypogon monspeliensis*), bermudagrass (*Cynodon dactylon*), and rescuegrass (*Bromus catharticus*).

The dominant forbs are introduced and dominated by the ubiquitous white- or yellow-flowering sweetclover (*Melilotus officinalis*).

Environmental Setting. - The community occurs in narrow to wide valleys. the stream can be characterized as a C3 stream type of Rosgen (1992) where the channel is slightly confined and moderately entrenched with a moderate gradient and sinuosity. It has a gravel bed with mixtures of small cobble and sand. Bankfull widths are between 50-75 feet. Streamflows are intermittent. It occurs where stream gradients seldom exceed 0.5 to 1.0% and on side bars dominated by cobbly substrates. It is likely situated within the one- to two-year flood zone and may be bordered by many secondary or overflow channels. Soils are derived from coarse-textured alluvium and dominated by sands, small gravels, and medium-sized cobbles.

Adjacent Vegetation. - Adjacent riparian communties include Fremont's cottonwood—Goodding's willow forests on narrow terraces. Arizona walnut—netleaf hackberry or juniper—oak woodlands may be scattered at the base of adjoining hillslopes. In the channel, where streamflows are obstructed by boulders or woody debris, small pools are formed, and herbaceous semi-aquatic vegetation, typically American speedwell, watercress, and seep monkeyflower may be common.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water-table heights. Along low elevation cobbly floodplains, these two species are typically the first to colonize and are well adapted to frequent flooding. The community predominantly occupies cobble and gravel side bars situated below the high-water mark, and is thus subject to frequent periodic flooding, in many cases annually, or from two- to five-year intervals. Under the present hydrological regime, most of the youngest tree seedlings are not be able to withstand repeated flooding and are removed by floods. Helce, this community is deemed to be stable in its present condition.

Documentation. - This description is based on plot 94PD013. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions.

V. Coyote Willow (*Salix exigua*) Series

1. Coyote Willow—Seepwillow Community Type

Salix exigua—Baccharis salicifolia; **SALEXI—BACSAL)**

Distribution. - The Coyote Willow—Seepwillow Community Type occurs on the main stem of the middle Rio Grande in central New Mexico. It is known from the Socorro reach at elevations near 1402 meters (4600 ft).

Vegetation. - Total canopy cover in this shrub-dominated community is very luxuriant. Coyote willow (*Salix exigua*) and seepwillow (*Baccharis salicifolia*) co-dominate, forming a dense thicket. The herbaceous understory is well developed. Forbs tend to dominate the graminoids. Common are western goldentop (*Euthamia occidentalis*), Canada goldenrod (*Solidago canadensis*), annual sunflower (*Helianthus annuus*), western water hemlock (*Cicuta douglasii*), Texas croton (*Croton texensis*), cocklebur (*Xanthium strumarium*) and the ubiquitous exotic sweetclover (*Melilotus officinalis*). Graminoids are scattered and include witchgrass (*Panicum capillare*), the exotic annual rabbitsfoot grass (*Polypogon monspeliensis*), Torrey's rush (*Juncus torreyi*) and chufa flatsedge (*Cyperus esculentus*).

Environmental Setting. - The community typically occupies former channels situated in the lowest position of the floodplain and within the surrounding cottonwood-dominated forest. The river can be classified as a C4 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of moderate sinuosity, with an unstable sand bed, unarmored and mixed with silt/clay. Bankfull width ranges from 350 to 500 feet and the channel may have mixed side and mid-channel depositional bars. Streamflows are perennial and regulated by Cochiti Dam and irrigation withdrawals. Highest annual flows are during the spring snowmelt, typically peaking in May. However, assessing streamflows under natural/nonregulated conditions is difficult. Flows may peak again during summer thunderstorms particularly south of the confluences of the nonregulated tributary streams (Rio Puerco and Rio Salado). Soils are classified as Typic Psammaquents with a wetness rank of 2.5, slightly calcareous and having low salinity levels. Texture is predominantly sandy. They are structureless and have few distinct mottles from 5 cm to 23 cm.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by mature Rio Grande cottonwood–Russian olive and cottonwood–saltcedar forests. Adjacent uplands are dominated either by mesquite and creosote shrublands or have been converted for agricultural purposes.

Discussion. - Community dynamics are driven primarily by flooding processes. This community occurs along a highly regulated segment of river and streamflows under natural/unregulated conditions are difficult to assess. Based on water marks, flood debris and its low to intermediate position within the floodplain, it is likely to lie within the two- to five- year floodplain. Young cottonwood recruitment is fairly low, but some may be capable of attaining maturity if they are able to become established on bare soils within the protection of the shrub thicket. Beaver herbivory within these communities is low and the community is deemed to be capable of supporting continued use by beaver.

Documentation. - This description is based on plot 94PD094. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

2. Coyote Willow/Yerba Mansa Community Type
***Salix exigua/Anemopsis californica;* SALEXI/ANECAL)**

Distribution. - The Coyote Willow/Yerba Mansa Community Type is known to occur in the middle Rio Grande in small, fragmented stands in the Belen reach at an elevation of 1475 meters (4840 ft).

Vegetation. - Canopy cover of coyote willow (*S. exigua*) in this shrub-dominated community is luxuriant, while the forb yerba mansa (*A. californica*) is very abundant. The herbaceous understory is scarce with only scattered grasses and forbs and without significant dominants. Mature Rio Grande cottonwood may overhang the community, providing some shade to the stand. Other herbs are grass dominated. Saltgrass (*Distichlis spicata*) is well represented, while the forbs annual ragweed (*Ambrosia artemisiifolia*) and spreading dogbane (*Apocynum androsaemifolium*) are present within the community and American licorice (*Glycyrrhiza lepidota*) is present near the stand along the periphery.

Environmental Setting. - The community typically occupies former channels situated in the lowest position of the floodplain and within the surrounding cottonwood dominated forest. The river can be classified as a C4 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of moderate sinuosity, with an unstable sand bed, unarmored and mixed with silt/clay. Bankfull width ranges from 350 to 500 feet and the channel may have mixed side and mid-channel depositional bars. Streamflows are perennial and regulated by Cochiti Dam and irrigation withdrawals. Highest annual flows are during the spring snowmelt, typically peaking in May. However assessing streamflows under natural/nonregulated conditions is difficult. Flows may peak again during summer thunderstorms, particularly south of the confluences of the nonregulated tributary streams (Rio Puerco and Rio Salado). Soils are Oxyaquic Ustifluvents having a high wetness rank (8), low salinities and are calcareous. Texture is predominantly clayey over loamy with common and distinct mottling within 60 cm of the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by mature Rio Grande cottonwood—Russian olive and cottonwood—saltcedar forests. Adjacent uplands are dominated either by mesquite and creosote shrublands or have been converted for agricultural purposes.

Discussion. - Community dynamics are driven by hydrological processes such as flooding and fluctuations in water-table heights. The position of the water table is important in maintaining the community. The combination of episodic floods and a historically high water table created this community. Flooding created environments for the coyote willow and adjacent cottonwoods. Maintenance of the community, particularly yerba mansa, the hydric codominant, requires fluctuations of the groundwater so that the water table is at or near the surface at some point during the growing season. The obligate woody riparian species (i.e., willows and cottonwoods) may still resprout by asexual suckering if roots remain in contact with the water table. Based on historical accounts of the middle Rio Grande floodplain, pre-impoundment (see Introduction), we believe this community to be an important remnant community type that is highly threatened by regulation and exotic enroachment by saltcedar and Russian olive.

Documentation. - This description is based on plot 94PD053. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

3. Coyote Willow/Sparse Community Type
***Salix exigua*/Sparse; SALEXI/SPARSE)**

Distribution. - The Coyote Willow/Sparse Community Type occurs along depositional reaches of the upper Rio Grande in northern New Mexico through the Rio Grande gorge at Orilla Verde and from Taos Junction to Pilar. Elevations range from 1841-2060 meters (6040 to 6760 ft).

Vegetation. - Canopy cover of coyote willow (*S. exigua*) ranges from common to very well represented (5-25%). Herbaceous cover is very scarce with only scattered grasses and forbs and without significant dominants. Some common grasses present include Canada wildrye (*Elymus canadensis*), redtop (*Agrostis gigantea*), shortawn foxtail (*Alopecurus aequalis*) and Indian ricegrass (*Oryzopsis hymenoides*), while forbs include cocklebur (*Xanthium strumarium*), smooth horsetail (*Equisetum laevigatum*), sweet clover (*Melilotus officinalis*) and Canadian horseweed (*Conyza canadensis*). Recruitment of obligate riparian tree species is rare.

Environmental Setting. - The river can be characterized as a B2 stream type of Rosgen (1992) -- moderate confinement and entrenchment with a stable cobble/coarse gravel channel of moderate gradient and sinuosity. Highest annual flows are during spring runoff, typically peaking in May between 1000 and 5000 cfs. Channel configurations and flows severely limit the development of soils. As a result of scouring, much of the substrate is very rocky. Substrates are as much as 75% rock (of basaltic origin) with only very shallow, surficial fine sediments overlying coarser textured sandy-skeletal substrates. Soils are classified as Aeric Fluvaquents.

Adjacent Vegetation. - The vegetation immediately bordering these communities are considered arroyo riparian species and include apacheplume and rubber rabbitbrush, while further up the adjacent hillslopes ponderosa pine forests are common, as are juniper and big sagebrush dominated shrublands.

Discussion. - The community occurs on river bars in deep canyons (gorges) where there is moderate development of a floodplain. Channels cut through bars and terraces leaving long narrow, linear areas that have been scoured down to the coarse, somewhat stable sediments. The community is well adapted to frequent scouring and is considered to be mid- to late-progressional under these conditions.

Documentation. - This description is based on plots 92EM021, 92RW006, 92RW019, 92RW021, 92RW027 and 92RW029. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions. However, this type may be closely related to plant associations documented in Colorado (Kittel 1993, Kittel et al. 1994), Montana (Hansen et al. 1990), Utah and Idaho (Padgett et al. 1989).

I. PERSISTENT-EMERGENT WETLANDS CLASS - HERBACEOUS WETLANDS

II. COLD TEMPERATE RIPARIAN/WETLANDS
III. ROCKY MOUNTAIN MONTANE PERSISTENT-EMERGENT WETLANDS
IV. PERSISTENT SERIES GROUP

Baltic rush and American bulrush dominate these wetlands at higher elevations of the upper and middle Rio Grande. Other perennial graminoids and forbs are commonly associated with these wetlands. They are lush sites that are either intermittently saturated, perennially saturated or ponded.

V. Baltic Rush (*Juncus balticus*) Series

1. Baltic Rush—Nebraska Sedge Community Type
***Juncus balticus—Carex nebrascensis;* JUNBAL—CARNEB)**

Distribution. - The Baltic Rush—Nebraska Sedge Community Type occurs in linear-shaped communities along streambanks. It is known from the Rio Embudo of the upper basin at 6480 feet (1975 m) and from Las Animas Creek which drains the east side of the Black Range in south central New Mexico at 1524 meters (5000 ft).

Vegetation. - Baltic rush *(Juncus balticus)* can dominate this herbaceous wetland meadow while Nebraska sedge *(Carex nebrascensis)* typically co-dominates. Baltic rush arises singly from creeping rootstocks, whereas Nebraska sedge spreads rhizomatously and more often forms clumps. Oneseed juniper *(Juniperus monosperma)* and canyon grape *(Vitis arizonica)* represent the shrub and tree layers respectively and are typically found towards the peripheral drier margins of these wetlands. Slender wheatgrass *(Elymus trachycaulus* ssp. *trachycaulus)* and alkali muhly *(Muhlenbergia asperifolia)* are common grasses. The exotic grass redtop *(Agrostis gigantea)* can be abundant. Forbs present often include smooth horsetail *(Equisetum laevigatum)* or field horsetail *(E. arvense),* common horehound *(Marrubium vulgare)* and white sweetclover *(Melilotus* *officinalis)*. Stalky berula *(Berula erecta)* forms spongy mats in and about the main channel.

Environmental Setting. - The river can be characterized as a B2 stream type of Rosgen (1992) -- moderately confined and entrenched with a stable cobble/coarse gravel channel of moderate gradient and sinuosity. Bankfull width ranges from 50-75 feet. Streamflows may be sporadically intermittent or perennial and fed from snowmelt. Based on Waltmeyer's (1986) equations and cross sectional hydraulic analyses flows of 475 cfs would be required to inundate the community at two-year intervals. Soils are Aeric Endoaquents and Oxyaquic Ustifluvents with wetness rankings ranging from 3-8. Textures are coarse-silty over sandy-skeletal and coarse-loamy. The Aeric Endoaquents soils are nonacidic and nonsaline, while the Oxyaquic Ustifluvents are calcareous with low salinity levels (2.32 mS). Mottles are distinct at shallow depths (20-30 cm), soil moisture increases with depth and the water table is within less than one meter from the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by Rio Grande cottonwood—Russian olive forests bordering the creek on the Embudo, while Fremont's cottonwood—Goodding's willow or Arizona sycamore/seepwillow border the community on Las Animas. Upland vegetation on the adjacent hillslopes at Embudo is dominated by big sagebrush and juniper woodlands, while juniper—oak woodlands and ocotillo scrub commonly comprise the upland vegetation along Las Animas Creek.

Discussion. - The community occurs along intermediate-sized streams in mountainous canyons. It occurs in narrow linear strands at the lowest position in the riparian landscape. Consequently, the community lies within the one- to two-year floodplain and is frequently flooded. The community is driven by hydrological processes and periodic flooding for maintenance, growth and reproduction.

Documentation. - This description is based on plots 93PD008 and 94PD029. Our type is analogous to the *Juncus balticus/Carex aurea* PNC described by Muldavin et al. (1993b) in the upper Rio Grande Basin of New Mexico. It is also closely related to the grazing-induced types described in other states. Kittel and Lederer (1993) describe a *Juncus balticus* plant association like ours in the Yampa River Basin of Colorado. Padgett et al. (1989) in Utah and Idaho, and Hansen et al. (1990) in Montana classify similar types. All authors regard *Juncus balticus* plant associations to be grazing-induced disclimaxes where *Juncus balticus* replaces the sedges, *C. praegracilis* or *C. rostrata*.

2. Baltic Rush—Common Spikerush Community Type
***Juncus balticus—Eleocharis palustris;* JUNBAL—ELEPAL)**

Distribution. - The Baltic Rush—Common Spikerush Community Type occurs in widely variable habitats, such as spring-fed wet meadows and along streambanks. It is known to occur along the lower reaches of the Rio Embudo and Rio Truchas in the upper basin of northern New Mexico at elevations ranging 1049-1743 meters (3440-5720 ft).

Vegetation. - The community is dominated by hydric graminoids where Baltic rush (*Juncus balticus*) and common spikerush (*Eleocharis palustris*) co-dominate. Overall the vegetation is very luxuriant and forms thick mats and is characteristically bog-like. Associated herbs are hydric species. Several species of rushes (*J. saximontanus, J. longistylis, J. dudleyi*) and sedges (*Carex aurea, C. nebrascensis, C. filifolia*) are well represented, while grasses are common. These include alkali muhly (*Muhlenbergia asperifolia*), little barley (*Hordeum pusillum*), Kentucky bluegrass (*Poa pratensis*) and muttongrass (*Poa fendleriana*). Forbs are scattered and represented by broadleaf cattails (*Typha latifolia*), horsetails (*Equisetum laevigatum* and *E. arvense*) and Canadian horseweed (*Conyza canadensis*).

Environmental Setting. - The river can be characterized as a C3 stream type of Rosgen (1992) -- slight confinement, moderate entrenchment of low gradient and sinuosity. The channel consists of a gravel bed with mixtures of small cobbles and sand. Soils are classified as Mollic Psammaquents and Typic Endoaquents with a wetness ranking of 2. Bankfull width ranges from 100-150 feet. Texture classes range from sandy to very fine where the fine soils (Typic Endoaquents) have excellent water-holding capacities and exhibit reduced conditions (gleying) at 40 cm. These soils are also slightly calcareous and saline (15.3 mS). The sandy soils have poor water-holding capacities and do not exhibit reduced conditions, yet soils are shallow and saturated within 30 cm of the surface.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by Rio Grande cottonwood—Russian olive bordering the creek as well as Rio Grande cottonwood/Sparse forests. Upland vegetation on the adjacent hillslopes is dominated by big sagebrush and juniper woodlands.

Discussion. - The community is found near the confluence of the main stem and two intermediate-sized mountain tributaries. It may be fed by subsurface contributions from the main channel and the tributary which combine to produce these mesic communities. Although the community is located in the floodplain, it is commonly found in protected locations away from the direct impacts of floods and the associated aggradational or degradational processes of the river. Major upstream diversions would likely have negative impacts on the community and cause these riparian/wetlands to degrade.

Documentation. - This description is based on plots 92EM019 and 94PD038. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

3. Baltic Rush—Smooth Horsetail Community Type
***Juncus balticus/Equisetum laevigatum;* JUNBAL/EQULAE)**

Distribution. - The Baltic Rush/Smooth Horsetail Community Type occurs on the main stem of the middle Rio Grande basin in central New Mexico. It is known to occur in the Albuquerque reach at elevations ranging from 1494-1524 meters (4900-5000 ft).

Vegetation. - The community is dominated by hydric herbs where Baltic rush (*J. balticusi*) and the forb smooth horsetail (*E. laevigatum*) co-dominate. Overall diversity of species is low, yet coverage is luxuriant. Young cottonwood (*Populus deltoides*) reproduction may occur. Common reed (*Phragmites australis*) may be well represented, while other herbs are scarce.

Environmental Setting. - The community occurs on the lowest position within the riparian landscape where it is prone to and well adapted to frequent flooding. The river can be characterized as a C4 stream type of Rosgen (1992) -- slight confinement, moderate entrenchment of low gradients and sinuosity with a shifting sand bed mixed with suspended silts/clay. Bankfull widths range from 500-1000 feet. Streamflows are perennial, but regulated by Cochiti Dam and irrigation withdrawals. The highest flows generally still peak in May during the spring snowmelt. Soils are of mixed mineralogy and classified as Oxyaquic Ustifluvents with a wetness ranking of 8, very low salinity levels (.64mS) and slightly calcareous. Texture is sandy over coarse-loamy with fine, distinct mottling at 68 cm from the surface.

Adjacent Vegetation. - Adjacent riparian vegetation includes coyote willow/sparse in intermediate positions on mid-channel bars and Rio Grande cottonwood—Russian olive bordering the banks and on higher and drier positions in the floodplain. Upland vegetation has typically been converted for agricultural or residential/commercial use.

Discussion. - The community predominantly occurs in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is dominated by graminoids tolerant of high flood frequency and saturated soils. Species diversity is moderate and encroachment by exotics is minimal. Young cottonwood reproduction may occur, yet due to the flood regime they rarely persist through subsequent growing seasons, as they are removed by high flows. The community is considered early progressional and commonly colonizes recently deposited alluvial sites that are frequently or intermittently inundated that are generally non-alkaline and nonsaline.

Documentation. - This description is based on plot 94PD055. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

V. American Bulrush (*Scirpus americanus*) Series

1. American Bulrush—Common Spikerush Community Type
Scirpus americanus—Eleocharis palustris; SCIAME—ELEPAL)

Distribution. - The American Bulrush—Common Spikerush Community Type is widely distributed in the upper and middle Rio Grande of northern and central New Mexico at elevations ranging from 1786-1951 meters (5860 to 6400 ft). It is known from the main stem of the Rio Grande and Tesuque Creek in northern New Mexico, as well as from Palomas Creek in south central New Mexico.

Vegetation - The community is dominated by hydric graminoids where American bulrush (*Scirpus americanus*) and common spikerush (*Eleocharis palustris*) co-dominate, although the bulrushes are usually more abundant. Mature trees and shrubs are rare or absent. Other herbs are diverse, though no other graminoid or forb is significantly dominant. Rushes (*Juncus saximontanus, J. longistylis, J. tenuis, J. effusus*) are well represented as are several grasses. Deergrass (*Muhlenbergia rigens*), considered to be an important streambank stabilizer, can be well represented, along with alkali muhly (*M. asperifolia*), Indiangrass (*Sorghastrum nutans*) and alkali sacaton (*Sporobolus airoides*). Forbs are mesic and commonly represented by the horsetails (*Equisetum laevigatum* and *E. arvense*), roundfruit yellowcress (*Rorippa sphaerocarpa*) and the knotweeds (*Polygonum persicaria* and *P. lapathifolium*). Young cottonwood (*Populus fremontii* or *P. deltoides*) seedling establishment is often present on the wetted perimeter of these communities as can be the exotic trees saltcedar (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*).

Environmental Setting. - The community occurs on the lowest position within the riparian landscape where it is prone to and well adapted to frequent flooding. The river can be characterized as B2 or C1 stream types of Rosgen (1992) -- moderately entrenched, moderately confined and of moderate sinuosity, with a cobble bed mixed with small boulders and coarse gravel. Bankfull width ranges from 100-150 feet. The channel may cut through stable alluvial coarse textured alluvial terraces. Flows may be intermittent or perennial. Soils are classified as Oxyaquic Ustifluvents, Typic Fluvaquents and riverwash with wetness rankings ranging from 1-8, low salinities, nonacidic or slightly calcareous. Textures are sandy-skeletal or loamy-skeletal. Water tables are high. Standing water may be present during the growing or within one meter of the surface.

Adjacent Vegetation. - Adjacent riparian vegetation includes Fremont's cottonwood—Arizona alder or juniper—oak forests, as well as coyote willow/false quackgrass shrublands. Adjacent upland vegetation consists of mesquite and creosotebush shrublands, juniper woodlands, or converted for agricultural use.

Discussion. - The community predominantly occurs in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is dominated by graminoids tolerant of high flood frequency and saturated soils. Young cottonwood reproduction is common, yet due to the flood regime they rarely persist through subsequent growing seasons, as they are removed by high flows. The community is considered early progressional and commonly colonizes recently deposited alluvial sites that are frequently or intermittently inundated that are generally non-alkaline and nonsaline.

Documentation. - This description is based on plots 92EM016, 94PD016 and 94PD107. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

2. American Bulrush/Smooth Horsetail Community Type
***Scirpus americanus/Equisetum laevigatum;* SCIAME/EQULAE)**

Distribution. - The American Bulrush/Smooth Horsetail Community Type is widely distributed throughout the upper and middle Rio Grande at elevations ranging from 1524-1853 meters (5000 to 6080 ft). It is typically a streambank community known from the main stem in northern and central New Mexico, as well as from the Pojoaque River in northern New Mexico.

Vegetation. - The community is dominated by hydric herbs. American bulrush (*Scirpus americanus*) and the forb smooth horsetail (*Equisetum laevigatum*) share dominance in this low-diversity herbaceous wetland. Young cottonwood (*Populus deltoides*) recruitment is common. The associated herbs are predominantly graminoid with no significant dominant, yet total canopy cover is luxuriant. Saltgrass (*Distichlis spicata*) may be very well represented. Other common species include little barley (*Hordeum pusillum*), tall fescue (*Festuca pratensis*), Canada wildrye (*Elymus canadensis*) and toadrushes (*Juncus balticus* and *J. saximontanus*). Forbs are scarce, but may include cocklebur (*Xanthium strumarium*), Canada goldenrod (*Solidago canadensis*) and annual ragweed (*Ambrosia artemisiifolia*).

Environmental Setting. - The community occurs on the lowest position within the riparian landscape where it is prone to and well adapted to frequent flooding. It also occurs along varying stream types where the river can be classified as C2, C3 and C4 stream types of Rosgen (1992). C2 stream types are well confined, moderately entrenched of moderate gradients and low sinuosity with a large cobble bed mixed with small boulders and coarse gravel. C3 and C4 stream types are slightly confined and moderately entrenched with low gradients and sinuosity. C3 stream types differ from C4 types by having a predominantly gravel bed with mixtures of small cobble and sand, while the C4 type has a shifting sand bed mixed with suspended silt/clay and is unarmored. Bankfull widths vary from 150-1000 feet. Streamflows on the Pojoaque River are intermittent, while on the main stem flows are perennial. Flows in the middle basin are highly regulated by Cochiti Dam and irrigation withdrawals. Soils are classified as Mollic

Fluvaquents, Aeric Fluvaquents and Oxyaquic Ustifluvents with wetness rankings ranging between 2 to 8 with low salinities and may be either slightly calcareous or nonacidic. Textures may be sandy-skeletal throughout the profile or coarse-loamy over sandy. Soils are shallow and moisture increases with depth. Water is often within one meter from the surface.

Adjacent Vegetation. - Adjacent riparian vegetation includes coyote willow/redtop shrublands in intermediate positions, typically on mid-channel (island) bars and Rio Grande cottonwood—Russian olive forests bordering the riverbanks or dominating the floodplain forest. Adjacent upland vegetation has typically been converted for agricultural use.

Discussion. - The community predominantly occurs in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is dominated by graminoids tolerant of high flood frequency and saturated soils. Species diversity is low and encroachment by exotics is moderate. Young cottonwood reproduction is common, yet due to the flood regime they rarely persist through subsequent growing seasons, as they are removed by high flows. The community is considered early progressional and commonly colonizes recently deposited alluvial sites that are frequently or intermittently inundated and are generally non-alkaline and nonsaline.

Documentation. - This description is based on plots 92RW004, 93PD034, 94PD044 and 94PD063. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

III. RIO GRANDE/GREAT PLAINS PERSISTENT-EMERGENT WETLANDS

IV. PERSISTENT SERIES GROUP

This group is dominated by three series, water sedge, common spikerush and broadleaf cattail. The plant communities occupy low-elevation sites and are comprised of species that have floristic affinities closely tied to the southwestern region of the United States. They are frequently flooded communities occupying the one- to two-year flood zone and commonly have soils that are saturated for much of the growing season.

V. Water Sedge (*Carex aquatilis*) Series

1. Water Sedge/Smooth Horsetail Community Type
***Carex aquatilis/Equisetum laevigatum;* CARAQU/EQULAE)**

Distribution. - The Water Sedge/Smooth Horsetail Community Type occurs in the upper

Rio Grande of northern New Mexico. It is known from the Rio Grande gorge and the Rio Chama at elevations ranging from 1951-2066 meters (6400-6780 ft).

Vegetation. - The community is dominated by hydric herbs where water sedge (*C. aquatilis*) and smooth horsetail (*E. laevigatum*) co-dominate. Graminoid species are distinctly dominant and include American bulrush (*Scirpus americanus*), hardstem bulrush (*S. acutus*) and several grasses, commonly, tall fescue (*Festuca pratensis*), little barley (*Hordeum pusillum*), Canada wildrye (*Elymus canadensis*) and the exotic redtop (*Agrostis gigantea*). Forbs are present with no other significant dominant. Present are spearmint (*Mentha spicata*), cutleaf coneflower (*Rudbeckia laciniata*), broadleaf plantain (*Plantago major*), cinquefoil (*Potentilla pulcherima*) and several ubiquitous species including Canadian horseweed (*Conyza canadensis*), cocklebur (*Xanthium strumarium*), as well as the exotic sweetclover (*Melilotus officinalis*) and common mullein (*Verbascum thapsus*).

Environmental Setting. - The community occurs on the lowest position within the riparian landscape where it is prone to and well adapted to frequent flooding. The river can be characterized as Rosgen's (1992) C3 stream type on the Rio Chama and a B2 stream type through the gorge. The C3 type is slightly confined, moderately entrenched and of low gradients and sinuosity. The channel consists of a gravel bed with mixtures of small cobbles and sand. The B2 stream type is moderately confined and entrenched of moderate gradient and sinuosity and with a stable large cobble bed mixed with small boulders and coarse gravel channel. Bankfull width ranges from 50-75 feet. Soils are classified as Typic Fluvaquents and Mollic Endoaquents with a wetness ranking of 2, low salinities and slightly calcareous. Textures are coarse-loamy with many distinct mottles at varying depths throughout the soil profile. Streamflows are perennial and regulated by major upstream impoundments on the Rio Chama and irrigation withdrawals in Colorado on the main stem.

Adjacent Vegetation. - Adjacent riparian vegetation consists of coyote willow/false quackgrass at slightly higher positions on mid-channel bars and arroyo riparian species include apacheplume and rubber rabbitbrush, while further up the adjacent hillslopes, the upland vegetation consists of ponderosa pine forests are common, as are juniper woodlands and big sagebrush flats.

Discussion. - The community predominantly occurs in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is dominated by graminoids tolerant of frequent flooding and saturated soils. Species diversity is moderate. Encroachment by exotics is low as human impacts. Young cottonwood reproduction is common, yet due to the flood regime they rarely persist through subsequent growing seasons, as they are removed by high flows. The community is considered early progressional and commonly colonizes recently deposited alluvial sites that are frequently or intermittently inundated that are generally non-alkaline and nonsaline.

Documentation. - This description is based on plots 94PD025 and 94PD089. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

V. Common Spikerush (*Eleocharis palustris*) Series

1. Common Spikerush—Rice Cutgrass Community Type
***Eleocharis palustris—Leersia oryzoides;* ELEPAL—LEEORY)**

Distribution. - The Common Spikerush—Rice Cutgrass Community Type occurs along the main stem of the upper Rio Grande in northern New Mexico. It is known from the Pajarito reach at elevations near 1682 meters (5520 ft).

Vegetation. - The community is dominated by hydric graminoids where common spikerush (*E. palustris*) and rice cutgrass (*L. oryzoides*) co-dominate. Associated herbaceous species are likewise water-loving or mesic species. Diverisity of species is moderate to high. Many grasses and sedges are characteristic and luxuriant. The grasses are represented by redtop (*Agrostis gigantea*), a common exotic, little barley (*Hordeum pusillum*), American sloughgrass (*Beckmannia syzigachne*), prairie wedgescale (*Sphenopholis obtusata*) and annual rabbitsfoot grass (*Polypogon monspeliensis*), another common exotic species. Sedges and rushes are also present and include, water sedge (*Carex aquatilis*), bearded flatsedge (*Cyperus aristatus*), the bulrushes (*Scirpus americanus, S. tabernaemontani*) and the toadrushes (*Juncus saximontanus* and *J. balticus*). Forbs include broadleaf cattail (*Typha latifolia*), horsetail (*Equisetum laevigatum*), willowherb (*Epilobium ciliatum*), arumleaf arrowhead (*Sagittaria cuneata*), silverweed cinquefoil (*Argentina anserina*), alkali buttercup (*Ranunculus cymbalaria*), as well as cocklebur (*Xanthium strumarium*) and the ubiquitous Canadian horseweed (*Conyza canadensis*).

Environmental Setting. - The community occurs along the periphery of mid-channel bars where flooding occurs frequently. The river can be characterized as a C3 stream type of Rosgen (1992) -- slight confinement, moderately entrenched and of low gradient and sinuosity, with a gravel bed and mixed with small cobbles and sand. Bankfull width ranges from 250-350 feet and the channel may have mixed side and mid-channel depositional bars. Streamflows are perennial. Highest annual flows are during the spring snowmelt, typically peaking in May. Soils are classified as Aeric Fluvaquents with a wetness ranking of 3, with very low salinities and are slightly calcareous. Texture is predominantly sandy and shallow. Moisture increases with depth and mottles are common and distinct throughout the profile.

Adjacent Vegetation. - Adjacent riparian vegetation consists of coyote willow/redtop shrublands on mid-channel bars and Rio Grande cottonwood—Russian olive forests along the streambanks and Rio Grande cottonwood/New Mexico olive on higher and drier terraces. Adjacent uplands have typically been converted for agricultural use.

Discussion. - The community predominantly occurs in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is dominated by graminoids tolerant of high flood frequency and saturated soils. Species diversity is moderate and encroachment by exotics is minimal. Young cottonwood reproduction is common, yet due to the flood regime they rarely persist through subsequent growing seasons, as they are removed by high flows. The community is considered early progressional and commonly colonizes recently deposited alluvial sites that are frequently or intermittently inundated and that are generally non-alkaline and nonsaline.

Documentation. - This description is based on plot 94PD058. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

2. Common Spikerush/Smooth Horsetail Community Type
***Eleocharis palustris/Equisetum laevigatum*; ELEPAL/EQULAE)**

Distribution. - The Common Spikerush/Smooth Horsetail Community Type occurs in small mountainous canyon of the upper Rio Grande of northern New Mexico at elevations near 1981 meters (6500 ft). It is known to occur along a smaller tributary of the Rio Embudo, known as Cañada de Ojo Sarco.

Vegetation. - The community is dominated by hydric herbs where common spikerush (*E. palustris*) and smooth horsetail (*E. laevigatum*) are co-dominant. Both are very abundant. Overall diversity of species is low and distinctly graminoid dominated. Common associates that are present include American bulrush (*Scirpus americanus*), poverty rush (*Juncus tenuis*), little barley (*Hordeum pusillum*), tall fescue (*Festuca pratensis*), fringed brome (*Bromus ciliatus*), Sandberg's bluegrass (*Poa secunda*) and the exotic redtop (*Agrostis gigantea*).

Environmental Setting. - The community occurs on a low to intermediate position within the riparian landscape where it is prone to and well adapted to a fluctuating water table. The creek can be classified as a C1 stream type of Rosgen (1992) -- moderately confined, moderately entrenched and of low gradient and moderate sinuosity. Bankfull width ranges from 100-150 feet. Streamflows are perennial and unregulated. Soils are classified as Oxyaquic Torrifluvents with a wetness ranking of 9, nonsaline and slightly calcareous. Texture is sandy with distinct mottling at one meter depth. Standing water occurs at 148 cm.

Adjacent Vegetation. - Adjacent riparian vegetation consists of Rio Grande cottonwood/coyote willow at slightly higher positions in the floodplain. Upland vegetation consists of big sagebrush flats and pinyon pine—juniper woodlands on the hillslopes.

Discussion. - The community occurs predominantly in narrow, linear strands along riverbanks, margins of abandoned channels or dissected bars and along the periphery of mid-channel bars. This herbaceous community is marshy and dominated by graminoids that are tolerant to fluctuating water levels and saturated soils. Although the community is well within the floodplain, it may be spring fed from upland sources or from subsurface flows. Species diversity is low and encroachment by exotics is low.

Documentation. - This description is based on plot 94PD030. No synonymous types have been documented at the community level from New Mexico or from the surrounding Southwest and Rocky Mountain regions.

V. Broadleaf Cattail (*Typha latifolia*) Series

1. Broadleaf Cattail/American Bulrush Community Type
***Typha latifolia/Scirpus americanus;* TYPLAT/SCIAME)**

Distribution. - The Broadleaf Cattail/American Bulrush Community Type is widely distributed in both basins and occurs along the narrow borders of pond margins or completely colonizing overflow or secondary channels and oxbow marshes at low-to-mid elevations near 975-1890 meters (3200-6200 ft).

Vegetation. - This forb dominated community is characterized by the tall broadleaf cattail (*T. latifolia*) that is abundant and capable of rapid colonization and of forming nearly monotypic stands. Co-dominating the community is the graminoid American bulrush (*S. americanus*). Height of the canopy is generally between 1 to 1.5 meters. Common associates are other hydric graminoid species, such as common spikerush (*Eleocharis palustris*), rushes (*Juncus saximontanus, J. torreyi, J. balticus*), sedges (*Carex lanuginosa, C. aquatilis*) and horsetails (*Equisetum laevigatum*). Forbs are obligate riparian as well and best represented by the knotweeds (*Polygonum lapathifolium*) and willowherbs (*Epilobium ciliatum* and *E. brachycarpum*).

Environmental Setting. - This community is associated with intermittently ponded overflow flood channels and oxbow marshes. Standing water is present at the surface for most of the growing season and thus soils are saturated nearly year round. Soils are classified as Mollic Fluvaquents, Aeric Fluvaquents and Aquents. They are dark, mineral soils that are often completely saturated and anaerobic as evidenced by strong mottling and gleying.

Adjacent Vegetation. - Adjacent riparian vegetation is dominated by Rio Grande cottonwood—Russian olive forests, coyote willow/redtop riparian shrublands. Adjacent upland vegetation is dominated by mesquite shrublands and alkali sacaton bottomlands at the lower elevations and pinyon pine—juniper woodlands at higher elevations.

Discussion. - The community is an early progressional community dependent upon and thriving in situations where surface waters fluctuate during the growing season. Cattails (*T. latifolia*) are prolific seed setters and rapid colonizers. They require wet, bare, mineral soils for germination, as well as periodic flooding for growth and maintenance. Because these soils are finer textured they are prone to compaction and can tolerate only limited impacts by livestock. Diversity of other forbs and graminoids is extremely low. Only along the margins of the community can other species tolerate the wet conditions associated with this community.

Documentation. - This description is based on plots 93PD059, 93PD061, 94PD021 and 94PD023. No synonymous types of this kind have been documented for the surrounding Southwest and Rocky Mountain regions. However, this type may be closely related to plant associations documented in Colorado (Kittel 1993, Kittel et al. 1994), Montana (Hansen et al. 1990), Utah and Idaho (Padgett et al. 1989).

2. Broadleaf Cattail/Rice Cutgrass Community Type
***Typha latifolia/Leersia oryzoides;* TYPLAT/LEEORY)**

Distribution. - The Broadleaf Cattail/Rice Cutgrass Community Type occurs along overflow or secondary channels and oxbows of the main stem at mid-elevations near 1707 meters (5600 ft).

Vegetation. - The vegetation is characterized by nearly pure and very luxuriant stands of broadleaf cattail (*T. latifolia*). Height of the canopy is 1 to 1.5 meters. Co-dominating the community is rice cutgrass (*Leersia oryzoides*), a perennial species native to riverbanks of the Southwest.

Environmental Setting. - This community is associated with intermittently ponded overflow flood channels and oxbow marshes. Standing water is present at the surface for most of the growing season and thus soils are saturated nearly year round. Soils are classified as Aeric Fluvaquents. Soil textures are fine-loamy over sandy-skeletal. They are calcareous, dark mineral soils and strongly anaerobic as evidence by the color of the soil and the many coarse and distinct mottles throughout the soil profile.

Adjacent Vegetation. - Cottonwood-dominated-riparian forests border these communities. Commonly occuring are Rio Grande cottonwood—Russian olive forests, while upland vegetation is typically converted to agricultural purposes.

Discussion. - The Broadleaf Cattail/Rice Cutgrass is an early progressional community dependent upon and thriving in situations where surface waters fluctuate during the growing season. Temporal fluctuations in water table height can affect vegetation distribution, reducing or expanding the aerial extent of the community. Generally, these fluctuations probably need to be multi-year continuous events where continual dryness or wetness will have significant impacts on community dynamics. Cattails are prolific seed setters and rapid colonizers. They require wet, bare, mineral soils for germination, as well as periodic flooding for growth and maintenance. Because these soils are finer textured they are prone to compaction and can tolerate only limited impacts by livestock. Diversity of other forbs and graminoids is extremely low. Only along the margins of the community can other species tolerate the wet conditions associated with this community.

Documentation. - This description is based on plot 94PD060. No synonymous types of this kind have been documented at the community level from the surrounding Southwest and Rocky Mountain regions. However, this type may be closely related to plant associations documented in Colorado (Kittel 1993; Kittel et al. 1994), Montana (Hansen et al. 1990), Utah and Idaho (Padgett et al. 1989).

APPENDIX B. RIPARIAN/WETLAND PLANT SPECIES OF THE UPPER AND MIDDLE RIO GRANDE, NEW MEXICO.

Taxonomic nomenclature and synonymy (SY) follows Kartesz (1994) using the Soil Conservation Service database PLANTS - An Alphabetical Listing of the Plants of New Mexico. A double asterisk (**) preceeding scientific names indicates those species that are either introduced into North America, or are native but have escaped from cultivation; while a single asterisk (*) denotes those species that are cosmopolitan, occurring not only in North America, but also in other continents of the world.

SCIENTIFIC NAME	COMMON NAME	FAMILY
TREES		
Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.	white fir	PINACEAE
Acer glabrum var. *glabrum* Torr.	Rocky Mountain maple	ACERACEAE
Acer negundo L.	boxelder	ACERACEAE
** *Ailanthus altissima* (Mill.) Swingle	tree-of-heaven	SIMAROUBACEAE
Alnus incana ssp. *tenuifolia* (Nutt.) Breitung	thinleaf alder	BETULACEAE
SY = *Alnus tenuifolia* Nutt.		
Alnus oblongifolia Torr.	Arizona alder	BETULACEAE
Amelanchier utahensis ssp. *utahensis* Koehne	Utah serviceberry	ROSACEAE
SY = *Amelanchier bakeri* Greene		
Betula occidentalis Hook.	water birch	BETULACEAE
** *Catalpa bignonioides* Walt.	Southern catalpa	BIGNONIACEAE
Celtis laevigata var. *reticulata* (Torr.) L. Benson	netleaf hackberry	ULMACEAE
SY = *Celtis reticulata* Torr.		
** *Elaeagnus angustifolia* L.	Russian olive	ELAEAGNACEAE
Fraxinus velutina Torr.	velvet ash	OLEACEAE
Juglans major (Torr.) Heller	Arizona walnut	JUGLANDACEAE
Juniperus deppeana Steud.	alligator juniper	CUPRESSACEAE
Juniperus monosperma (Engelm.) Sarg.	oneseed juniper	CUPRESSACEAE
Juniperus scopulorum Sarg.	Rocky Mountain juniper	CUPRESSACEAE
** *Morus alba* L.	white mulberry	MORACEAE
Picea pungens Engelm.	blue spruce	PINACEAE
Pinus edulis Engelm.	twoneedle pinyon	PINACEAE
Pinus ponderosa P.& C. Lawson	ponderosa pine	PINACEAE
Platanus wrightii S. Wats.	Arizona sycamore	PLATANACEAE
Populus x *acuminata* Rydb.	lanceleaf cottonwood	SALICACEAE
Populus angustifolia James	narrowleaf cottonwood	SALICACEAE
Populus fremontii S. Wats.	Fremont's cottonwood	SALICACEAE
Populus tremuloides Michx.	quaking aspen	SALICACEAE
Prunus virginiana var. *melanocarpa* (A. Nels.) Sarg.	western chokecherry	ROSACEAE
Ptelea trifoliata ssp. *polyadenia* (Greene) V. Bailey	common hoptree	RUTACEAE
Quercus gambelii Nutt.	Gambel's oak	FAGACEAE
Quercus grisea Liebm.	gray oak	FAGACEAE
** *Robinia pseudoacacia* L.	black locust	FABACEAE
Salix amygdaloides Anderss.	peachleaf willow	SALICACEAE
Salix gooddingii Ball.	Goodding's willow	SALICACEAE
** *Tamarix chinensis* Lour.	saltcedar/fivestamen tamarix	TAMARICACEAE
SY = *Tamarix pentandra* Pallas		
** *Ulmus pumila* L.	Siberian elm	ULMACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
SHRUBS		
Acacia neovernicosa Isely	viscid acacia	FABACEAE
Amorpha fruticosa L.	desert indigobush	FABACEAE
Artemisia filifolia Torr.	sand sagebrush	ASTERACEAE
Artemisia frigida Willd.	fringed sagewort	ASTERACEAE
Artemisia tridentata Nutt.	big sagebrush	ASTERACEAE
Atriplex canescens (Pursh) Nutt.	fourwing saltbush	CHENOPODIACEAE
Baccharis salicifolia (Ruiz & Pavon) Pers.	seepwillow/mule's fat	ASTERACEAE
SY = *Baccharis glutinosa* Pers.		
Baccharis salicina Torr. & Gray	Great Plains falsewillow	ASTERACEAE
Berberis fendleri Gray	Colorado barberry	BERBERIDACEAE
Brickellia californica (Torr. & Gray) Gray	California brickellbush	ASTERACEAE
Cercocarpus montanus Raf.	true mountain mahogany	ROSACEAE
Chrysothamnus nauseosus (Pallus ex Pursh) Britt.	rubber rabbitbrush	ASTERACEAE
Clematis ligusticifolia Nutt.	western white clematis	RANUNCULACEAE
Cornus sericea ssp. *sericea* L.	redosier dogwood	CORNACEAE
SY = *Cornus stolonifera* Michx.		
Crataegus erythropoda Ashe	cerro hawthorn	ROSACEAE
Fallugia paradoxa (D. Don) Endl. ex Torr.	apacheplume	ROSACEAE
Forestiera pubescens var. *pubescens* Nutt.	New Mexico olive	OLEACEAE
SY = *Forestiera neomexicana* Gray		
Fouquieria splendens Engelm.	ocotillo	FOUQUIERIACEAE
Garrya wrightii Torr.	Wright's silktassel	GARRYACEAE
Gutierrezia sarothrae (Pursh) Britt. & Rusby	broom snakeweed	ASTERACEAE
Holodiscus dumosus (Nutt. ex Hook.) Heller	rockspirea	ROSACEAE
Hymenoclea monogyra Torr. & Gray ex Gray	singlewhorl burrobush	ASTERACEAE
Larrea tridentata (Sesse & Moc. ex DC.) Coville	creosotebush	ZYGOPHYLLACEAE
Lonicera involucrata Banks ex Spreng.	twinberry honeysuckle	CAPRIFOLIACEAE
Lycium pallidum Miers	pale wolfberry	SOLANACEAE
Mahonia repens (Lindl.) G. Don	Oregon grape	BERBERIDACEAE
SY = *Berberis repens* Lindl.		
Opuntia imbricata (Haw.) DC.	tree cholla	CACTACEAE
Opuntia macrocentra var. *macrocentra* Engelm.	redjoint pricklypear	CACTACEAE
SY = *Opuntia violacea* Engelm.		
Opuntia phaeacantha Engelm.	tulip pricklypear	CACTACEAE
Parthenocissus quinquefolia var. *quinquefolia* (L.) Planch.	Virginia creeper	VITACEAE
SY = *Parthenocissus inserta* (Kerner) Fritsch		
Paxistima myrsinites (Pursh) Raf.	boxleaf myrtle	CELASTRACEAE
* *Pentaphylloides floribunda* (Pursh) A. Love	shrubby cinquefoil	ROSACEAE
SY = *Potentilla fruticosa* auct. non L.		
Philadelphus occidentalis A. Nels.	western mockorange	HYDRANGEACEAE
Physocarpus monogynus (Torr.) Coult.	mountain ninebark	ROSACEAE
Prosopis glandulosa Torr.	honey mesquite	FABACEAE
Prunus virginiana var. *melanocarpa* (A. Nels.) Sarg.	black chokecherry	ROSACEAE
Psorothamnus scoparius (Gray) Rydb.	broom dalea	FABACEAE
SY = *Dalea scoparia* Gray		
Rhus microphylla Engelm. ex Gray	littleleaf sumac	ANACARDIACEAE
Rhus trilobata var. *trilobata* Nutt.	skunkbush sumac	ANACARDIACEAE
SY = *Rhus aromatica* ssp. *trilobata* (Nutt.) W.A. Weber		
Ribes americanum P. Mill.	American black currant	GROSSULARIACEAE
Ribes cereum Dougl.	wax currant	GROSSULARIACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
Ribes inerme Rydb.	whitestem gooseberry	GROSSULARIACEAE
Ribes leptanthum Gray	trumpet gooseberry	GROSSULARIACEAE
Rosa woodsii Lindl.	Woods' rose	ROSACEAE
Rubus idaeus ssp. *strigosus* (Michx.) Focke	grayleaf red raspberry	ROSACEAE
SY = *Rubus strigosus* Michx.		
Rubus parviflorus Nutt.	thimbleberry	ROSACEAE
Salix bebbiana Sarg.	Bebb willow	SALICACEAE
Salix exigua Nutt.	coyote willow/sandbar willow	SALICACEAE
SY = *Salix interior* Rowlee		
Salix irrorata Anderss.	bluestem/sandbar willow	SALICACEAE
Salix lutea Nutt.	yellow willow	SALICACEAE
Sambucus racemosa ssp. *pubens* var. *melanocarpa* (Gray) McMinn	black elderberry	CAPRIFOLIACEAE
SY = *Sambucus melanocarpa* Gray		
Sarcobatus vermiculatus (Hook.) Torr.	greasewood	CHENOPODIACEAE
Sorbus dumosa Greene	Arizona mountainash	ROSACEAE
Symphoricarpos oreophilus Gray	whortleleaf snowberry	CAPRIFOLIACEAE
Toxicodendron radicans ssp. *radicans* (L.) Kuntze	eastern poison ivy	ANACARDIACEAE
SY = *Rhus radicans* L.		
Vitis arizonica Engelm.	canyon grape/Arizona grape	VITACEAE
Yucca elata (Engelm.) Engelm.	soaptree yucca	AGAVACEAE
GRAMINOIDS		
** *Aegilops cylindrica* Host	jointed goatgrass	POACEAE
Agrostis exarata var. *minor* Hook.	minor spike bentgrass	POACEAE
** *Agrostis gigantea* Roth	redtop	POACEAE
SY = *Agrostis alba* auct. non L.		
** *Agrostis stolonifera* L.	creeping bentgrass	POACEAE
Alopecurus aequalis Sobol.	shortawn foxtail	POACEAE
Aristida purpurea Nutt.	purple threeawn	POACEAE
Beckmannia syzigachne (Steud.) Fern	American sloughgrass	POACEAE
Bothriochloa saccharoides (Sw.) Rydb.	silver bluestem	POACEAE
SY = *Andropogon saccharoides* Sw.		
Bothriochloa laguroides ssp. *torreyana* (Steud.) Allred & Gould		
Bouteloua curtipendula (Michx.) Torr.	sideoats grama	POACEAE
Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama	POACEAE
Bouteloua hirsuta Lag.	hairy grama	POACEAE
** *Bromus catharticus* Vahl.	rescuegrass	POACEAE
Bromus ciliatus L.	fringed brome	POACEAE
** *Bromus commutatus* Schrad.	meadow brome	POACEAE
** *Bromus inermis* Leyss.	smooth brome	POACEAE
** *Bromus japonicus* Thunb. ex Murr.	Japanese brome	POACEAE
** *Bromus tectorum* L.	cheatgrass	POACEAE
Carex aquatilis Wahlenb.	water sedge	CYPERACEAE
Carex aurea Nutt.	golden sedge	CYPERACEAE
Carex bolanderi Olney	Bolander's sedge	CYPERACEAE
SY = *Carex deweyana* var. *bolanderi* (Olney) W. Boott		
Carex emoryi Dewey	Emory's sedge	CYPERACEAE
Carex filifolia Nutt.	threadleaf sedge	CYPERACEAE
Carex foena Willd.	dryspike sedge	CYPERACEAE
Carex lanuginosa Michx.	woolly sedge	CYPERACEAE
Carex lenticularis var. *lipocarpa* (Holm) L.A. Standley	Kellogg sedge	CYPERACEAE
SY = *Carex kelloggii* W. Boott.		

SCIENTIFIC NAME	COMMON NAME	FAMILY
Carex microptera Mackenzie	smallwing sedge	CYPERACEAE
SY = *Carex festivella* Mackenzie		
Carex nebrascensis Dewey	Nebraska sedge	CYPERACEAE
Carex occidentalis Bailey	western sedge	CYPERACEAE
Carex oreocharis Holm	grassyslope sedge	CYPERACEAE
Carex praegracilis W. Boott.	clustered field sedge	CYPERACEAE
Carex rostrata Stokes	beaked sedge	CYPERACEAE
Carex scoparia Schkuhr ex Willd.	broom sedge	CYPERACEAE
Carex stipata Muhl. ex Willd.	owlfruit sedge	CYPERACEAE
Cenchrus carolinianus Walt.	coastal sandbur	POACEAE
SY = *Cenchrus pauciflorus* Benth.		
** *Cynodon dactylon* (L.) Pers.	bermudagrass	POACEAE
Cyperus esculentus L.	chufa flatsedge	CYPERACEAE
Cyperus niger Rui & Pavon	black flatsedge	CYPERACEAE
SY = *Cyperus niger* var. *capitatus* (Britt.) O'Neill		
* *Cyperus squarrosus* L.	bearded flatsedge	CYPERACEAE
SY = *Cyperus aristatus* Rottb.		
** *Dactylis glomerata* L.	orchardgrass	POACEAE
** *Digitaria sanguinalis* (L.) Scop.	hairy crabgrass	POACEAE
Distichlis spicata (L.) Greene	inland saltgrass	POACEAE
SY = *Distichlis stricta* (Torr.) Rydb.		
Distichlis strica var. *spicata* (Torr.) Beetle		
** *Echinochloa crus-galli* (L.) Beauv.	barnyardgrass	POACEAE
Echinochloa muricata (Beauv.) Fern.	rough barnyardgrass	POACEAE
Eleocharis palustris (L.) Roemer & J.A. Schultes	common spikerush	CYPERACEAE
SY = *Eleocharis macrostachya* Britt.		
Elymus canadensis L.	Canada wildrye	POACEAE
Elymus lanceolatus ssp. *lanceolatus* (Scribn. & J.G. Sm.) Gould	thickspike wheatgrass	POACEAE
SY = *Agropyron dasystachyum* (Hook.) Scribn. & J.G. Sm.		
Elymus longifolius (Smith) Gould	longleaf squirreltail	POACEAE
SY = *Sitanion hystrix* (Nutt.) L.G. Sm.		
Elymus x *pseudorepens* (Scribn. & J.G. Sm.) Barkworth & Dewey	false quackgrass	POACEAE
SY = *Agropyron pseudorepens* Scribn. & J.G. Sm.		
Elymus trachycaulus ssp. *trachycaulus* (Link) Gould ex Shinners	slender wheatgrass	POACEAE
SY = *Agropyron trachycaulum* (Link) Malte ex H.F. Lewis		
** *Elytrigia intermedia* (Host) Nevski	intermediate wheatgrass	POACEAE
SY = *Agropyron intermedium* (Host) Beauv.		
Elymus hispidus (Opiz) Melderis		
Elytrigia repens var. *repens* (L.) Desv. ex B.D. Jackson	quackgrass	POACEAE
SY = *Agropyron repens* (L.) Beauv.		
Elymus repens (L.) Gould		
** *Eragrostis cilianensis* (All.) Lut. ex Janchen	stinkgrass	POACEAE
Eragrostis hypnoides (Lam.) B.S.P.	teal lovegrass	POACEAE
Eragrostis intermedia A.S. Hitchc.	plains lovegrass	POACEAE
Erioneuron pulchellum (Kunth) Tateoka	low woollygrass	POACEAE
SY = *Dasyochloa pulchella* (H.B.K). Steudl.		
Tridens pulchellus (H.B.K.) A.S. Hitchc.		
Festuca arizonica Vasey	Arizona fescue	POACEAE
** *Festuca pratensis* Huds.	meadow fescue	POACEAE
Glyceria striata (Lam.) A.S. Hitchc.	fowl mannagrass	POACEAE
Hordeum jubatum L.	foxtail barley	POACEAE
Hordeum pusillum Nutt.	little barley	POACEAE
Juncus balticus Willd.	Baltic rush	JUNCACEAE
Juncus bufonius L.	toad rush	JUNCACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
Juncus dudleyi Wieg.	Dudley's rush	JUNCACEAE
SY = *Juncus tenuis* var. *dudleyi* (Wieg.) F.J. Herm.		
Juncus effusus var. *solutus* Fern. & Wieg.	lamp/soft rush	JUNCACEAE
* *Juncus filiformis* L.	threadrush	JUNCACEAE
Juncus interior Wieg.	inland rush	JUNCACEAE
Juncus longistylis Torr.	longstyle rush	JUNCACEAE
Juncus saximontanus A. Nels.	Rocky Mountain rush	JUNCACEAE
Juncus tenuis Willd.	poverty rush	JUNCACEAE
Juncus torreyi Coville	Torrey's rush	JUNCACEAE
Juncus xiphoides E. Mey.	irisleaf rush	JUNCACEAE
Koeleria macrantha (Ledeb.) J.A. Schultes	prairie Junegrass	POACEAE
SY = *Koeleria cristata* auct. p.p. non Pers.		
Leersia oryzoides (L.) Sw.	rice cutgrass	POACEAE
Leptochloa dubia (Kunth) Nees	green sprangletop	POACEAE
Lycurus phleoides Kunth	common wolfstail	POACEAE
* *Luzula parviflora* (Ehrh.) Desv.	smallflowered woodrush	JUNCACEAE
Muhlenbergia arenacea (Buckl.) A.S. Hitchc.	ear muhly	POACEAE
Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	alkali muhly	POACEAE
Muhlenbergia brevis C.O. Goodding	short muhly	POACEAE
Muhlenbergia minutissima (Steud.) Swallen	annual muhly	POACEAE
Muhlenbergia racemosa (Michx.) B.S.P.	marsh muhly	POACEAE
Muhlenbergia rigens (Benth.) A.S. Hitchc.	deergrass	POACEAE
Muhlenbergia wrightii Vasey ex Coult.	spike muhly	POACEAE
Oryzopsis hymenoides (Roemer & J.A. Schultes) Ricker ex Piper	Indian ricegrass	POACEAE
Oryzopsis micrantha (Trin. & Rupr.) Thurb.	littleseed ricegrass	POACEAE
Panicum capillare L.	witchgrass	POACEAE
Panicum obtusum Kunth	obtuse panicgrass	POACEAE
Panicum virgatum L.	switchgrass	POACEAE
Pascopyrum smithii (Rydb.) A. Love	western wheatgrass	POACEAE
SY = *Agropyron smithii* Rydb.		
Elymus smithii (Rydb.) Gould		
Paspalum distichum L.	knotgrass	POACEAE
Phalaris arundinacea L.	reed canarygrass	POACEAE
** *Phleum pratense* L.	timothy	POACEAE
Phragmites australis (Cav.) Trin. ex Steud.	common reed	POACEAE
* *Poa compressa* L.	Canada bluegrass	POACEAE
Poa fendleriana (Steud.) Vasey	muttongrass	POACEAE
Poa leptocoma Trin.	bog bluegrass	POACEAE
** *Poa pratensis* L.	Kentucky bluegrass	POACEAE
Poa secunda J. Presl	Sandberg's bluegrass	POACEAE
** *Polypogon monspeliensis* (L.) Desf.	annual rabbitsfoot grass	POACEAE
** *Polypogon viridis* (Gouan) Breistr.	beardless rabbitsfoot grass	POACEAE
SY = *Agrostis semiverticillata* (Forsk.) C. Christens.		
Pseudoroegneria spicata ssp. *spicata* (Pursh) A. Love	bluebunch wheatgrass	POACEAE
SY = *Agropyron spicatum* Pursh		
Elymus spicatus (Pursh) Gould		
Elytrigia spicata Dewey		
Schizachyrium scoparium (Michx.) Nash	little bluestem	POACEAE
Scirpus acutus Muhl. ex Bigelow	hardstem bulrush	CYPERACEAE
* *Scirpus americanus* Pers.	American bulrush	CYPERACEAE
SY = *Scirpus olneyi* Gray		
* *Scirpus maritimus* L.	saltmarsh bulrush	CYPERACEAE
SY = *Scirpus paludosus* A. Nels.		
Scirpus microcarpus J. & K. Presl	panicled bulrush	CYPERACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
Scirpus tabernaemontani K.C. Gmel.	softstem bulrush	CYPERACEAE
SY = *Scirpus validus* Vahl.		
Scleropogon brevifolius Phil.	burrograss	POACEAE
Setaria grisebachii Fourn.	Grisebach's bristlegrass	POACEAE
Setaria leucopila (Scribn. & Merr.) K. Schum.	streambed bristlegrass	POACEAE
Sorghastrum nutans (L.) Nash	yellow indiangrass	POACEAE
** *Sorghum halapense* (L.) Pers.	Johnsongrass	POACEAE
Sphenopholis obtusata (Michx.) Scribn.	prairie wedgescale	POACEAE
Sporobolus airoides (Torr.) Torr.	alkali sacaton	POACEAE
Sporobolus contractus A.S. Hitchc.	spike dropseed	POACEAE
Sporobolus cryptandrus (Torr.) Gray	sand dropseed	POACEAE
Sporobolus flexuosus (Thurb. ex Vasey) Rydb.	mesa dropseed	POACEAE
Sporobolus giganteus Nash	giant dropseed	POACEAE
Sporobolus wrightii Munro ex Scribn.	giant sacaton	POACEAE
Stipa comata Trin. & Rupr.	needle and thread	POACEAE
Stipa lettermanii Vasey	Letterman's needlegrass	POACEAE
Stipa robusta (Vasey) Scribn.	sleepygrass	POACEAE
FORBS		
Achillea millefolium L.	common yarrow	ASTERACEAE
Aconitum columbianum var. *columbianum* Nutt.	Columbian monkshood	RANUNCULACEAE
Actaea rubra ssp. *arguta* (Nutt.) Hulten	red baneberry	RANUNCULACEAE
SY = *Actaea rubra* (Ait.) Willd.		
Ageratina herbacea (Gray) King & H.E. Robins.	fragrant snakeroot	ASTERACEAE
SY = *Eupatorium herbaceum* (Gray) Greene		
Agrimonia striata Michx.	roadside agrimony	ROSACEAE
Allionia incarnata L.	trailing windmills	NYCTAGINACEAE
Allium cernuum Roth	nodding onion	ASTERACEAE
Ambrosia artemisiifolia L.	annual ragweed	ASTERACEAE
Ambrosia psilostachya DC.	Cuman ragweed	ASTERACEAE
Anaphalis margaritacea (L.) Benth. & Hook. f. ex Gray	western pearlyeverlasting	ASTERACEAE
Anemone canadensis L.	Canadian anemone	RANUNCULACEAE
Anemopsis californica (Nutt.) Hook. & Arn.	yerba mansa	SAURURACEAE
Antennaria parvifolia Nutt.	smallleaf pussytoes	ASTERACEAE
Antennaria umbrinella Rydb.	umber pussytoes	ASTERACEAE
Aphanostephus ramosissimus var. *humilis* (Benth.) B.L. Turner & Birdsong	plains dozedaisy	ASTERACEAE
SY = *Aphanostephus arizonicus* Gray		
Apocynum androsaemifolium L.	spreading dogbane	APOCYNACEAE
Apocynum cannabinum L.	Indianhemp	APOCYNACEAE
Aquilegia coerulea James	Colorado blue columbine	RANUNCULACEAE
Arabis drummondii Gray	Drummond's rockcress	BRASSICACEAE
** *Arctium minus* Bernh.	lesser burdock	ASTERACEAE
Argemone hispida Gray	rough pricklypoppy	PAPAVERACEAE
Argentina anserina (L.) Rydb.	silverweed cinquefoil	ROSACEAE
SY = *Potentilla anserina* L.		
Artemisia campestris ssp. *pacifica* (Nutt.) Hall & Clements	Pacific wormwood	ASTERACEAE
SY = *Artemisia pacifica* Nutt.		
Artemisia carruthii Wood ex Carruth.	Carruth's sagewort	ASTERACEAE
Artemisia dracunculus L.	wormwood	ASTERACEAE
Artemisia ludoviciana Nutt.	Louisiana sagewort	ASTERACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
Artemisia ludoviciana ssp. *mexicana* (Willd. ex Spreng.) Keck SY = *Artemisia neomexicana* Greene ex Rydb.	Mexican white sagebrush	ASTERACEAE
Artemisia ludoviciana ssp. *redolens* (Gray) Keck	white sagebrush	ASTERACEAE
Asclepias incarnata L.	swamp milkweed	ASCLEPIADACEAE
Asclepias subverticillata (Gray) Vail	whorled milkweed	ASCLEPIADACEAE
** *Asparagus officinalis* L.	garden asparagus	LILIACEAE
Aster eatonii (Gray) T.J. Howell SY = *Aster oregonus* auct. non (Nutt.) Torr. & Gray	Eaton's aster	ASTERACEAE
Aster ericoides L.	heath aster	ASTERACEAE
Aster foliaceus var. *apricus* Gray	leafybract aster	ASTERACEAE
Aster lanceolatus ssp. *hesperius* (Gray) Semple & Chmielewski SY = *Aster hesperius* Gray	Siskiyou aster	ASTERACEAE
Aster praealtus Poir.	willowleaf aster	ASTERACEAE
Bahia biternata Gray	slimlobe bahia	ASTERACEAE
Bahia dissecta (Gray) Britt.	ragleaf bahia	ASTERACEAE
Baileya multiradiata Harvey & Gray ex Gray	desert marigold	ASTERACEAE
* *Berula erecta* (Huds.) Coville	cutleaf waterparsnip	APIACEAE
* *Bidens bipinnata* L.	spanish-needles	ASTERACEAE
* *Bidens cernua* L.	nodding beggartick	ASTERACEAE
Bidens frondosa L.	devil's beggartick	ASTERACEAE
Boehmeria cylindrica (L.) Sw. SY = *Boehmeria scabra* (Porter) Small	smallspike false nettle	URTICACEAE
** *Brassica nigra* (L.) W.D.J. Koch	black mustard	BRASSICACEAE
Brickellia grandiflora (Hook.) Nutt.	tasselflower brickellbush	ASTERACEAE
Brickellia rusbyi Gray	stinking brickellbush	ASTERACEAE
* *Campanula rotundifolia* L.	bluebell bellflower	CAMPANULACEAE
** *Cannabis sativa* L.	marijuana	CANNABINACEAE
Cardamine cordifolia Gray	heartleaf bittercress	BRASSICACEAE
Castilleja linariifolia Benth.	Wyoming Indian paintbrush	SCROPHULARIACEAE
Castilleja minor (Gray) Gray	lesser Indian paintbrush	SCROPHULARIACEAE
Castilleja rhexifolia Rydb.	splitleaf Indian paintbrush	SCROPHULARIACEAE
Cerastium nutans var. *nutans* Raf.	nodding chickweed	CARYOPHYLLACEAE
Chamaesyce maculata (L.) Small SY = *Euphorbia supina* Raf.	spotted sandmat	EUPHORBIACEAE
Chamaesyce serpens (Kunth) Small SY = *Euphorbia serpens* Kunth	matted sandmat	EUPHORBIACEAE
Chamaesyce serpyllifolia ssp. *serpyllifolia* (Pers.) Small SY = *Euphorbia serpyllifolia* Pers.	thymeleaf sandmat	EUPHORBIACEAE
Chenopodium album L.	lambsquarters	CHENOPODIACEAE
Chenopodium berlandieri Moq.	pitseed goosefoot	CHENOPODIACEAE
Chenopodium fremontii S. Wats.	Fremont's goosefoot	CHENOPODIACEAE
Chenopodium graveolens Willd.	fetid goosefoot	CHENOPODIACEAE
** *Chenopodium rubrum* L.	red goosefoot	CHENOPODIACEAE
Cicuta douglasii (DC.) Coult. & Rose SY = *Cicuta maculata* var. *californica* (Gray) Boivin	western water hemlock	APIACEAE
** *Cirsium arvense* (L.) Scop.	Canada thistle	ASTERACEAE
Cirsium neomexicanum Gray	New Mexico thistle	ASTERACEAE
Cirsium undulatum (Nutt.) Spreng.	wavyleaf thistle	ASTERACEAE
** *Cirsium vulgare* (Savi.) Ten.	bull thistle	ASTERACEAE
Cleome serrulata Pursh	Rocky Mountain beeplant	CAPPARIDACEAE
** *Conium maculatum* L.	poison hemlock	APIACEAE
** *Convolvulus arvensis* L.	field bindweed	CONVOLVULACEAE
** *Conyza canadensis* (L.) Cronq.	Canadian horseweed	ASTERACEAE
Croton texensis (Klotzsch) Muell.-Arg.	Texas croton	EUPHORBIACEAE

SCIENTIFIC NAME	COMMON NAME	FAMILY
Cucurbita foetidissima Kunth	Missouri gourd	CUCURBITACEAE
** *Cynoglossum officinale* L.	gypseyflower	BORAGINACEAE
Cystopteris fragilis (L.) Bernh.	brittle bladderfern	DRYOPTERACEAE
Dalea candida var. *candida* Willd.	white prairieclover	FABACEAE
SY = *Petalostemon candidus* Michx.		
Dalea terminalis M.E. Jones	slimleaf prairieclover	FABACEAE
** *Datura stramonium* L.	jimsonweed	SOLANACEAE
Dimorphocarpa wislizeni (Engelm.) Rollins	touristplant	BRASSICACEAE
SY = *Dithyrea wislizeni* Engelm.		
** *Dipsacus fullonum* ssp. *sylvestris* (Huds.) Clapham	Fuller's teasel	DIPSACACEAE
SY = *Dipsacus sylvestris* Huds.		
Epilobium brachycarpum K. Presl.	autumn willowweed	ONAGRACEAE
SY = *Epilobium paniculaturm* Nutt. ex Torr. & Gray		
Epilobium ciliatum Raf.	hairy willowherb	ONAGRACEAE
Epipactis gigantea Dougl. ex Hook	giant helleborine	ORCHIDACEAE
Equisetum arvense L.	field horsetail	EQUISETACEAE
Equisetum laevigatum A. Braun	smooth horsetail	EQUISETACEAE
Erigeron bellidiastrum var. *bellidiastrum* Nutt.	western daisy fleabane	ASTERACEAE
Erigeron divergens Torr. & Gray	spreading fleabane	ASTERACEAE
Erigeron eximius Greene	sprucefir fleabane	ASTERACEAE
Erigeron flagellaris Gray	trailing fleabane	ASTERACEAE
SY = *Erigeron nudiflorus* Buckl.		
Erigeron speciosus var. *speciosus* (Lindl.) DC.	aspen fleabane	ASTERACEAE
Eriogonum jamesii Benth.	James' buckwheat	POLYGONACEAE
Euthamia occidentalis Nutt.	western goldentop	ASTERACEAE
SY = *Solidago occidentalis* (Nutt.) Torr. & Gray		
Fragaria vesca ssp. *americana* (Porter) Staudt	woodland strawberry	ROSACEAE
SY = *Fragaria americana* (Porter) Britt		
Gaillardia pulchella Foug.	firewheel	ASTERACEAE
** *Galium aparine* L.	stickywilly	RUBIACEAE
Galium trifidum ssp. *subbiflorum*	threepetal bedstraw	RUBIACEAE
SY = *Galium tinctorium* ssp. *subbiflorum* (Wieg.) Fern.		
Gaura coccinea Nutt. ex Pursh	scarlet beeblossom	ONAGRACEAE
* *Gaura parviflora* Dougl. ex Lehm.	velvetweed	ONAGRACEAE
Geranium caespitosum var. *caespitosum* James	pineywoods geranium	GERANIACEAE
Geranium richardsonii Fisch. & Trautv.	Richardson's geranium	GERANIACEAE
Geum macrophyllum Willd.	largeleaf avens	ROSACEAE
Geum triflorum var. *ciliatum* (Pursh) Fassett	old man's whiskers	ROSACEAE
Glandularia wrightii (Gray) Umber	Davis Mountain mock vervain	VERBENACEAE
SY = *Verbena wrighti* Gray		
Glycyrrhiza lepidota Pursh	American licorice	FABACEAE
Gnaphalium stramineum Kunth	cottonbatting plant	ASTERACEAE
SY = *Gnaphalium chilense* Spreng.		
Pseudognaphalium stramineum (Kunth) W.A. Weber		
Grindelia nuda var. *nuda* Wood	curlytop gumweed	ASTERACEAE
SY = *Grindelia squarrosa* var. *nuda* (Wood) Gray		
Grindelia squarrosa (Pursh) Dunal	curlycup gumweed	ASTERACEAE
Hackelia floribunda (Lehm.) I.M. Johnston	manyflower stickseed	BORAGINACEAE
Helenium autumnale var. *montanum* (Nutt.) Fern.	mountain sneezeweed	ASTERACEAE
SY = *Helenium montanum* Nutt.		
Helianthus annuus L.	common sunflower	ASTERACEAE
Helianthus nuttallii Torr. & Gray	Nuttall's sunflower	ASTERACEAE
Helianthus petiolaris ssp. *petiolaris* Nutt.	prairie sunflower	ASTERACEAE

APPENDIX C. KEY TO THE RIO GRANDE RIPARIAN/WETLAND COMMUNITY TYPES.

Use the key like any other artificial key by determining at the couplet the best combination of potentially dominant species in the community. Community types are keyed to their common name. The key works best in stands from late-progressional to near-climax stages. Stands in early- to mid-progressional stages cannot generally be keyed directly to their community type. For these stands the community type must be inferred from site factors, indicator species, or successional relationships. Users may need to consult the community characterization abstracts (CCAs) to verify the determination. No stand will fit the CCAs exactly. Canopy coverage of principal understory shrubs, forbs, and graminoids in the CCAs correspond to the following descriptors used in the vegetation key:

ABSENT - cannot be found in stand (opp = present);
ACCIDENTAL - individuals very infrequent, occasional, or limited to special microsites;
ABUNDANT - canopy coverage >25%;
COMMON - canopy coverage >1% (opp = scarce);
DOMINANT - density or cover is as great as, or greater than, any other species of the same life form (two or more species can be dominant, i.e. co-dominant);
LUXURIANT - canopy coverage >50%;
POORLY REPRESENTED - canopy coverage <5% (opp = well represented);
PRESENT - individuals can be found in the stand (opp = absent);
REGENERATION - understory trees as established seedlings, saplings, or small poles (dbh <10 in.);
SCARCE - canopy coverage <1% (opp = common);
WELL REPRESENTED - canopy coverage >5% (opp = poorly represented).
VERY WELL REPRESENTED - canopy coverage >10%.

Key to Forested Wetlands:

1. Dominant trees of Rocky Mountain or Southwest montane regions 2
1. Dominant trees of Rio Grande/Great Plains regions 4

2. Needle-leaved evergreen trees dominate the overstory; of the Rocky Mountains. .... Group A
2. Not as above 3

3. Broad-leaved deciduous trees dominate the overstory; of the Rocky Mountains .... Group B
3. Broad-leaved deciduous trees dominate the overstory; of the Southwest .... Group C

4. Needle-leaved deciduous trees dominate; saltcedar woodlands .... Group D
4. Broad-leaved deciduous trees dominate; not as above 4

5. Dominant trees either Rio Grande cottonwood or Russian olive; of cold temperate regions .... Group E
5. Dominant trees either netleaf hackberry, Arizona walnut, Arizona sycamore or Fremont's cottonwood; of warm temperate regions .... Group F

Key to Community Types:

Group A. Rocky Mountain Montane Needle-Leaved Evergreen Forests (cold temperate)

1. Blue spruce dominates the overstory; of banks and terraces 2
1. Upland sites .... unclassified

2. Understories densely shrubby; thinleaf alder abundant; streambanks ...... Blue Spruce—Thinleaf Alder CT
2. Not as above .... unclassified

Group B. Rocky Mountain Montane Broad-Leaved Deciduous Forests (cold temperate)

1. Narrowleaf cottonwood dominant 2
1. Dominant trees thinleaf alder; canopy cover luxuriant 7

2. Thinleaf alder or Arizona alder well represented; of streambanks and bars 3
2. Coyote willow or bluestem willow well represented; also of streambanks and bars 4

3. Thinleaf alder dominates the subcanopy; usu. as tall, multi-stemmed trees .... Narrowleaf Cottonwood—Thinleaf Alder CT
3. Arizona alder dominates the subcanopy; usu. as tall single-trunked trees .... Narrowleaf Cottonwood—Arizona Alder CT

4. Coyote willow very well represented in the subcanopy .... Narrowleaf Cottonwood/Coyote Willow CT
4. Bluestem willow very well represented in the subcanopy .... Narrowleaf Cottonwood/Bluestem Willow CT

5. Understories grass dominated; Kentucky bluegrass abundant; of terraces .... Narrowleaf Cottonwood/Kentucky Bluegrass CT
5. Understories dominated by shrubs or evergreen trees 6

6. Rocky Mountain juniper well represented .... Narrowleaf Cottonwood—Rocky Mountain Juniper CT
6. New Mexico olive well represented; other shrubs may be present, but scattered .... Narrowleaf Cottonwood/New Mexico Olive CT

7. Thinleaf alder dominant; forms dense thickets along moderate gradient, perennial streams 8
7. Not as above .... unclassified

8. Bluestem willow abundant .... Thinleaf Alder/Bluestem Willow CT
8. Not as above .... unclassified

Group C. Southwest Montane Broad-Leaved Deciduous Forests (cold temperate)

1. Arizona alder dominant; forms dense stands along low gradient, intermittent streams 2
1. Not as above .... unclassified

2. Goodding's willow common tree of upper canopy; shrubs sparse .... Arizona Alder—Goodding's Willow CT
2. Seepwillow the dominant subcanopy shrub; well represented .... Arizona Alder/Seepwillow CT

Group D. Rio Grande/Great Plains Needle-Leaved Deciduous Forests (cold temperate)

1. Saltcedar well represented; shrubs present in the understory; coyote willow common ....
.... Saltcedar/Coyote Willow CT
1. Shrubs absent; herbaceous undertory sparse 2

2. Saltcedar luxuriant .... Saltcedar/Sparse CT
2. Not as above .... unclassified

Group E. Rio Grande/Great Plains Broad-Leaved Deciduous Forests (cold temperate)

1. Russian Olive dominant; saltcedar abundant .... Russian Olive—Saltcedar CT
1. Rio Grande Cottonwood dominant 2

2. Other trees, shrubs, or forbs well represented to abundant 3
2. Not as above; understories sparse .... Rio Grande Cottonwood/Sparse CT

3. Russian Olive or saltcedar well represented; of wide floodplain rivers 4
3. Not as above 5

4. Russian Olive well represented to abundant; understory scarce ....
.... Rio Grande Cottonwood—Russian Olive CT
4. Saltcedar well represented to abundant; understory scarce ....
.... Rio Grande Cottonwood—Saltcedar CT

5. Oneseed juniper very well represented as a subcanopy tree; of downcut terraces on intermediate sized rivers ....
.... Rio Grande Cottonwood—Oneseed Juniper CT
5. Shrubs well represented to abundant 6

6. New Mexico olive well represented; other shrubs present; herbs scarce ....
.... Rio Grande Cottonwood/New Mexico Olive CT
6. Coyote willow abundant; other shrubs and herbs scarce .... Rio Grande Cottonwood/Coyote Willow CT

7. Shrubs absent; understories forb dominated; of floodplain bars 8
7. Understories grassy; Kentucky bluegrass dominant; of terraces ....
.... Rio Grande Cottonwood/Kentucky Bluegrass CT

8. Water sedge dominates the understory; other herbs scarce .... Rio Grande Cottonwood/Water Sedge CT
8. Smooth Horsetail dominates the understory; other herbs present or common .... Rio Grande Cottonwood/Smooth Horsetail CT

Group F. Southwest Lowland Broad-Leaved Deciduous Forests (warm temperate)

1. Netleaf Hackberry dominates the overstory; skunkbush sumac co-dominates; herbaceous layer sparse .... Netleaf Hackberry/Skunkbush Sumac CT
1. Not as above 2

2. Arizona walnut dominates the overstory; understory grass dominated; shrubs scattered .... Arizona Walnut/Sideoats Grama CT
2. Not as above 3

3. Arizona sycamore dominates the overstory 4
3. Fremont's cottonwood dominates the overstory 8

4. Arizona alder an abundant subcanopy tree; shrubs scarce .... Arizona Sycamore—Arizona Walnut CT
4. Not as above 5

5. Canopies open 6
5. Canopies closed 7

6. Seepwillow well represented in the shrub layer .... Arizona Sycamore/Seepwillow CT
6. Understory grassy; Sideoats grama luxuriant; of terraces .... Arizona Sycamore/Sideoats Grama CT

7. Understories sparse; of terraces .... Arizona Sycamore/Sparse CT
7. Not as above .... unclassified

8. Velvet ash or Goodding's willow well represented; shrubs and herbs common 9
8. Yerba mansa abundant; otherwise not as above .... Fremont's Cottonwood/Yerba Mansa CT

9. Velvet ash co-dominant .... Fremont's Cottonwood—Velvet Ash CT
9. Goodding's willow co-dominant .... Fremont's Cottonwood—Goodding's Willow CT

Key to Scrub-Shrub Wetlands:

1. Dominant shrubs of Rio Grande/Great Plains regions (broad-leaved, deciduous) .... Group A
1. Dominant shrubs of Rocky Mountain montane or Southwest lowland regions (broad-leaved, deciduous) 2

2. Dominant shrubs of the Rocky Mountains; bluestem willow dominant .... Group B
2. Dominant shrubs of the Southwest; seepwillow or coyote willow dominant .... Group C

Key to Community Types:

Group A. Rocky Mountain Montane Shrublands (cold temperate)

1. Coyote willow dominant 2
1. Not as above .... unclassified

2. Understories dominated by mesic herbs; mature shrubs absent 3
2. Not as above; rubber rabbitbrush well represented .... Coyote Willow—Rubber Rabbitbrush CT

3. Understories dominated by grasses or sedges 4
3. Understories dominated by the forb smooth horsetail .... Coyote Willow/Smooth Horsetail CT

4. Sedges (*Carex* spp.) dominate the understory 5
4. Grasses dominate the understory 6

5. Water sedge luxuriant; of streambanks .... Coyote Willow/Water Sedge CT
5. Woolly sedge abundant; other sedges present; of wet meadows .... Coyote Willow/Woolly Sedge CT

6. Saltgrass abundant; of terraces .... Coyote Willow/Saltgrass CT
6. Not as above 7

7. Redtop abundant; of frequently flooded bars .... Coyote Willow/Redtop CT
7. False Quackgrass abundant; of infrequently flooded bars .... Coyote Willow/False Quackgrass CT

8. Baltic rush well represented; other rushes, sedges or grasses present .... Coyote Willow/Baltic Rush CT
8. Not as above 9

9. American bulrush well represented; other rushes, sedges or grasses present .... Coyote Willow/American Bulrush CT
9. Not as above 10

10. Common spikerush well represented; other rushes, sedges or grasses present .... Coyote Willow/Common Spikerush CT
10. Not as above .... unclassified

Group B. Rocky Mountain Montane Shrublands (cold temperate)

1. Coyote willow co-dominant; of cobble bars .... Bluestem Willow—Coyote Willow CT
1. Coyote willow absent; of frequently scoured cobble bars .... Bluestem Willow/Sparse CT

Group C. Southwest Lowland Broad-Leaved Deciduous Shrublands (warm temperate)

1. Seepwillow dominant; other shrubs absent; grasses common .... Seepwillow/Prairie Wedgescale CT
1. Coyote willow dominant; otherwise not as above 2

2. Understories scarce; of frequently scoured sand bars .... Coyote Willow/Sparse CT
2. Not as above 3

3. Seepwillow well represented; of coarse textured sand bars .... Coyote Willow—Seepwillow CT
3. Yerba mansa abundant; of fine textured overflow channels .... Coyote Willow/Yerba Mansa CT

Key to Persistent-Emergent Wetlands:

1. Dominant herbs of cold temperate Rocky Mountain montane regions .... Group A
1. Dominant herbs of cold temperate Rio Grande/Great Plains regions .... Group B

Key to Community Types:

Group A. Rocky Mountain Montane Herbaceous Wetlands (cold temperate)

1. American bulrush dominant 2
1. Baltic rush dominant 3

   2. Common Spikerush co-dominant; sites seasonally flooded, lush . . . . American Bulrush—Common Spikerush CT
   2. Smooth Horsetail co-dominant; otherwise, same as above . . . . American Bulrush/Smooth Horsetail CT

3. Baltic rush dominant 4
3. Not as above . . . . unclassified

   4. Sites of wet meadows, seasonally saturated; common spikerush co-dominant . . . . Baltic Rush—Common Spikerush CT
   4. Sites bordering streambanks 5

      5. Water sedge co-dominant; sites lush, mesic . . . . Baltic Rush—Water Sedge CT
      5. Smooth horsetail co-dominant; sites drier . . . . Baltic Rush/Smooth Horsetail CT

Group B. Rio Grande/Great Plains Herbaceous Wetlands (cold temperate)

1. Broadleaf cattail dominant; bulrushes common; sites marshy; ponded 2
1. Water sedge dominant; smooth horsetail co-dominant; sites seasonally flooded, lush; of streambanks . . . . Water Sedge/Smooth Horsetail CT

2. Broadleaf cattail dominant 3
2. Common spikerush dominant 4

   3. Rice cutgrass luxuriant and co-dominant; other herbs scarce . . . . Broadleaf Cattail/Rice Cutgrass CT
   3. American bulrush well represented; other herbs common . . . . Broadleaf Cattail/American Bulrush CT

4. Common spikerush dominant 5
4. Not as above . . . . unclassified

   5. Smooth horsetail co-dominant; sites seasonally flooded, lush; of small, abandoned channels . . . . Common Spikerush/Smooth Horsetail CT
   5. Rice cutgrass luxuriant and co-dominant; other herbs common . . . . . Common Spikerush—Rice Cutgrass CT

APPENDIX D. HIGH QUALITY SITES OF THE RIO GRANDE WATERSHED

Site descriptions for the eighteen high quality sites designated in the Rio Grande watershed. Each site description contains: river cross-section(s) generated from ground sampling at the site; a site map with site boundaries and; a site photograph (not included for the Cabresto Creek and the Arroyo Cuma Sites).

Site Name:	La Junta	**Site Number:**	2
River:	Rio Grande	**County:**	Taos
Quad:	GUADALUPE MOUNTAIN	**Basin Number**	13020101

Town 28N **Range:** 12E **Section** 17

Latitude: 363943W **Longitude:** 1054122N

Site Quality: high

Min Site Size: 10 Ha **Stream Length:** 1540 m

Data Sources: Ground Reconnaissance

General Description: This site is located in the upper reaches of the Rio Grande near the confluence of the Red River. At this site, the river flows unregulated and without any channel impacts or modifications (i.e. levee etc). Herbaceous riparian vegetation is lush on isolated side bars. Impacts here are light and include trails used by fishermen and hikers.

Hydrologic Status	**Flow Regulation:** No	**Jetty Jacks:**	No	**Levee:**	No
	Dredging: No	**RipRap:**	No		

Exotic veg dominant: no

Grazing: no

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: no

Mowing: no

Other Impacts: yes moderate use by fishermen

Cross Section: Rio Grande 1

Site Plots:
94PD024 94PD025

Jurisdiction: BLM

Survey Date: 6/21/94

Investigators: Durkin/Carr/Bradley

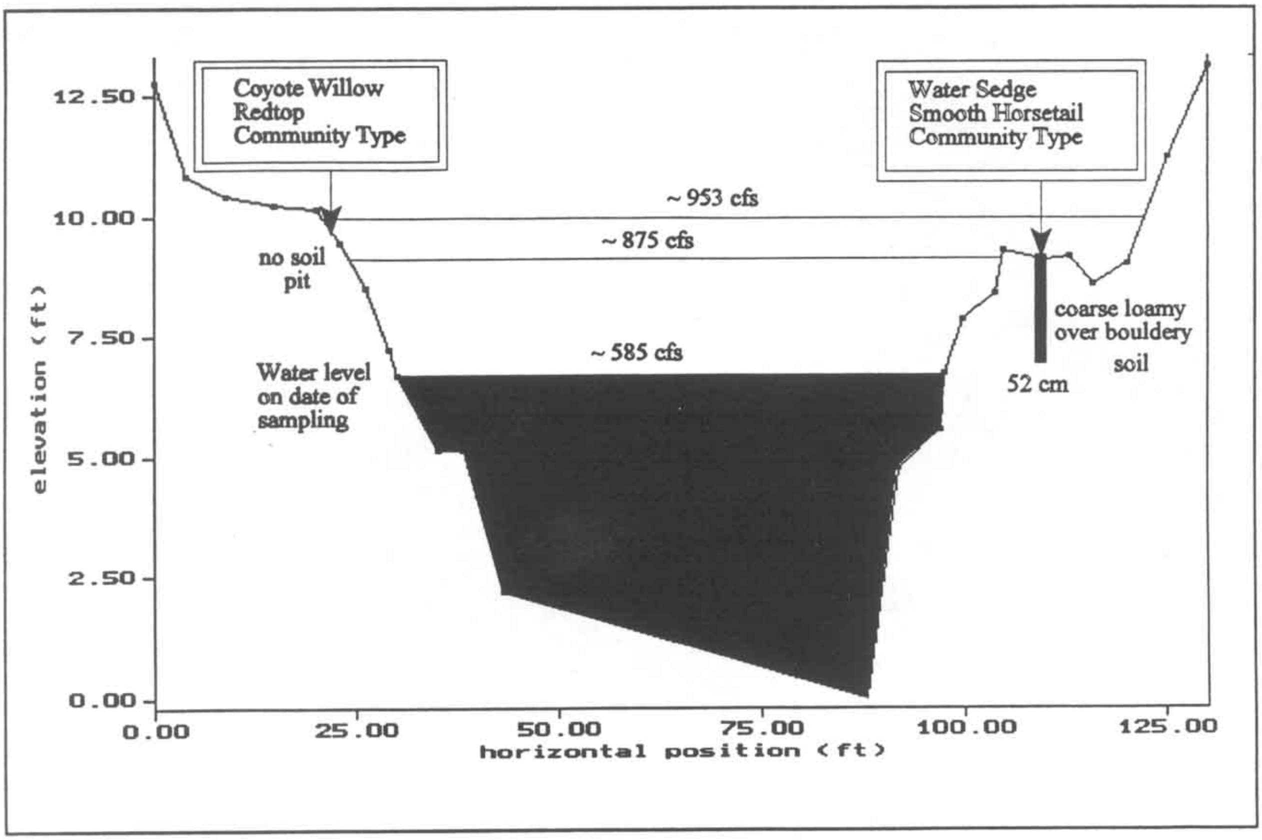

Figure D.1. Cross section of the Rio Grande at La Junta Site showing location of the communities, water level required to flood them, predominant soil texture and depth of the soil pit (black bar).

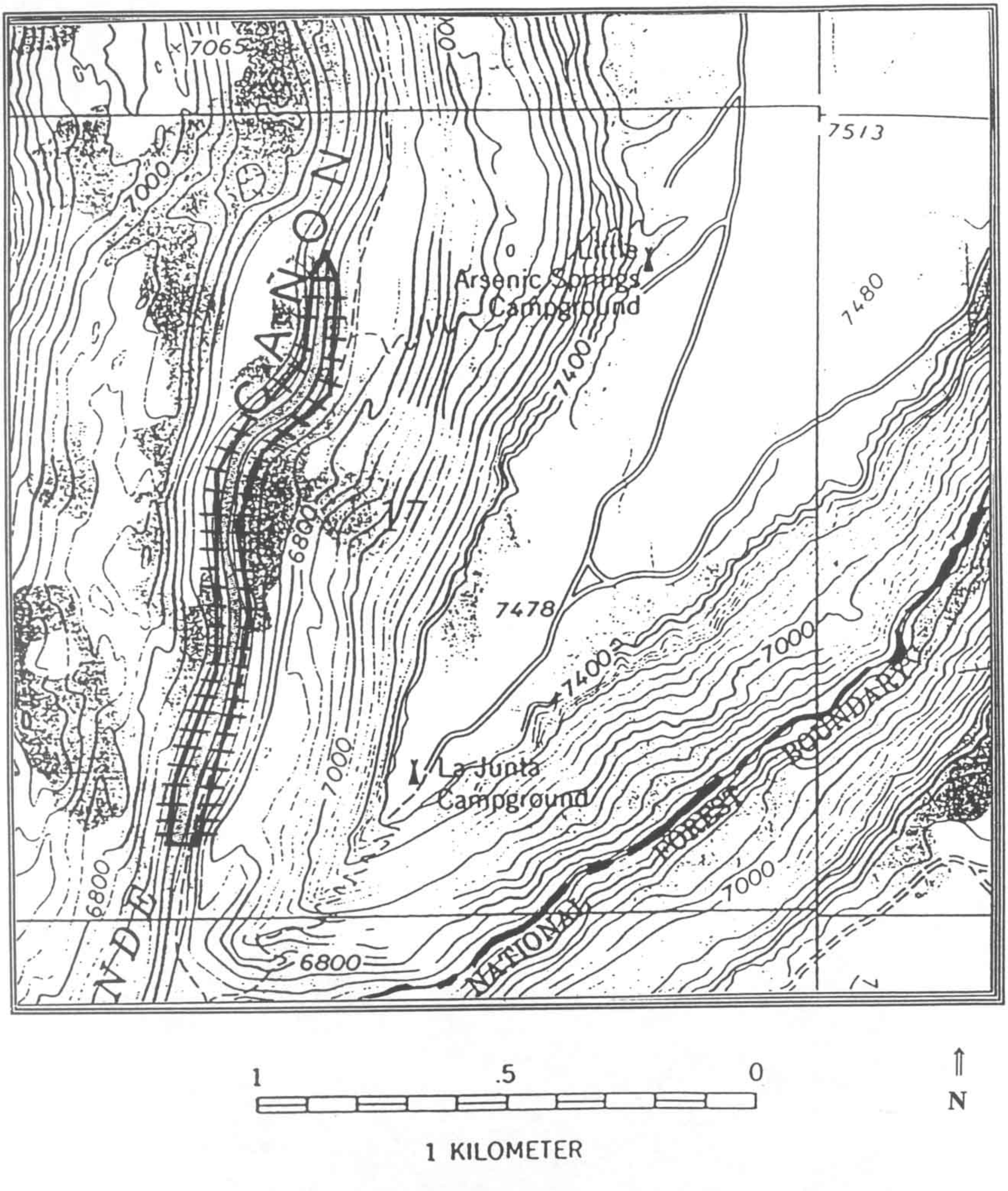

Figure D.2. Rio Grande, Site 2

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

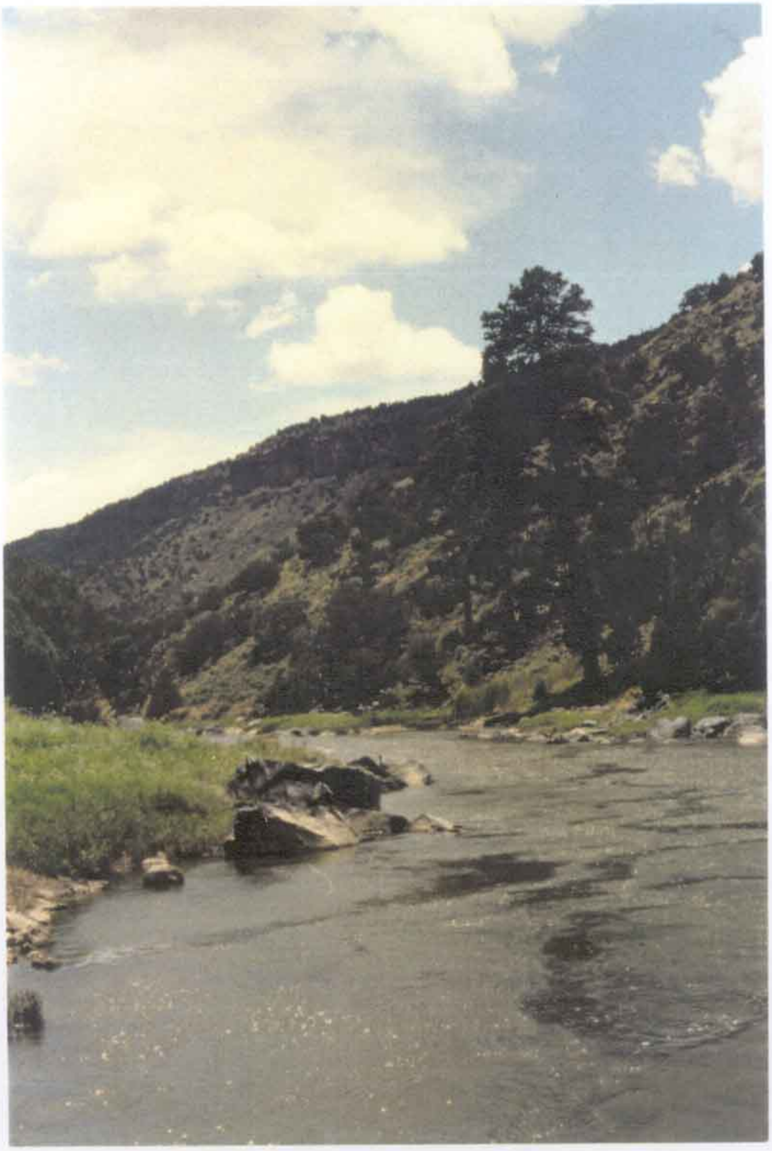

Photo: Mike Bradley

Figure D.3. The Rio Grande at the La Junta Site just north of the Red River confluence. Note the lush vegetation along the banks, which flood frequently.

Site Name:	Cabresto Creek	**Site Number:**	78
River:	Cabresto Creek	**County:**	Taos
Quad:	RED RIVER	**Basin Number**	13020101

Town 29N **Range:** 14E **Section** 19

Latitude: 364400W **Longitude:** 1052926N

Site Quality: high

Min Site Size: 13 Ha **Stream Length:** 1600 m

Data Sources: Ground Reconnaissance

General Description: Cabresto Creek is a mountain stream that is unregulated throughout its course to the confluence of the Red River. At this site, the riparian vegetation is lush where access to the river is limited. Impacts here include fisherman trails and the dirt road that is adjacent to the river.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: no

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: yes Adjacent to river but up and away from floodplain in most areas

Mowing: no

Other Impacts: yes light fishing

Cross Section: Cabresto Creek1

Site Plots:
94PD032 94PD033

Jurisdiction: Carson NF

Survey Date: 6/27/94

Investigators: Bradley/Durkin/Carr

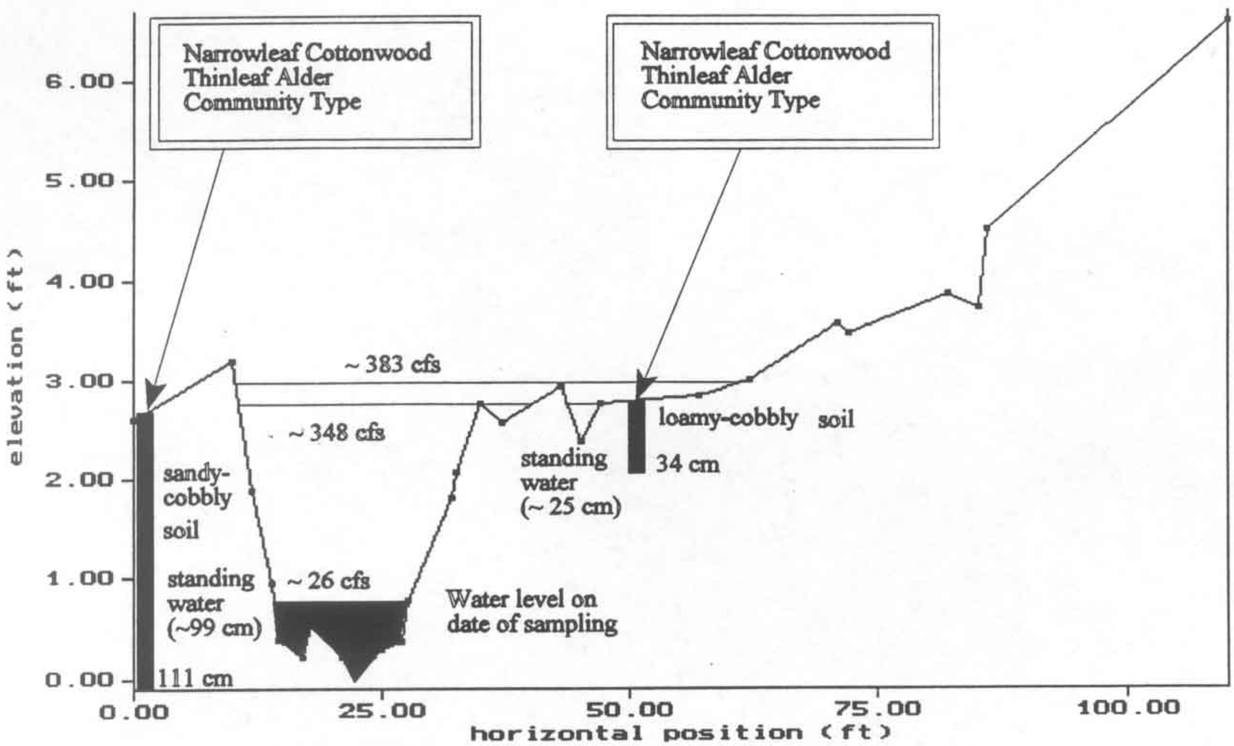

Figure D.4. Cross section of Cabresto Creek at the Cabresto Creek Site showing location of the communities, water level required to flood them, prodominant soil texture, and depth of the soil pit (black bar).

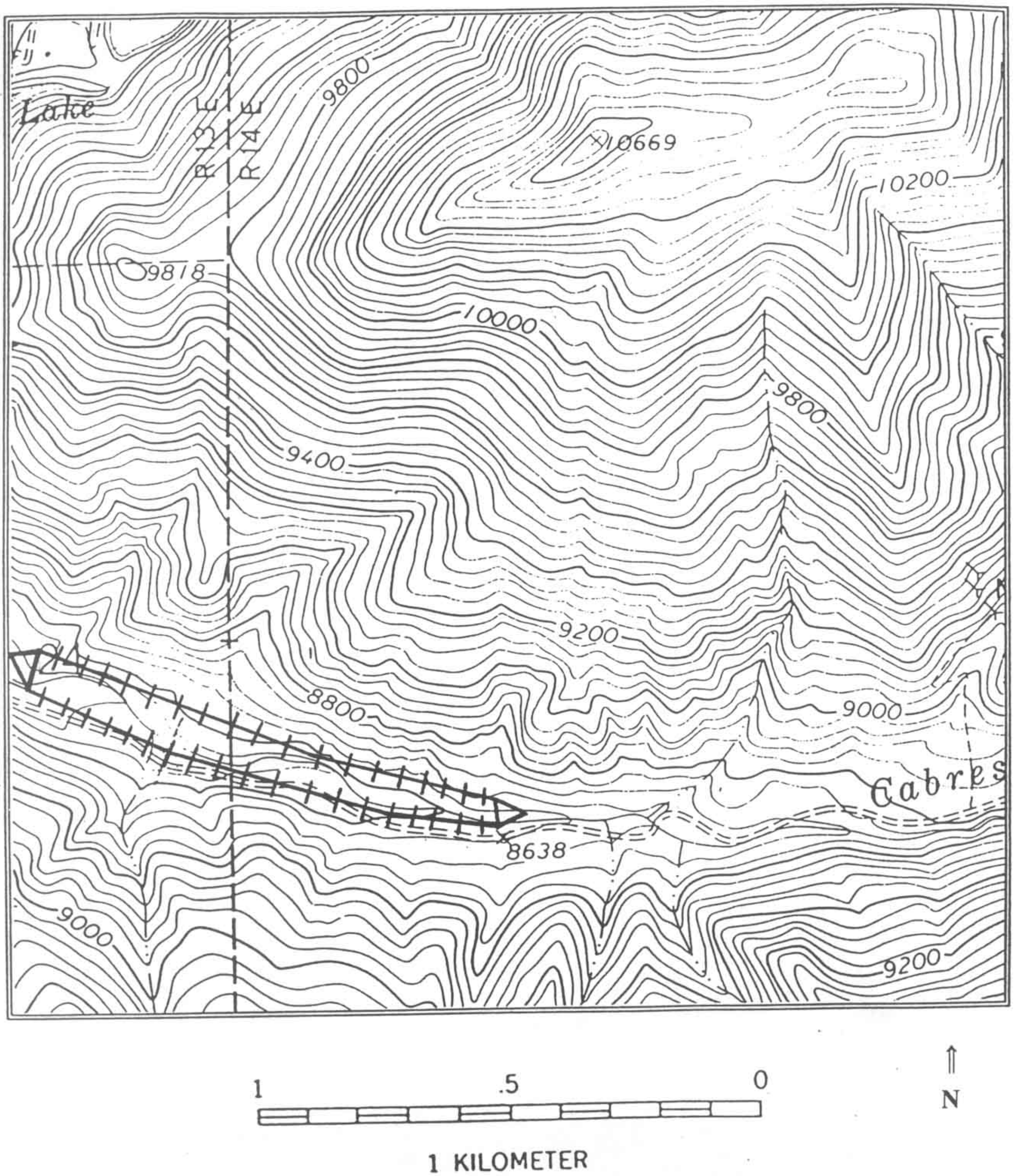

Figure D.5. Rio Chama, Site 78

Legend

= primary boundary

= indefinite upper or lower boundary

Site Name:	Upper Chama	**Site Number:**	79
River:	Rio Chama	**County:**	Rio Arriba
Quad:	CHAMA 15'	**Basin Number**	13020102

Town 31N **Range:** 03E **Section** 28

Latitude: 365212W **Longitude:** 1063504N

Site Quality: high

Min Site Size: 16 Ha **Stream Length:** 21 m

Data Sources: Ground Reconnaissance

General Description: The Rio Chama at this site is unregulated and the river is allowed to undergo natural fluvial processes. Riparian vegetation consists of narrowleaf cottonwoods in mixed aged stands. The cottonwood forests are fragmented by urbanization and grazing through this reach but some good isolated areas can be found. Fisherman trails are another impact at this site.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	light
Fuel Wood:	unknown	
Dumping:	no	no evidence seen
ORV Use:	no	no evidence seen
Roads:	no	
Mowing:	no	
Other Impacts:	yes	cabins and motels take up much of the floodplain

Cross Section: Chama1

Site Plots:
94PD084 94PD085 94PD086

Jurisdiction: NM Game and Fish and private

Survey Date: 8/10/94

Investigators: Bradley/Durkin/Carr

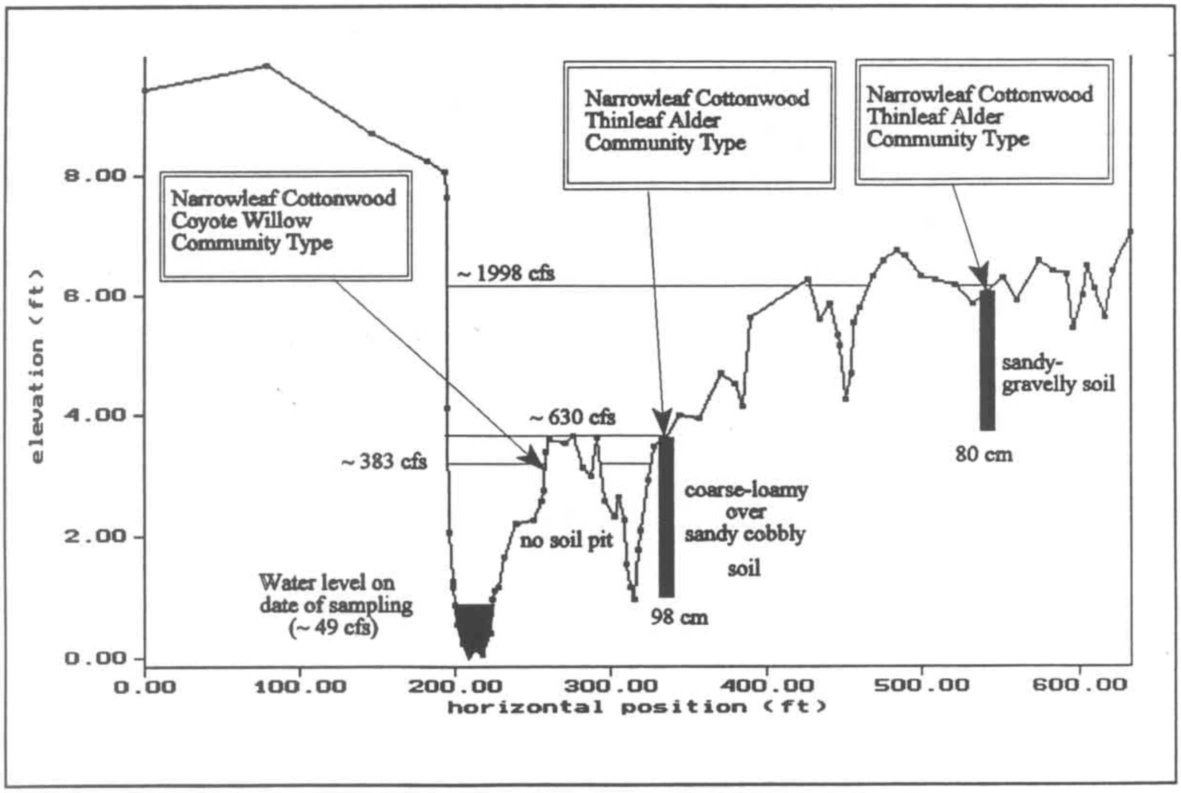

Figure D.6. Cross section of the Rio Chama at the Upper Chama Site showing location of the communities, water level required to flood them, predominant soil texture, depth of the soil pit (black bar).

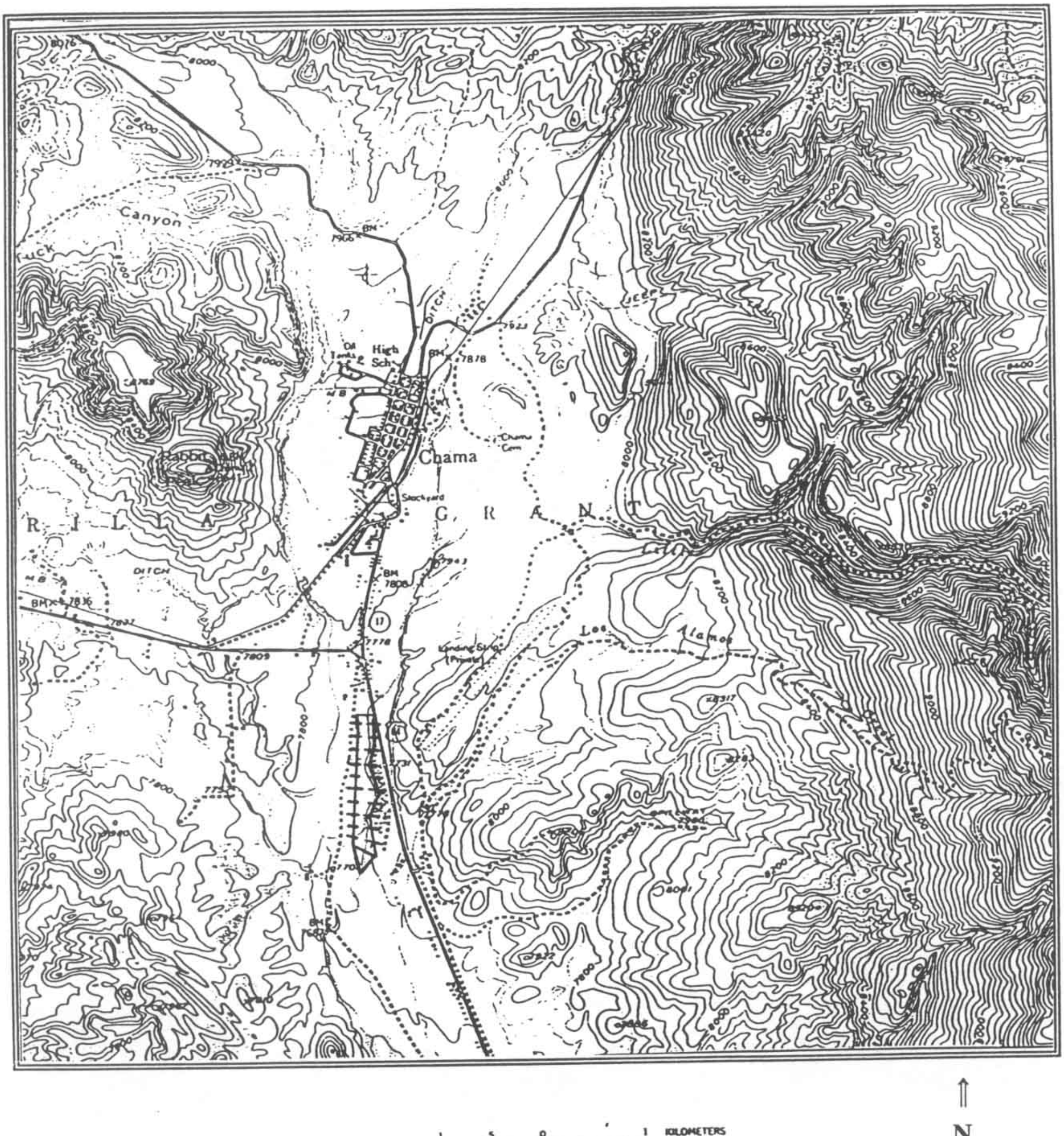

Figure D.7. Rio Chama, Site 79

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Ted Cline

Figure D.8. The upper Rio Chama Site just south of the town of Chama. Although fragmented, this site contains nice stands of narrowleaf cottonwood.

Site Name:	Canon Tio Maes	**Site Number:**	66
River:	Rio Pueblo	**County:**	Taos
Quad:	Tres Ritos	**Basin Number**	13020101

Town 22N **Range:** 13E **Section** 5

Latitude: 360943W **Longitude:** 1053505N

Site Quality: high

Min Site Size: 19 Ha **Stream Length:** 2750 m

Data Sources: Ground Reconnaissance; Air Photo Interpretation

General Description: This site is located on the Rio Pueblo above the junction of state road 518 and below Sipapu ski area. The entire river is unregulated and natural fluvial process occur. At this site, the riparian vegetation is fragmented by the highway and by campgrounds. Areas of lush vegetation are found in some of the more isolated areas along this reach.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	no	no evidence seen
Fuel Wood:	yes	use in campfires
Dumping:	no	
ORV Use:	no	
Roads:	yes	adjacent to river; and in campgrounds
Mowing:	no	
Other Impacts:	yes	campgrounds; moderate use by fishermen

Cross Section: Rio Pueblo1 and Rio Pueblo2

Site Plots:
94PD026 94PD027

Jurisdiction: Carson NF

Survey Date: 6/22/94

Investigators: Durkin/Carr/Bradley

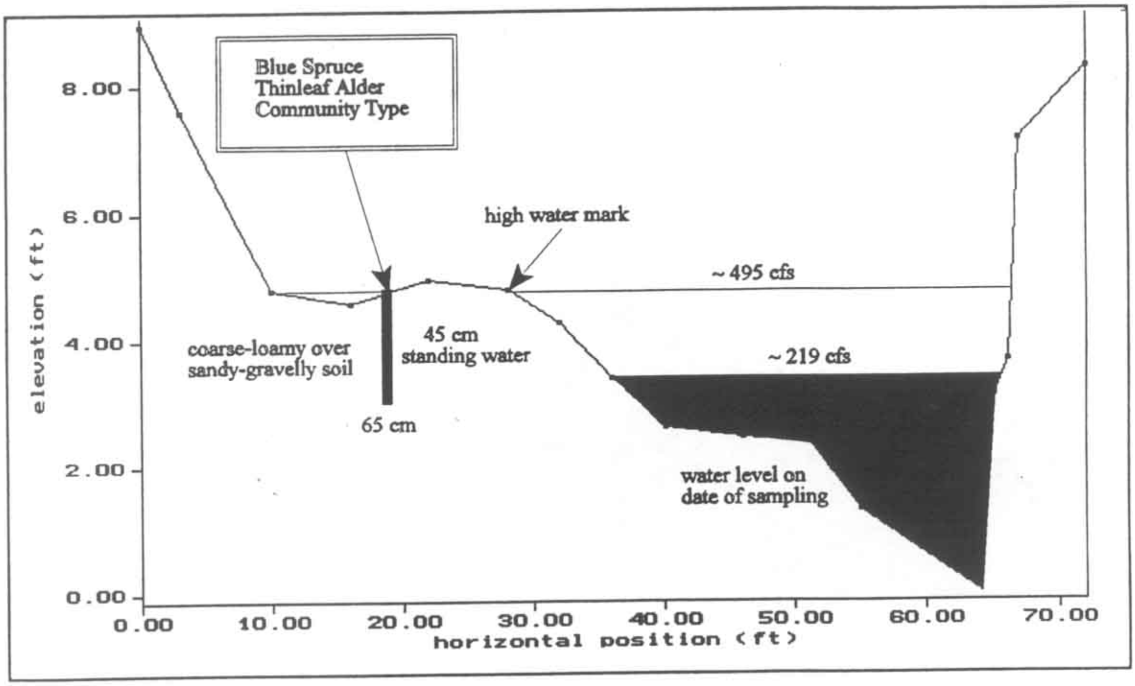

Figure D.9. Cross section of the Rio Pueblo at the Canon Tio Maes Sit showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

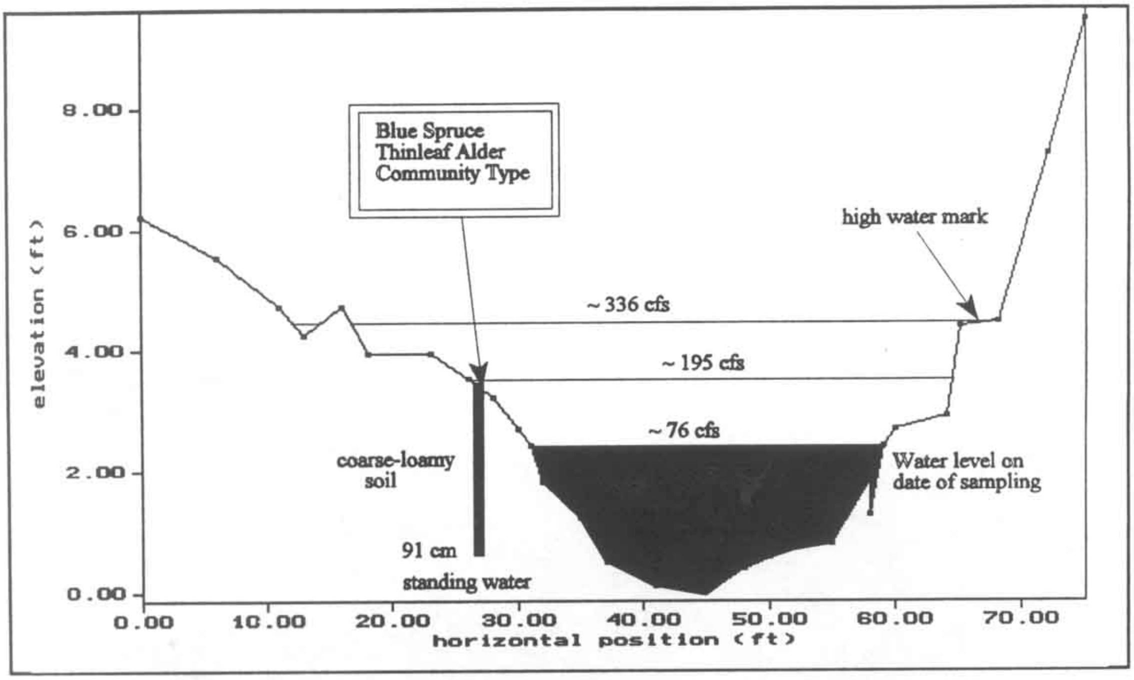

Figure D.10. Crosssection of the Rio Pueblo at the Canon Tio Maes Site showing location of the communities, water level required to flood them, the predominant soil texture, and depth of the soil pit (black bar).

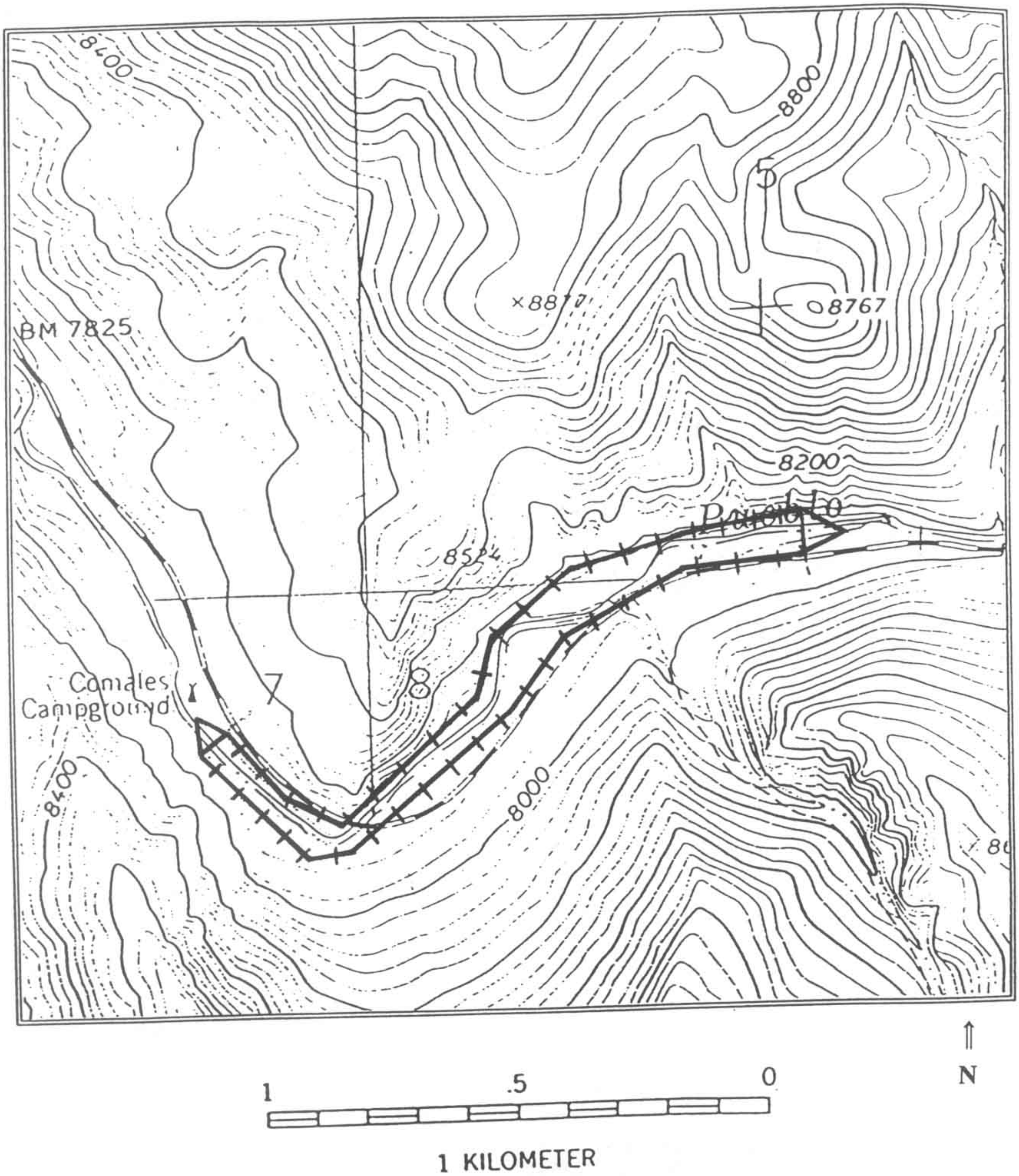

Figure D.11. Rio Pueblo, Site 66

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

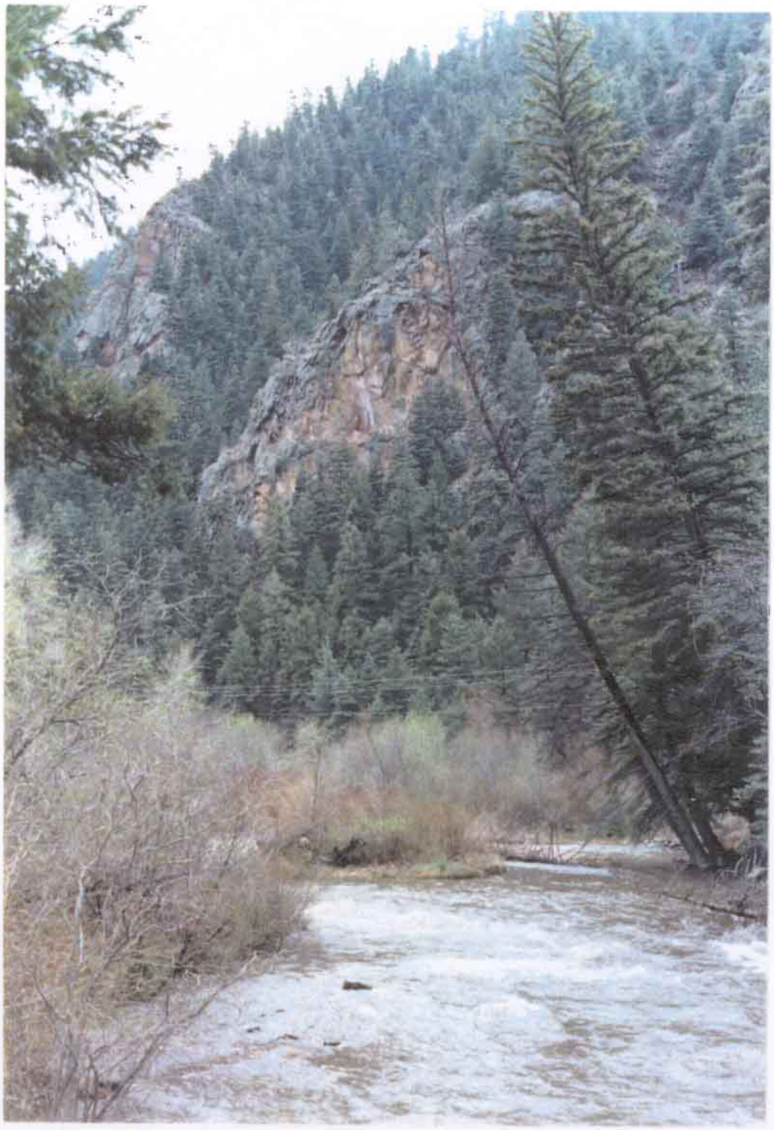

Photo: Stacey E. Carr

Figure D.12. The Rio Pueblo at the Canon Tio Maes Site dominated by bluestem willow.

Site Name:	Embudo Canyon	**Site Number:**	72
River:	Embudo Creek	**County:**	Rio Arriba
Quad:	TRAMPAS	**Basin Number**	13020101

Town 22N **Range:** 11E **Section** 6

Latitude: 361023W **Longitude:** 1054850N

Site Quality: high

Min Site Size: 51 Ha **Stream Length:** 5790 m

Data Sources: Air Photo Interpretation; Ground Reconnaissance

General Description: The Rio Embudo at this site is unregulated and natural fluvial process are allowed to occur. The herbaceous and shrubby vegetation that occur within the canyon reproduce naturally along narrow side bars. Impacts at this site are minimal and are limited to trails used by fishermen and hikers.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: no

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: no

Mowing: no

Other Impacts: yes light use by fishermen

Cross Section: Embudo1

Site Plots:
94PD029

Jurisdiction: BLM

Survey Date: 6/25/94

Investigators: Durkin/Bradley/Carr

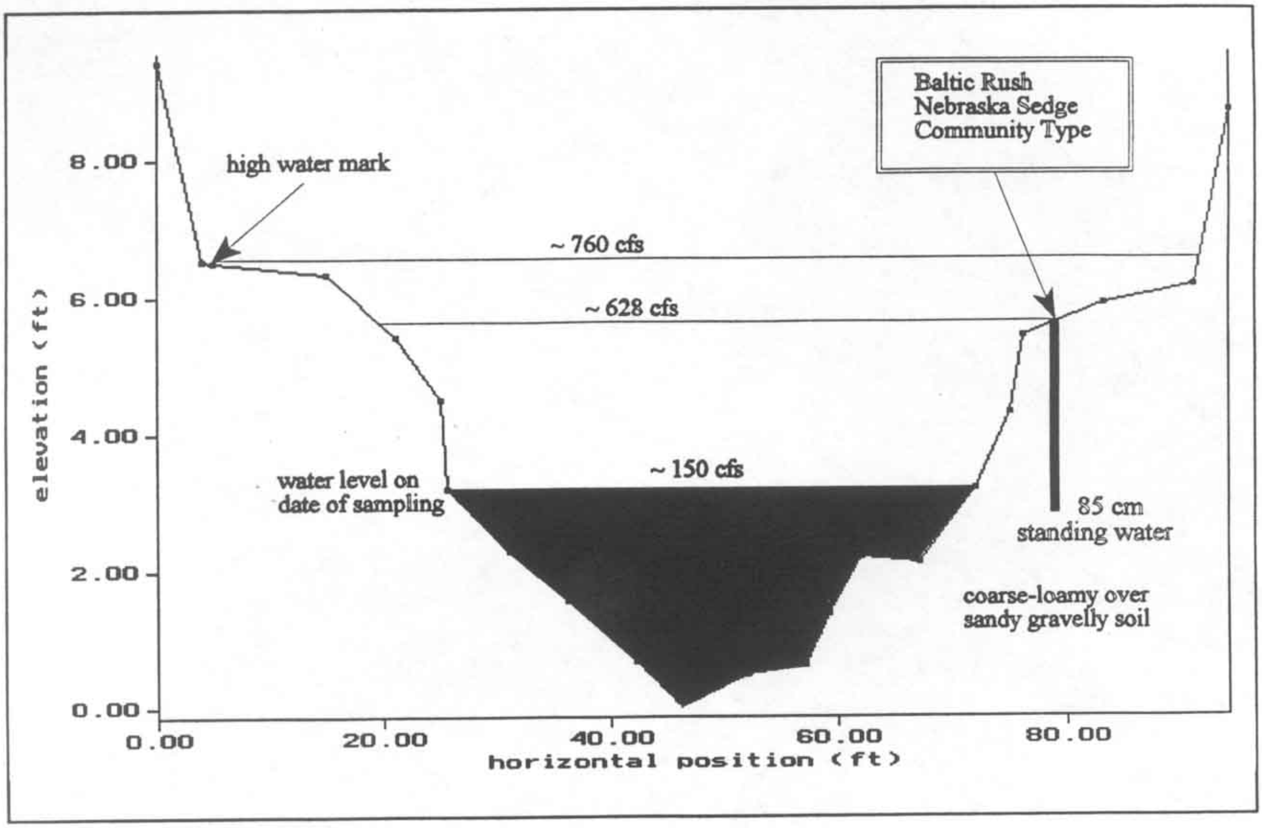

Figure D.13. Cross section of Embudo Creek at the Embudo Canyon Site showing location of communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

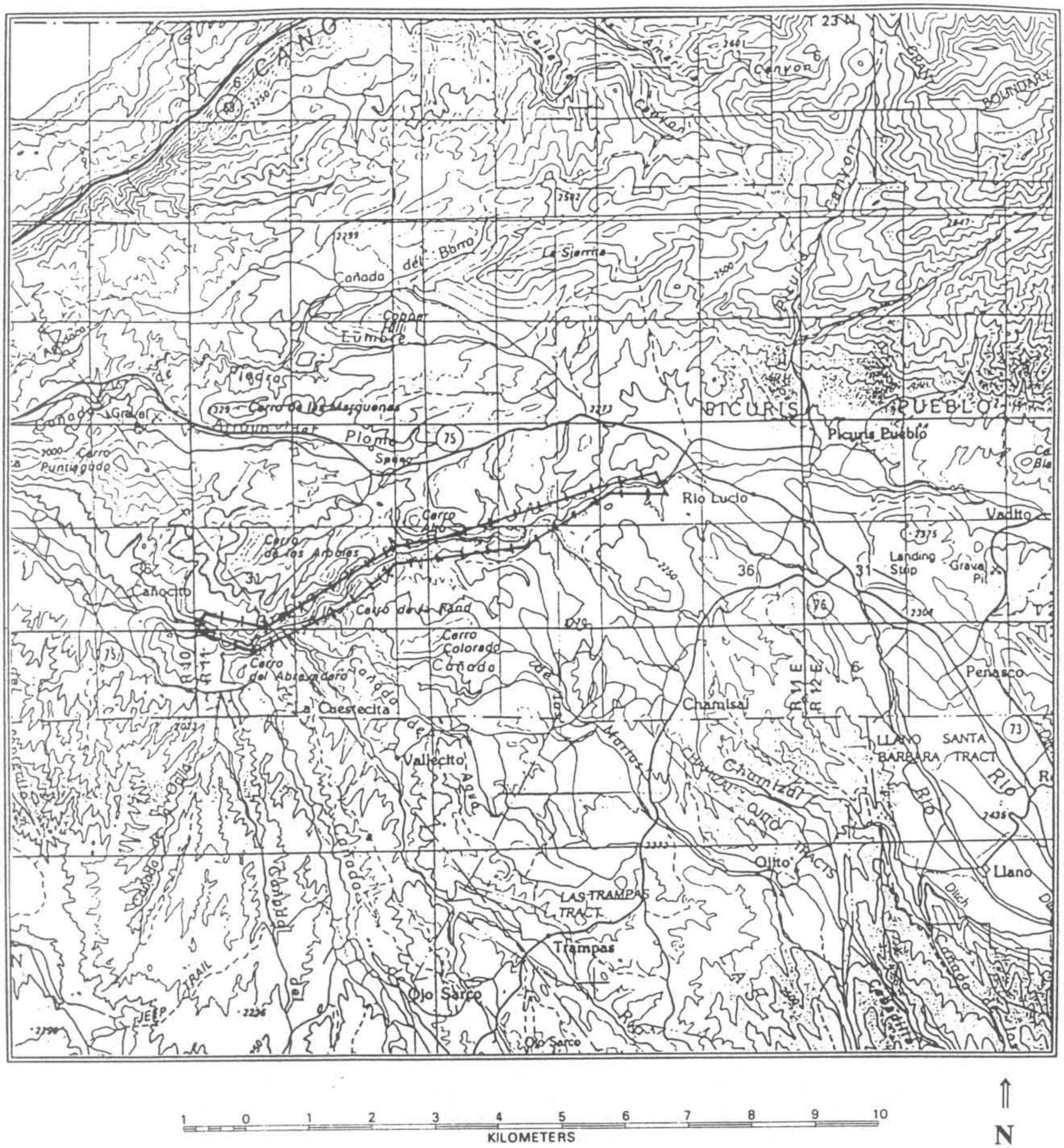

Figure D.14. Embudo Creek, Site 72

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

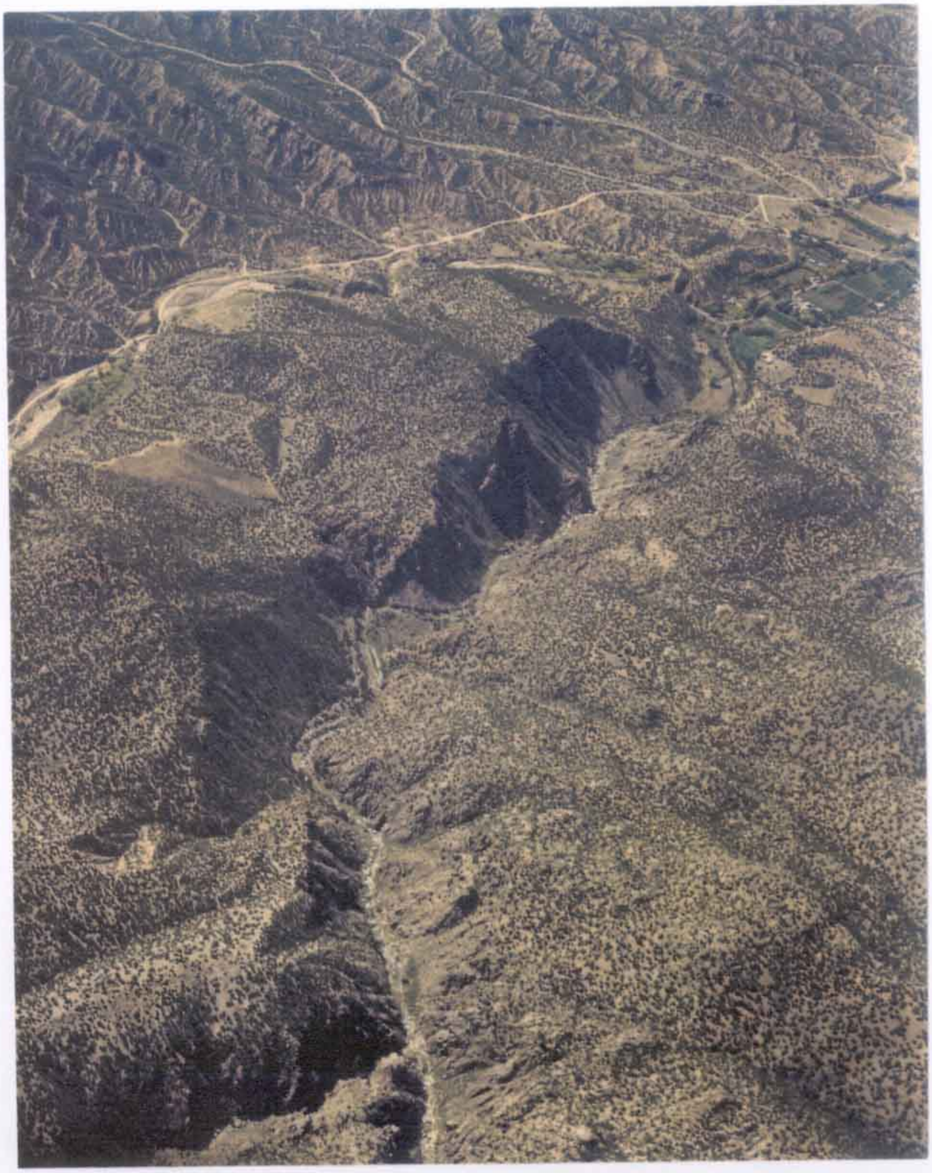

Photo: Ted Cline

Figure D.15. The Embudo Canyon Site. Herbaceous and shrubby vegetation dominate much of this site.

Site Name:	Rio Grande Confluence	**Site Number:**	74
River:	Embudo Creek	**County:**	Rio Arriba
Quad:	VELARDE	**Basin Number**	13020101

Town 23N **Range:** 10E **Section** 19

Latitude: 361250W **Longitude:** 1055500N

Site Quality: high

Min Site Size: 7 Ha **Stream Length:** 300 m

Data Sources: Ground Reconnaissance

General Description: The lower reach of the Rio Embudo is free of any large reservoirs, although diversion dams for irrigation ditches do occur upstream. The channel is relatively free of any impacts, although recently a small levee was built. Local residents are trying to remove it however. The highlight of this reach is the extensive marsh that borders the river. It seems to be stream-fed and is undisturbed.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** Yes

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: no no evidence seen

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: no

Mowing: no

Other Impacts: unknown

Cross Section: Embudo2

Site Plots:
94PD038 94PD039

Jurisdiction: Private

Survey Date: 6/29/94

Investigators: Bradley/Durkin/Carr

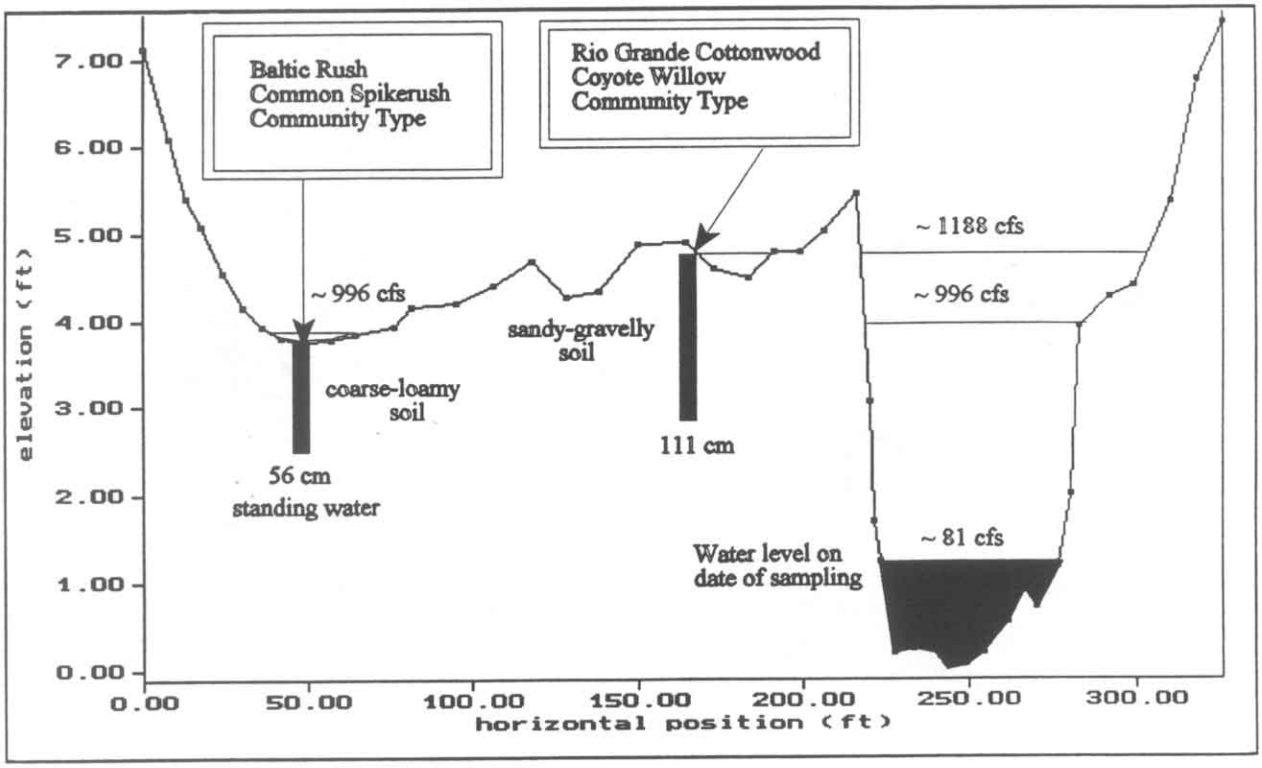

Figure D.16. Cross section of Embudo Creek at the Rio Grande Confluence Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

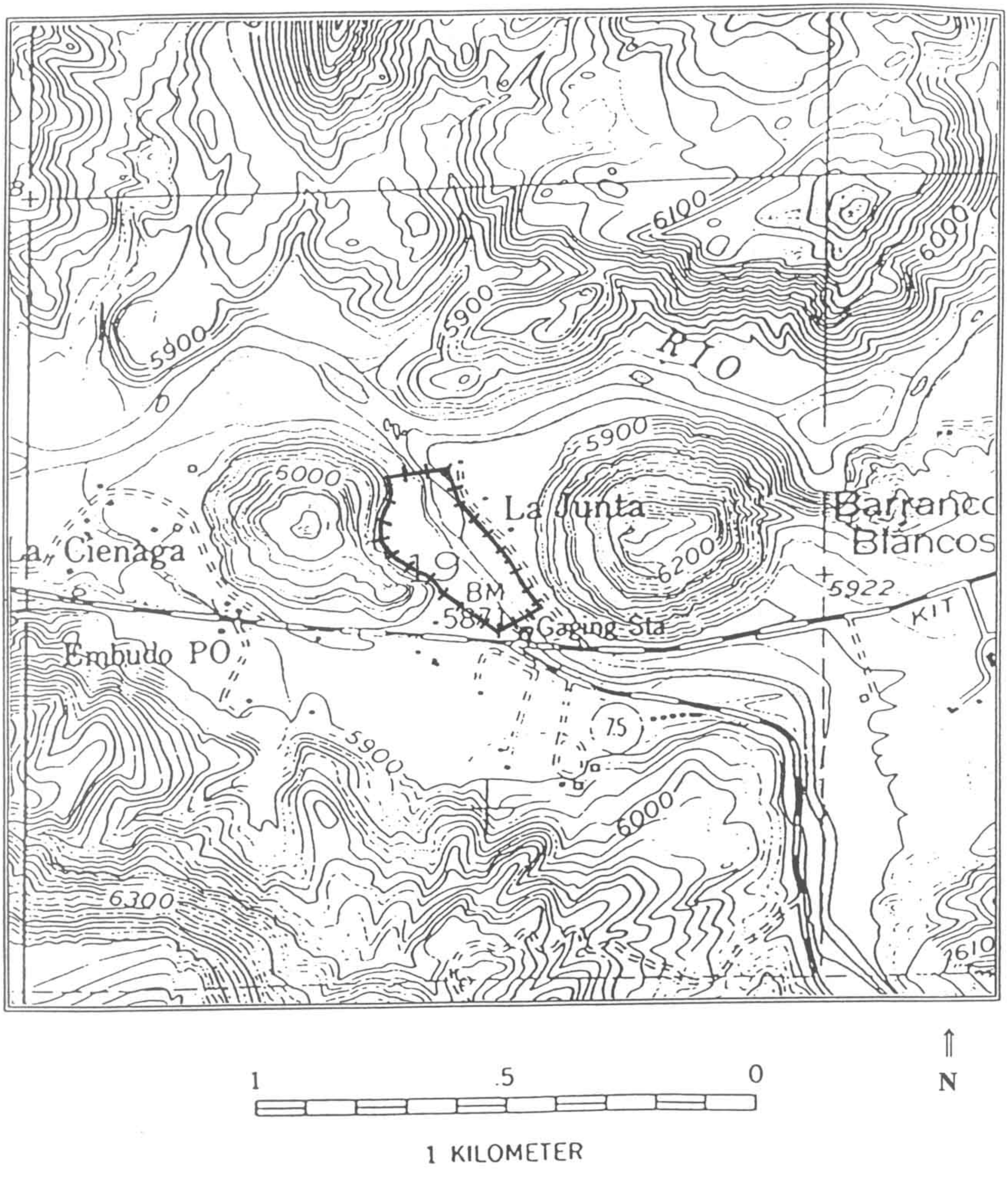

Figure D.17. Embudo Creek, Site 74

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Mike Bradley

Figure D.18. Baltic rush-common spikerush marsh located on Embudo Creek at the Rio Grande Confluence Site. Diversity is relatively high and immediate impacts are low.

Site Name: Embudo **Site Number:** 4

River: Rio Grande **County:** Rio Arriba

Quad: VELARDE **Basin Number** 13020101

Town 23N **Range:** 09E **Section** 24

Latitude: 361237W **Longitude:** 1055624N

Site Quality: high

Min Site Size: 70 Ha **Stream Length:** 4300 m

Data Sources: Ground Reconnaissance

General Description: The Rio Grande in this reach remains unregulated and the channel is free from levees and other channel impacts. Because of the hydraulic regime at this reach, cottonwoods and other riparian species are able to reproduce naturally. Impacts are minimal and limited to a few exotic species, as well as rafters, and fishermen. Off-road vehicles may pose a threat to this site if not regulated.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	no	no evidence seen
Fuel Wood:	no	
Dumping:	yes	light
ORV Use:	yes	moderate
Roads:	yes	highway out of active floodplain; some dirt roads
Mowing:	no	
Other Impacts:	unknown	

Cross Section: Rio Grande3-5

Site Plots:

94PD034	94PD035	94PD036	94PD037
94PD041	94PD042	94PD043	

Jurisdiction: Private

Survey Date: 6/28/94

Investigators: Bradley/Durkin/Carr

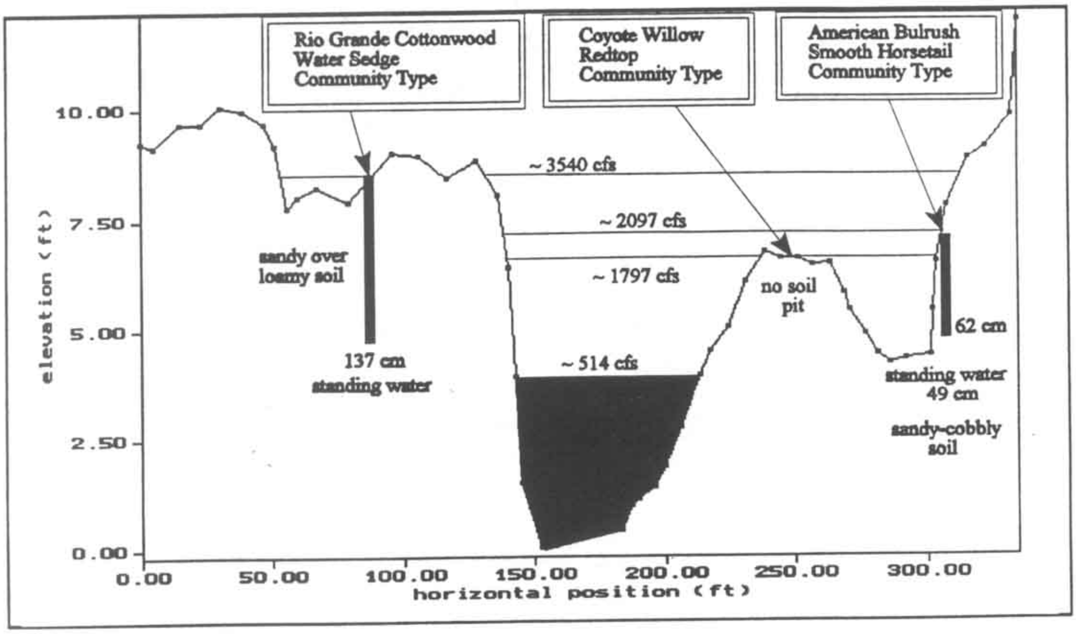

Figure D.19. Cross section of the Rio Grande at the Embudo Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

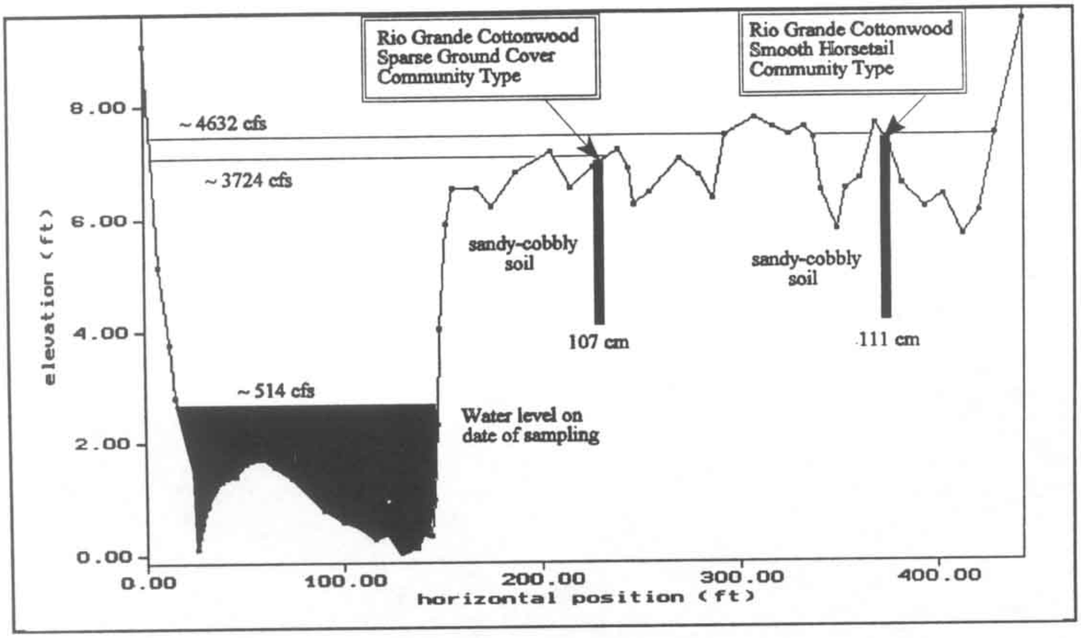

Figure D.20. Cross section of the Rio Grande at the Embudo Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

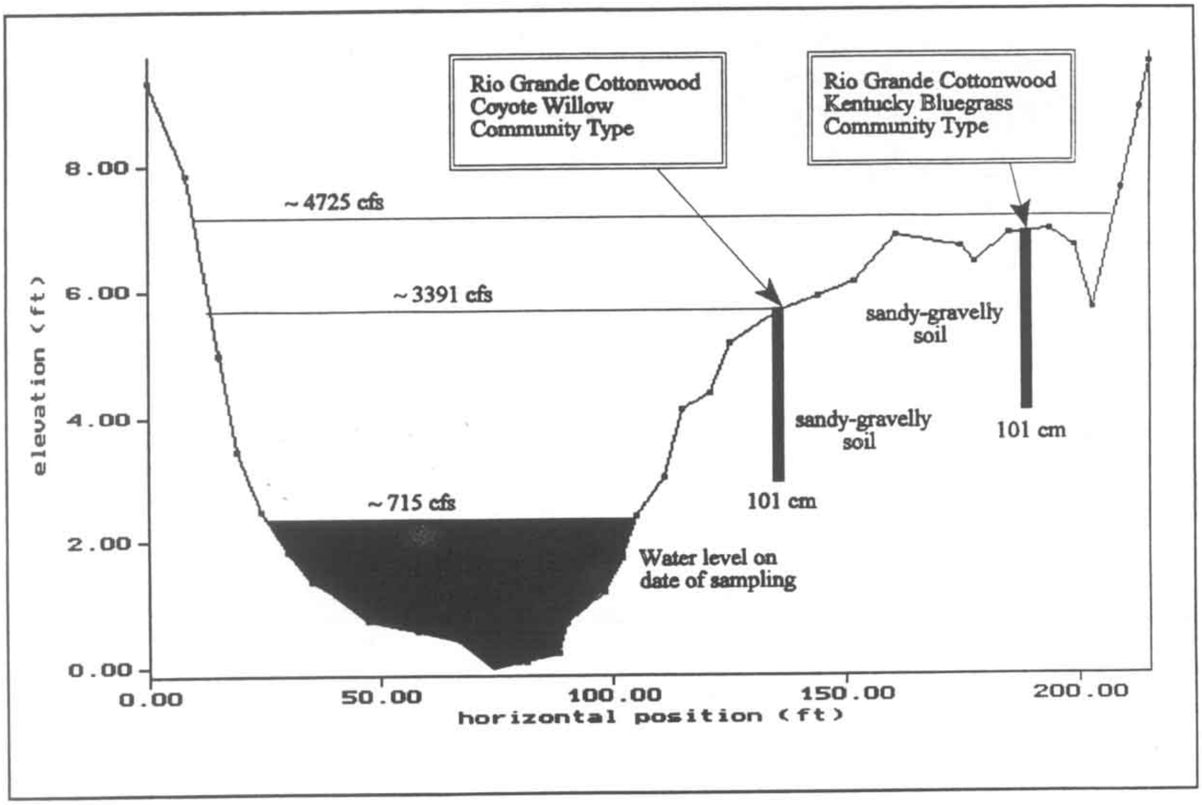

Figure D.21. Cross section of the Rio Grande at the Embudo Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

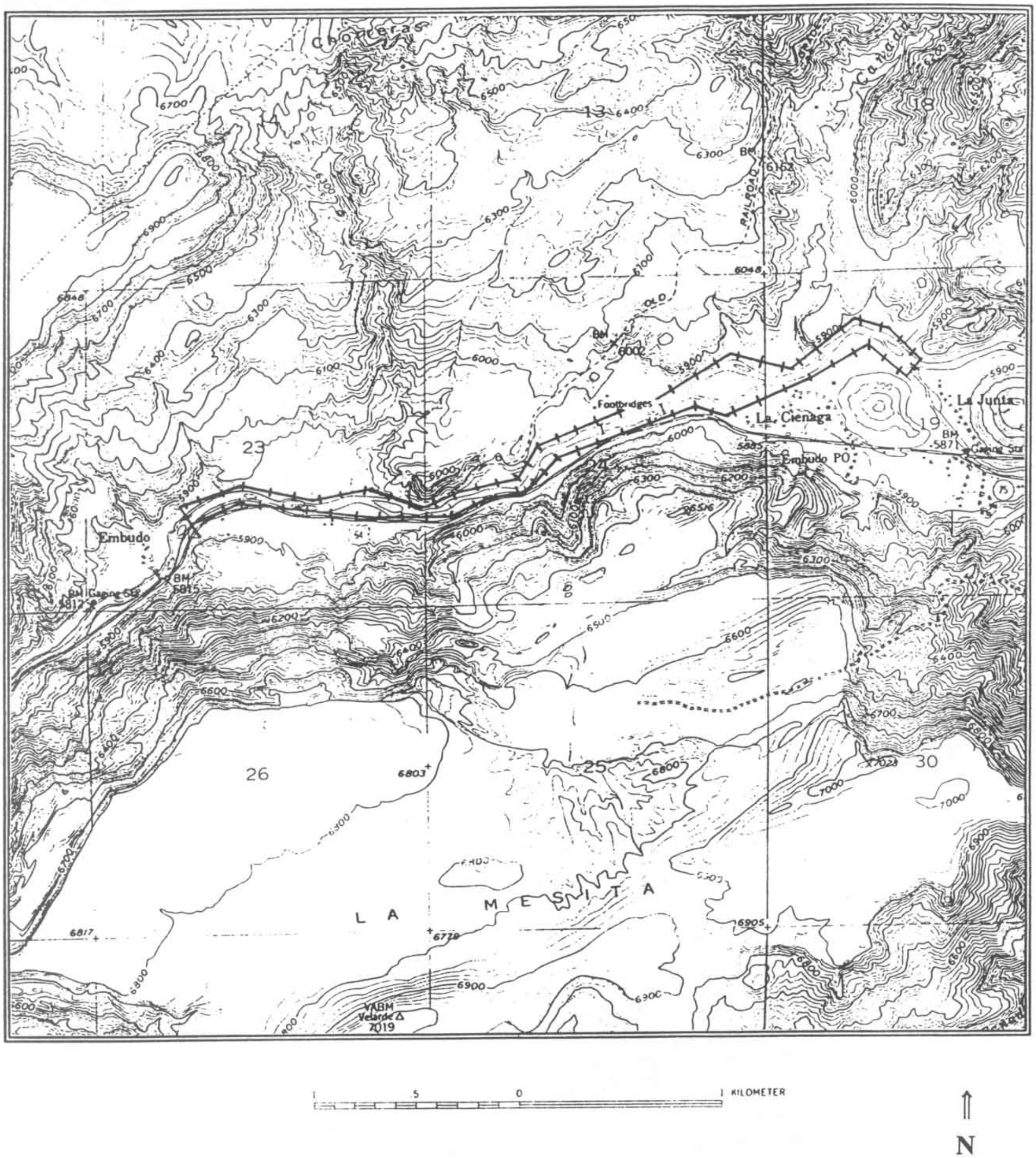

Figure D.22. Rio Grande, Site 4

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Ted Cline

Figure D.23. The upper reach of the Embudo Site on the Rio Grande. Rio Grande cottonwoods dominate the narrow floodplain throughout this site.

Site Name:	Lower Canada de Ojo Sarco	**Site Number:**	76
River:	Canada de Ojo Sarco	**County:**	Rio Arriba
Quad:	TRAMPAS	**Basin Number**	13020101

Town 22N **Range:** 11E **Section** 6

Latitude: 361000W **Longitude:** 1054910N

Site Quality: high

Min Site Size: 6 Ha **Stream Length:** 550 m

Data Sources: Ground Reconnaissance

General Description: This site is located at the lower reaches of the Canada de Ojo Sarco. Throughout its entire reach, the river remains unregulated and the channel is relatively free of other impacts such as levees. At this site, the floodplain is free of agriculture and grazing pastures. The channel is downcut and seems to isolate the common spikerush/smooth horsetail marsh at this site from the active channel. Based on hydraulic data, a 100-year flood would be required to inundate the marsh. The marsh therefore seems to be getting water from some other source. Off-road vehicles are the main impact here as roads were seen within the active floodplain and in overflow channels.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	light
Fuel Wood:	no	
Dumping:	no	
ORV Use:	yes	moderate
Roads:	yes	moderate
Mowing:	no	
Other Impacts:	unknown	

Cross Section: Canada de Ojo Sarco1

Site Plots:
94PD030 94PD031

Jurisdiction: BLM

Survey Date: 6/26/94

Investigators: Bradley/Durkin/Carr

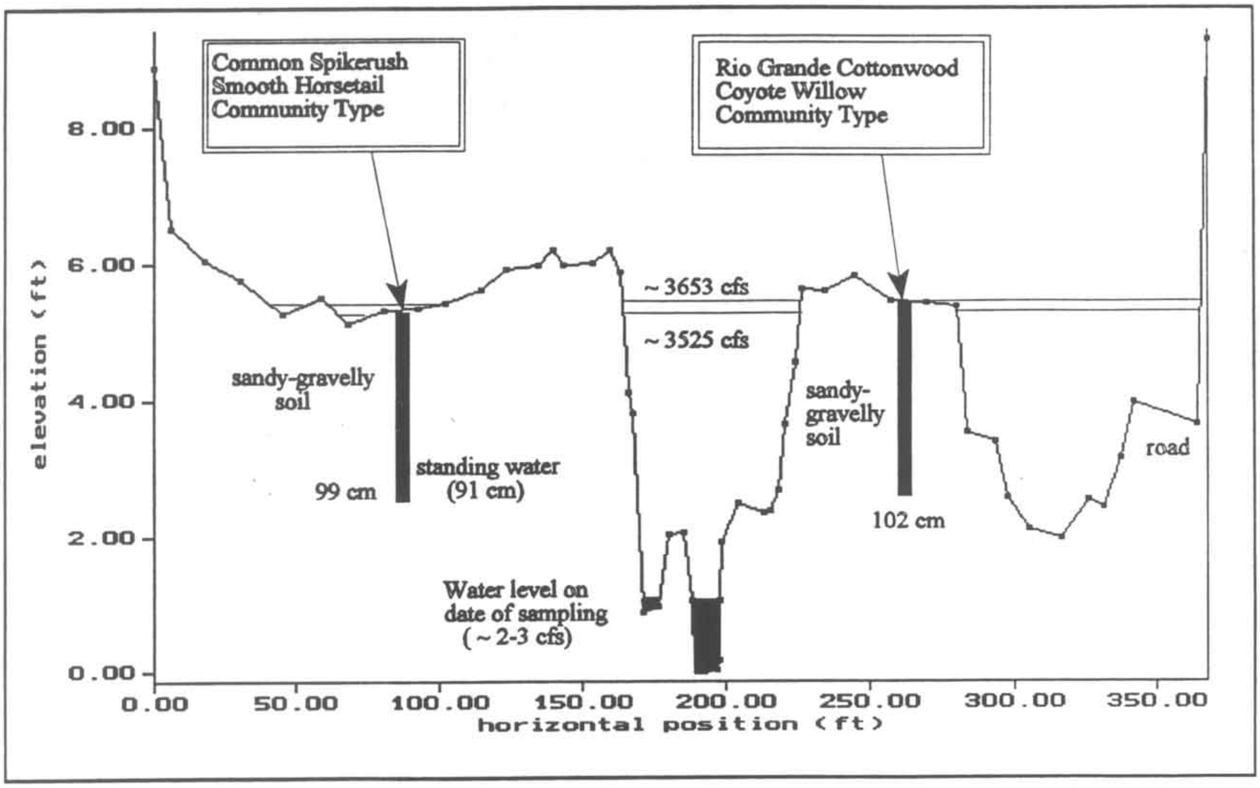

Figure D.24. Cross section of the Canada de Ojo Sarco at the Lower Canada de Ojo Sarco Site showing location of the communities, water required to flood them, predominant soil texture, and depth of the soil pit (black bar).

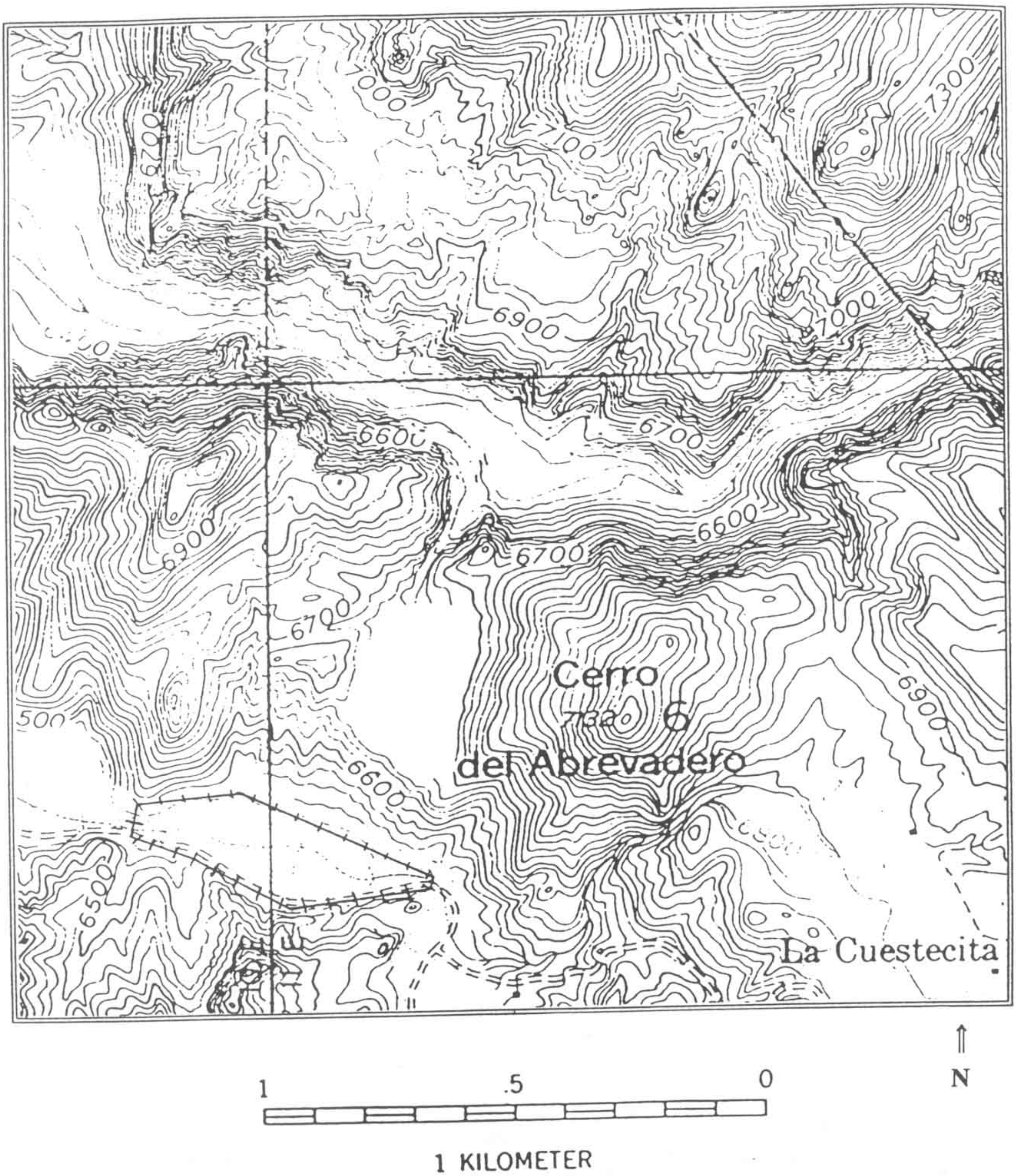

Figure D.25. Canada de Ojo Sarco, Site 76

Legend

+++++++++ = primary boundary

◁ = indefinite upper or lower boundary

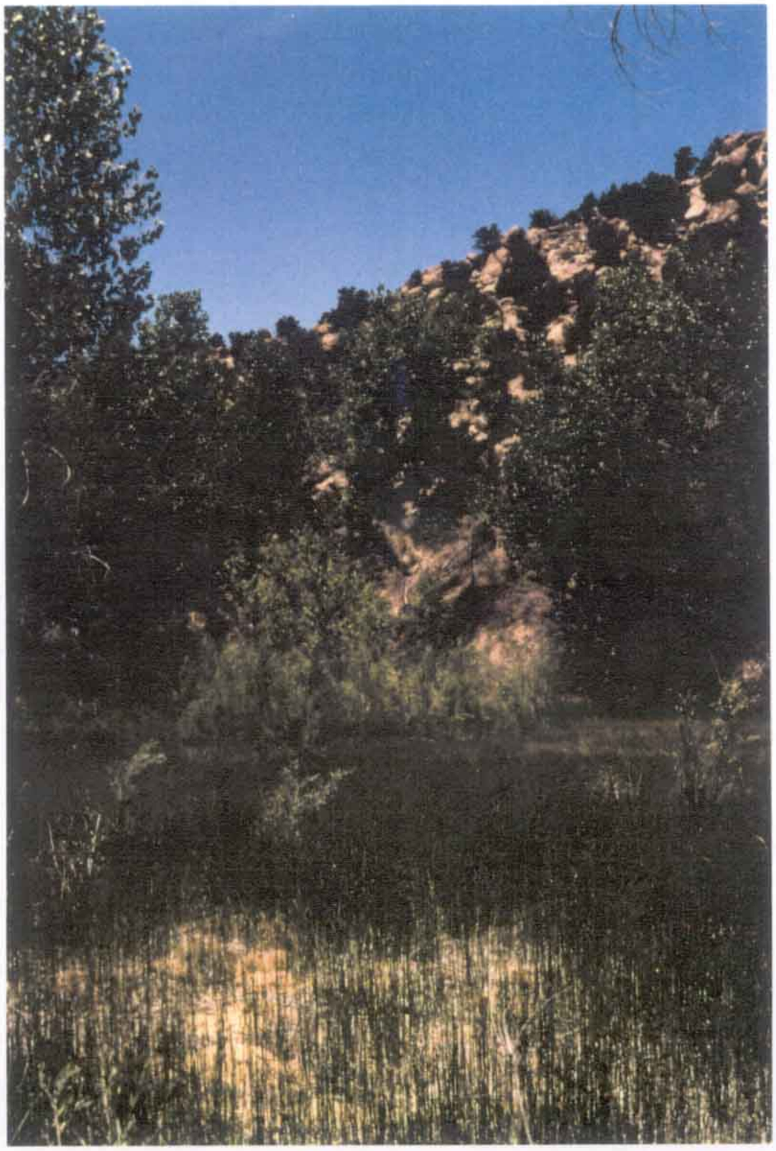

Photo: Mike Bradley

Figure D.26. The common spikerush/smooth horsetail community at the Lower Canada de Ojo Sarco site. Rio Grande cottonwoods and coyote willow are on the periphery of the marsh.

Site Name:	Rio Truchas	**Site Number:**	85
River:	Rio Truchas	**County:**	Rio Arriba
Quad:	VELARDE	**Basin Number**	13020101

Town 22N **Range:** 09E **Section** 24

Latitude: 360742W **Longitude:** 1055600N

Site Quality: high

Min Site Size: 5 Ha **Stream Length:** 300 m

Data Sources: Ground Reconnaissance

General Description: The Rio Truchas is entirely unregulated thoughout its course to the confluence of the Rio Grande. The hydraulic regime allows for natural reproduction of riparian species all along this reach. The marsh located at this site appears to be spring fed. High flows from an adjacent arroyo may also flood the site. The marsh is protected from scouring by natural burms that are upstream. The major impacts here are cattle and roads.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	occasional cattle
Fuel Wood:	unknown	
Dumping:	unknown	
ORV Use:	yes	light
Roads:	yes	dirt road adjacent to floodplain
Mowing:	no	
Other Impacts:	unknown	

Cross Section: BLM3

Site Plots:
92RW025 92EM019 92EM020
92RW020

Jurisdiction: BLM

Survey Date: 8/21/92

Investigators: Wallace/Muldavin

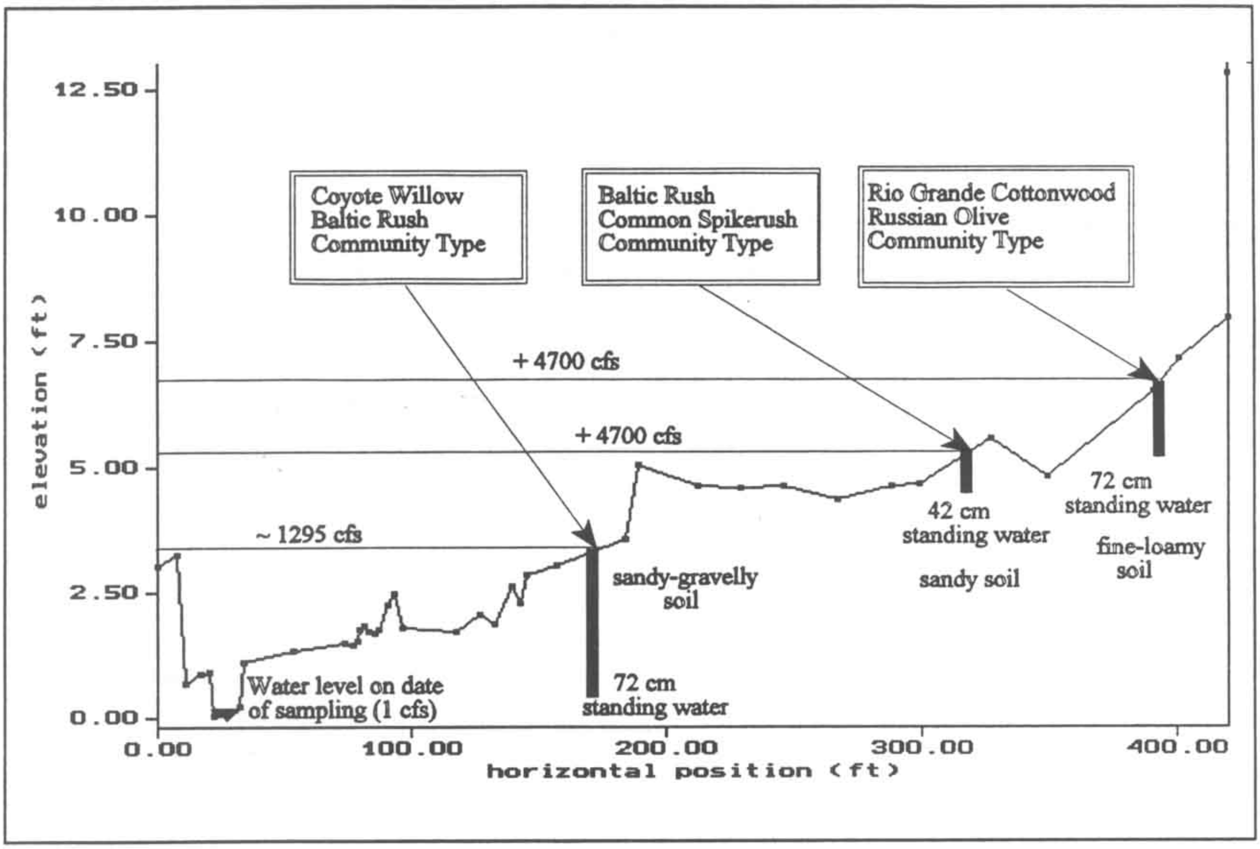

Figure D. 27. Cross section of the Rio Truchas at the Rio Truchas Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

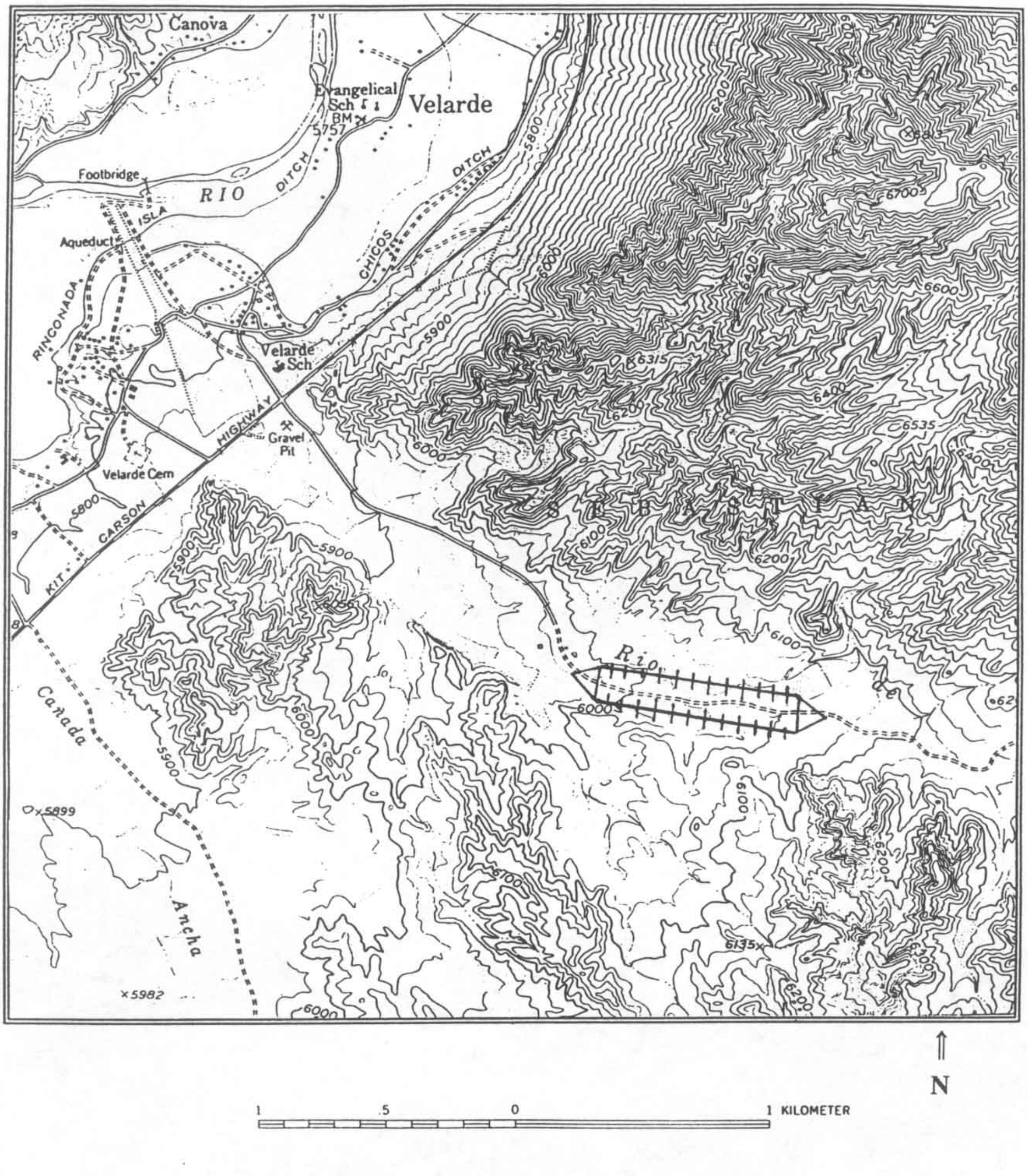

Figure D.28. Rio Truchas, Site 85

Legend

++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Esteban Muldavin

Figure D.29. The Baltic rush-common spikerush community on at the Rio Truchas Site.

Site Name:	Agua Caliente	**Site Number:**	84
River:	Agua Caliente	**County:**	Taos
Quad:	CARSON	**Basin Number**	13020101

Town 24N **Range:** 11E **Section** 33

Latitude: 361547W **Longitude:** 1054558N

Site Quality: high

Min Site Size: 16 Ha **Stream Length:** 1830 m

Data Sources: Ground Reconnaissance

General Description: The Agua Caliente is unregulated throughout its extent and therefore natural fluvial process still occur. The riparian vegetation is diverse and exotic species are low. The main impact at this site is grazing by cattle and horses.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant:	no	some sweet clover however
Grazing:	yes	light horse and cattle grazing
Fuel Wood:	unknown	
Dumping:	unknown	
ORV Use:	unknown	
Roads:	no	
Mowing:	no	
Other Impacts:	unknown	

Cross Section: BLM11

Site Plots:
92EM024 92RW016 92EM025

Jurisdiction: BLM

Survey Date: 8/28/92

Investigators: Muldavin/Wallace

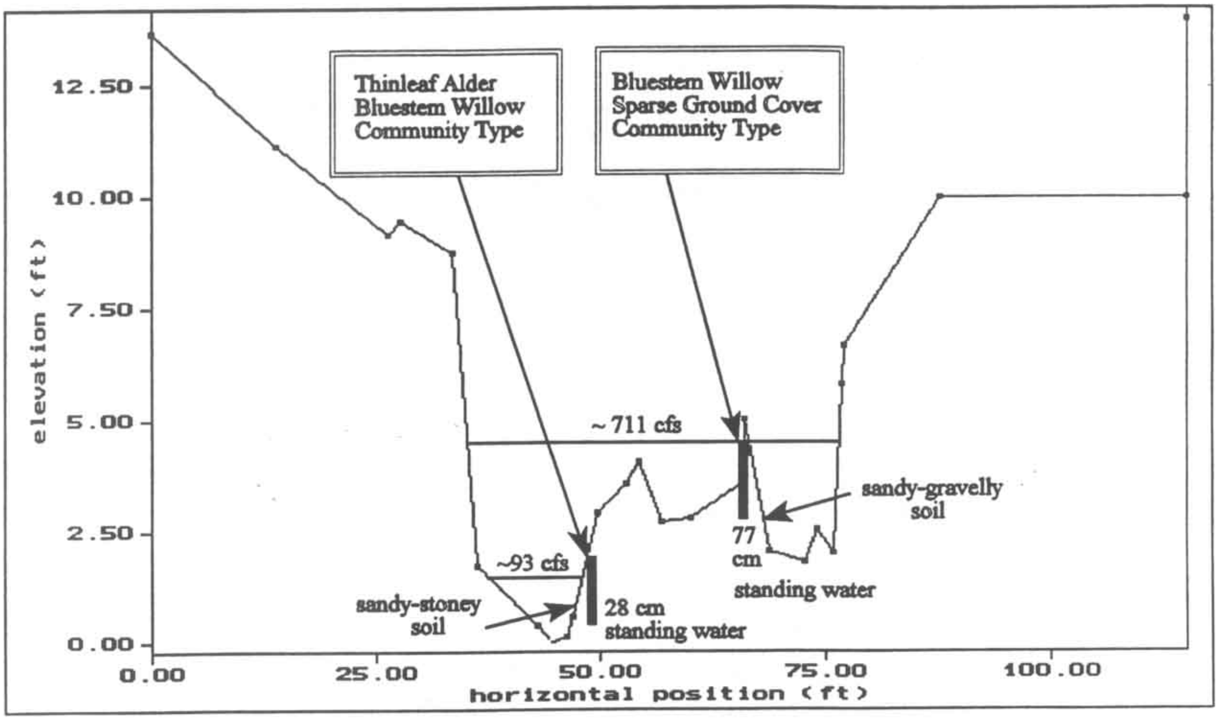

Figure D.30. Cross section of the Agua Caliente at the Agua Caliente Site showing location of the communities, water level required to flood them, predominant soil texture and depth of the soil pit (black bar).

Figure D.31. Agua Caliente, Site 84

<u>Legend</u>

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Esteban Muldavin

Figure D.32. The thinleaf alder/redosier dogwood community at the Agua Caliente Site.

Site Name:	Arroyo Cuma	**Site Number:**	98
River:	Rio Tesuque	**County:**	Santa Fe
Quad:	TESUQUE	**Basin Number**	13020101

Town 18N **Range:** 09E **Section** 14

Latitude: 354741W **Longitude:** 1055755N

Site Quality: high

Min Site Size: 10 Ha **Stream Length:** 920 m

Data Sources: Ground Reconnaissance

General Description: Except for some diversion dams for irrigation, the Rio Tesuque flows relatively unregulated. Russian olives and black locusts are common but cottonwoods dominate the floodplain. The highlight of this site is the American bulrush/smooth horetail marsh that is present here. A spring is thought to be the source of water for this marsh, although runoff from irrigation field may also contribute. Other impacts include some light grazing by horses.

Hydrologic Status	**Flow Regulation:**	No	**Jetty Jacks:**	No	**Levee:**	Yes
	Dredging:	No	**RipRap:**	No		

Exotic veg dominant:	no	but exotics common
Grazing:	yes	light; horses
Fuel Wood:	no	
Dumping:	no	
ORV Use:	no	
Roads:	yes	dirt road down to the river
Mowing:	no	
Other Impacts:	yes	agriculture

Cross Section: Tesuque1

Site Plots:
94PD107

Jurisdiction: Tesuque Reservation

Survey Date: 9/28/94

Investigators: Durkin/Carr

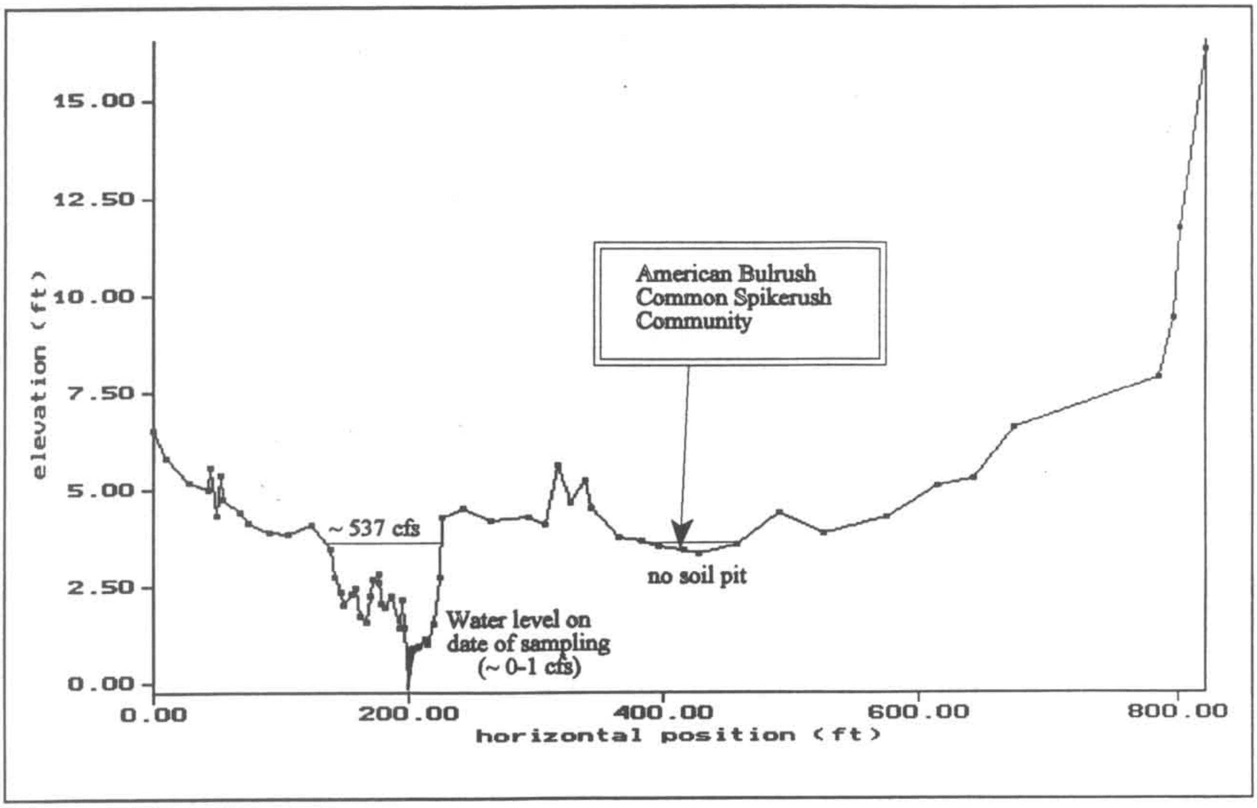

Figure D.33. Cross section of the Rio Tesuque at the Arroyo Cuma Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

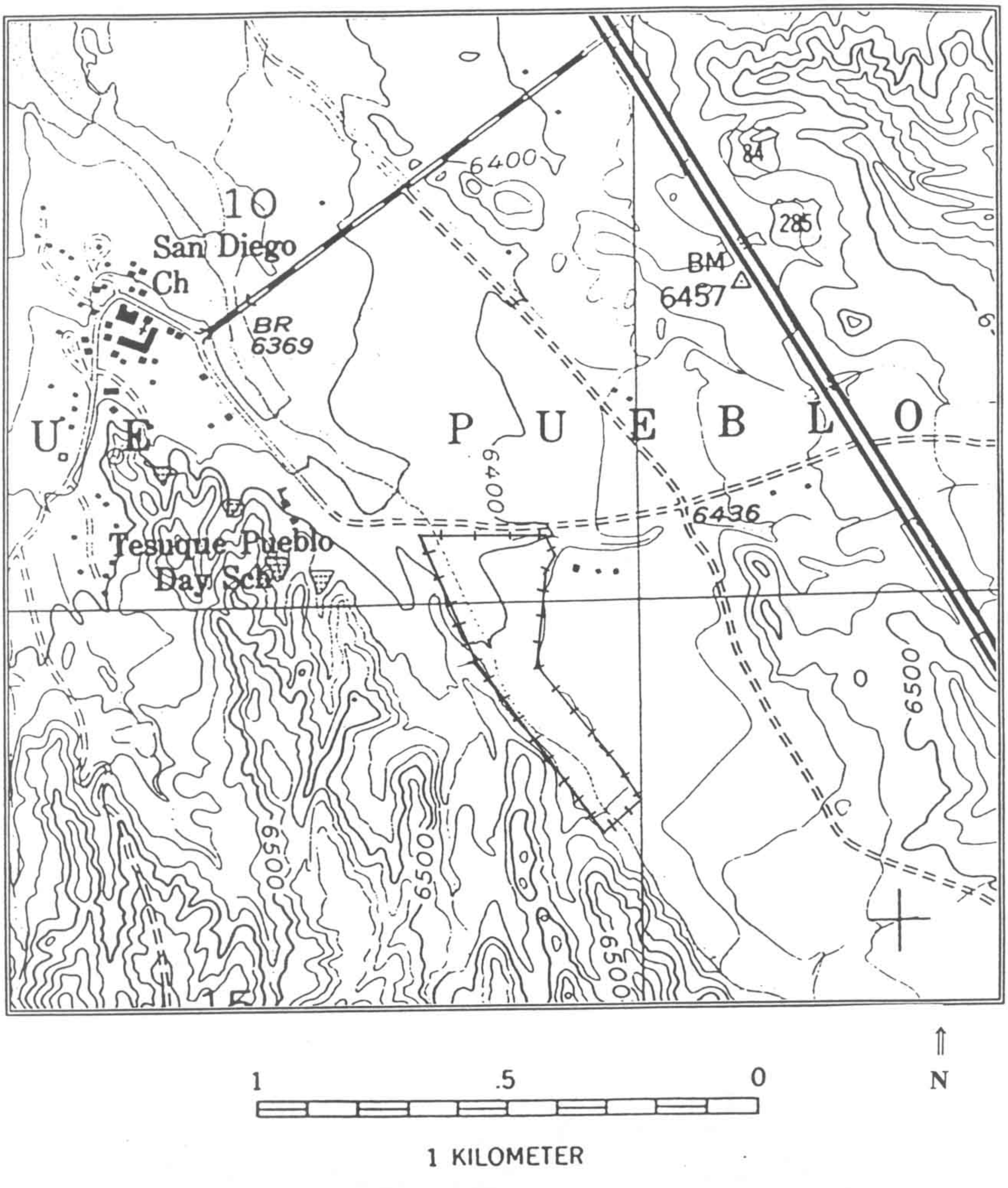

Figure D.34. Rio Tesuque, Site 98

Legend

+++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Site Name: Canon **Site Number:** 68

River: Jemez **County:** Sandoval

Quad: Ponderosa **Basin Number** 13020202

Town 17N **Range:** 02E **Section** 32

Latitude: 354000W **Longitude:** 1064438N

Site Quality: high

Min Site Size: 35 Ha **Stream Length:** 2200 m

Data Sources: Air Photo Interpretation; Ground Reconnaissance

General Description: Except for a small diversion dam, the Jemez river at this site is unregulated. Major channel movements within the floodplain will not occur as the river is confined by a levee on the east side and agricultural fields on the west side. Nonetheless, the Jemez still has a natural hydraulic regime that maintains good stands of riparian vegetation. Although fragmented by urbanization and agriculture, the Rio Grande cottonwood/New Mexico olive community forms some dense stands along this reach.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: no

Fuel Wood: unknown

Dumping: unknown

ORV Use: no

Roads: yes adjacent to floodplain

Mowing: no

Other Impacts: yes agricultural field on west side

Cross Section: Jemez1

Site Plots:
94PD068 94PD067

Jurisdiction: Private and Santa Fe NF

Survey Date: 7/28/94

Investigators: Bradley/Durkin/Carr

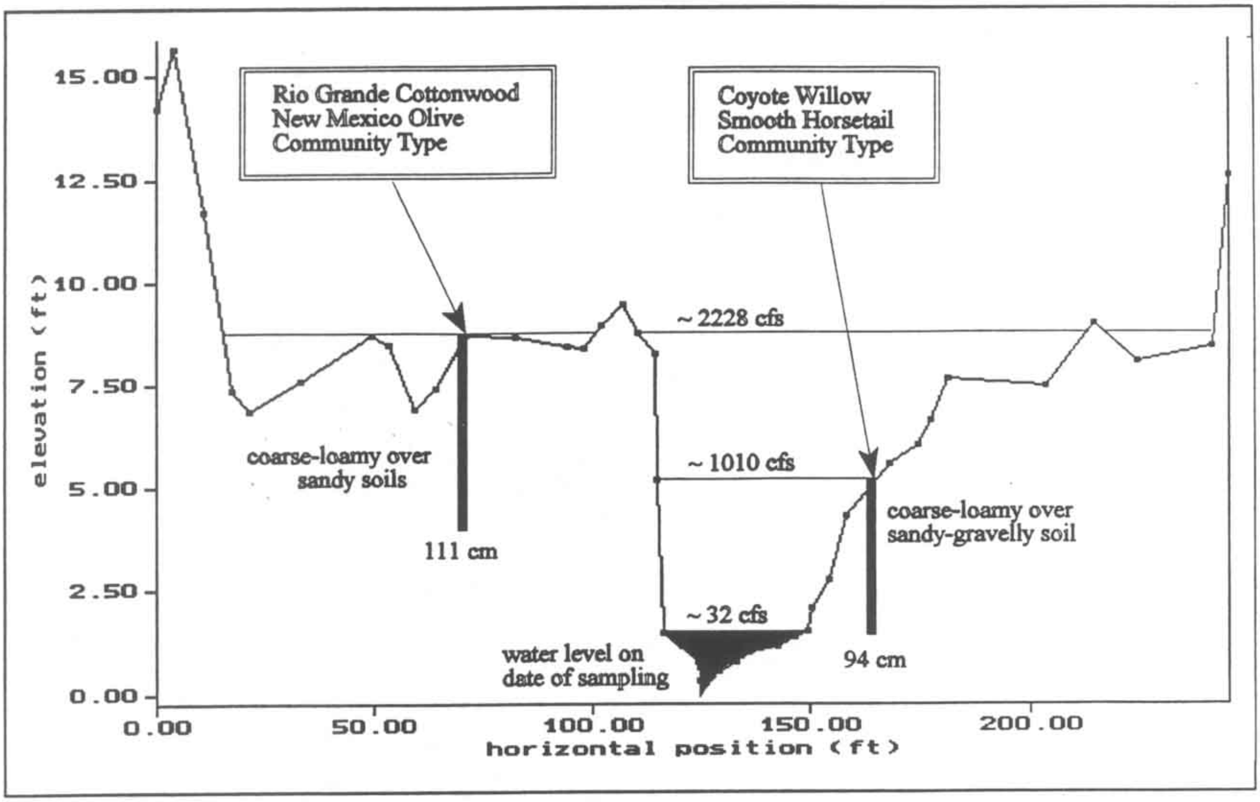

Figure D.35. Cross section of the Rio Jemez at the Canon Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

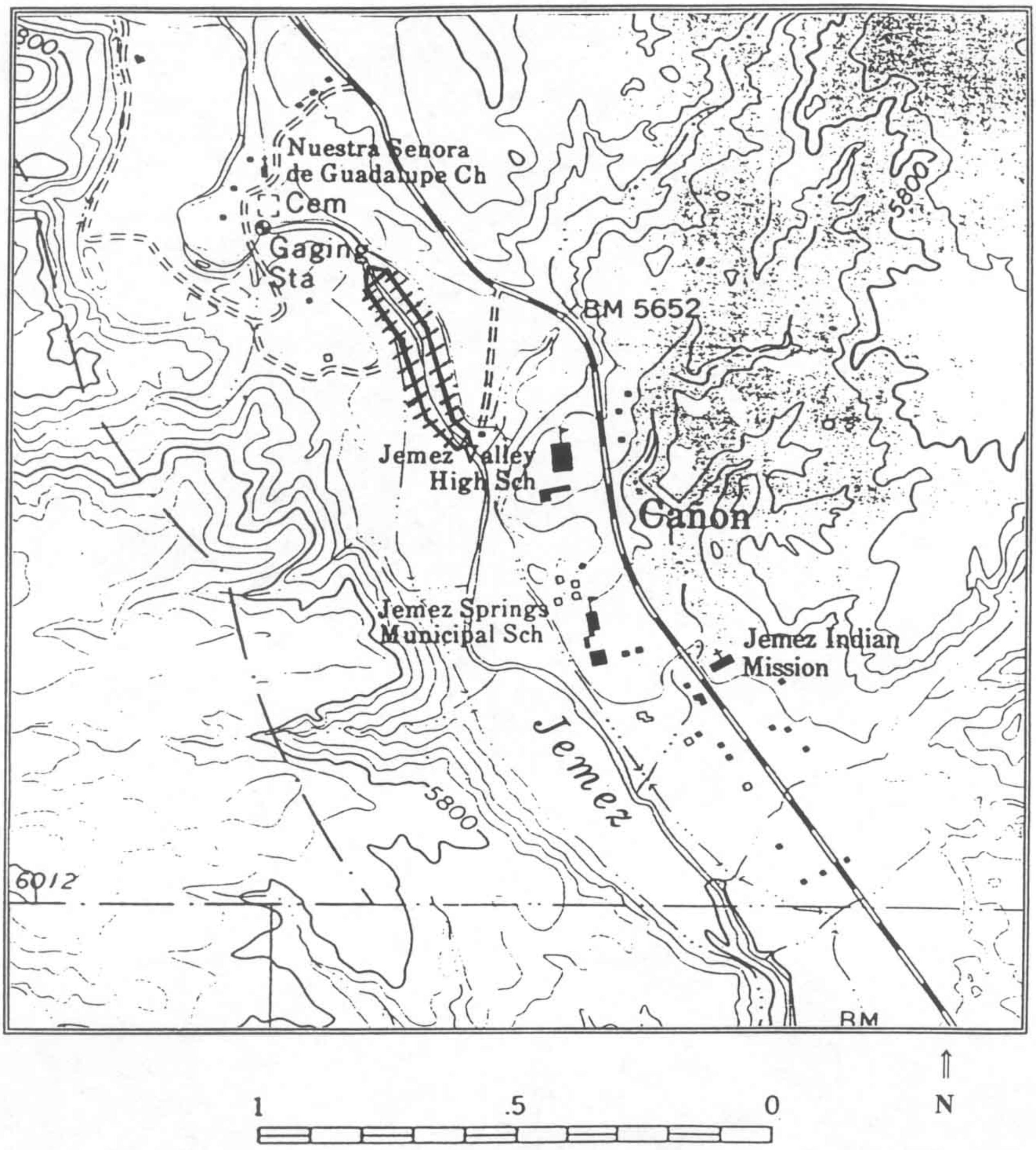

Figure D.36. Jemez River, Site 68

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

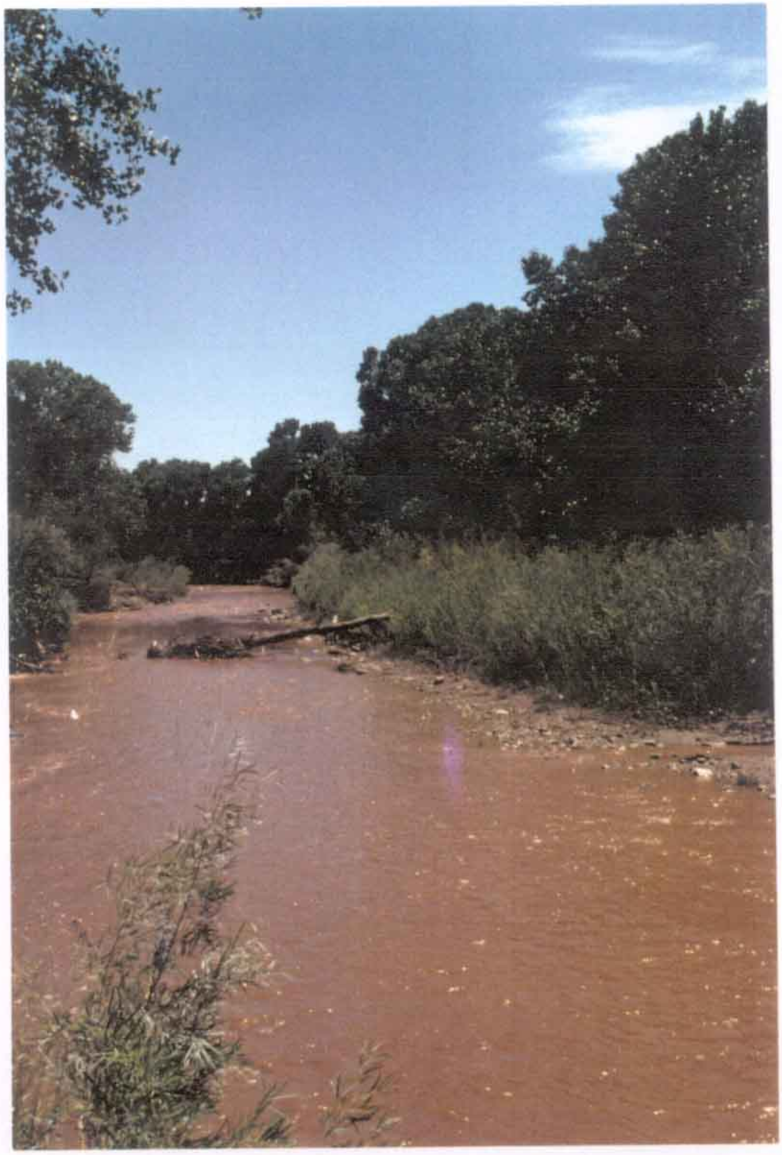

Photo: Mike Bradley

Figure D.37. The Jemez River at the Canon Site. Note lush areas of coyote willow on the side bar and the Rio Grande cottonwoods on the edges of the floodplain.

Site Name:	Paguate	**Site Number:**	93
River:	Rio Paguate	**County:**	Cibola
Quad:	SEBOYETA	**Basin Number**	13020207

Town 11N **Range:** 05W **Section** 30

Latitude: 350919W **Longitude:** 1072527N

Site Quality: high

Min Site Size: 28 Ha **Stream Length:** 3780 m

Data Sources: Ground Reconnaissance

General Description: The Rio Paguate is unregulated at this site and natural fluvial process are allowed to occur. At the upper reach of the site, a cattail marsh occurs. Impacts here include grazing and a trail used by fishermen. On the date of sampling no evidence of cattle was seen. Upon revisitation of the site however, evidence of cattle was observed.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	moderate
Fuel Wood:	no	
Dumping:	no	
ORV Use:	no	
Roads:	no	
Mowing:	no	
Other Impacts:	yes	trail used by fishermen

Cross Section: Rio Paguate1

Site Plots:
94PD020

Jurisdiction: Laguna Pueblo and private

Survey Date: 6/15/94

Investigators: Bradley/Carr/Durkin

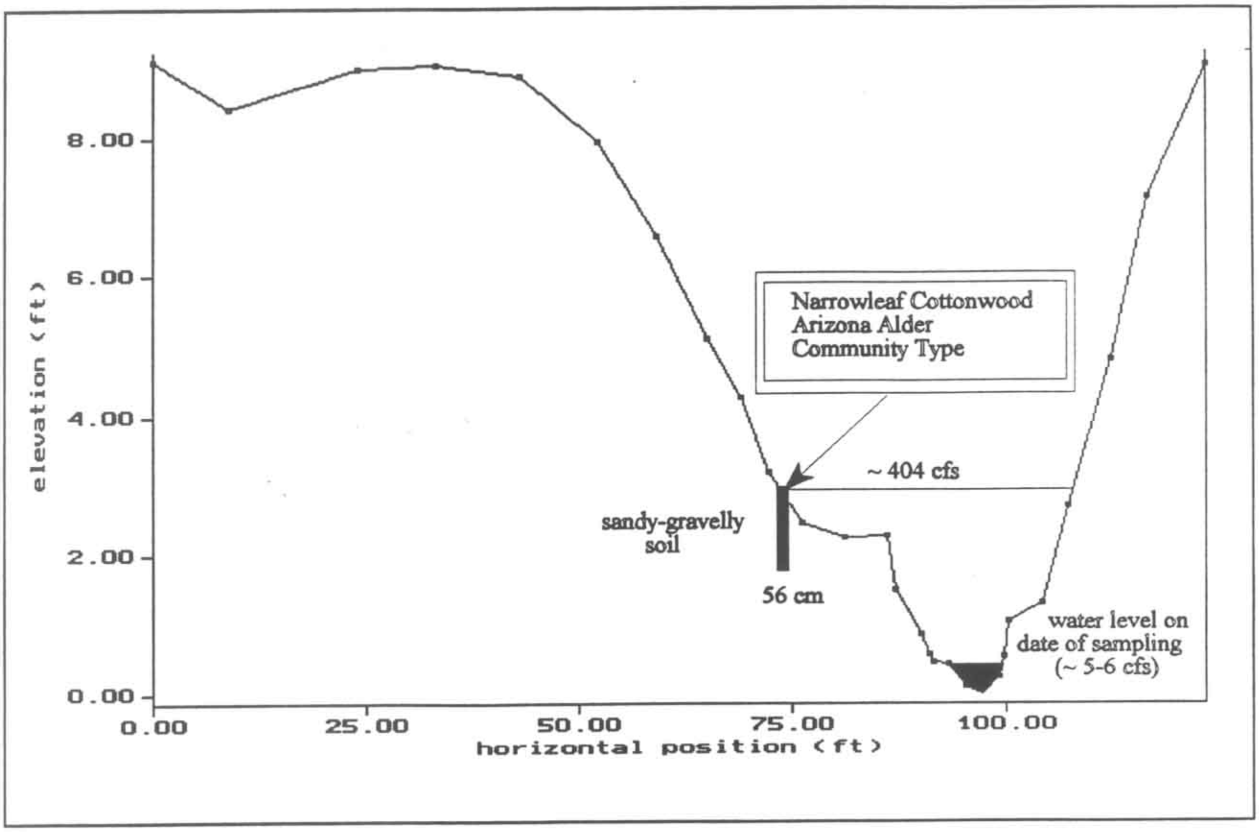

Figure D.38. Cross section of Paguate Creek at the Paguate Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit (black bar).

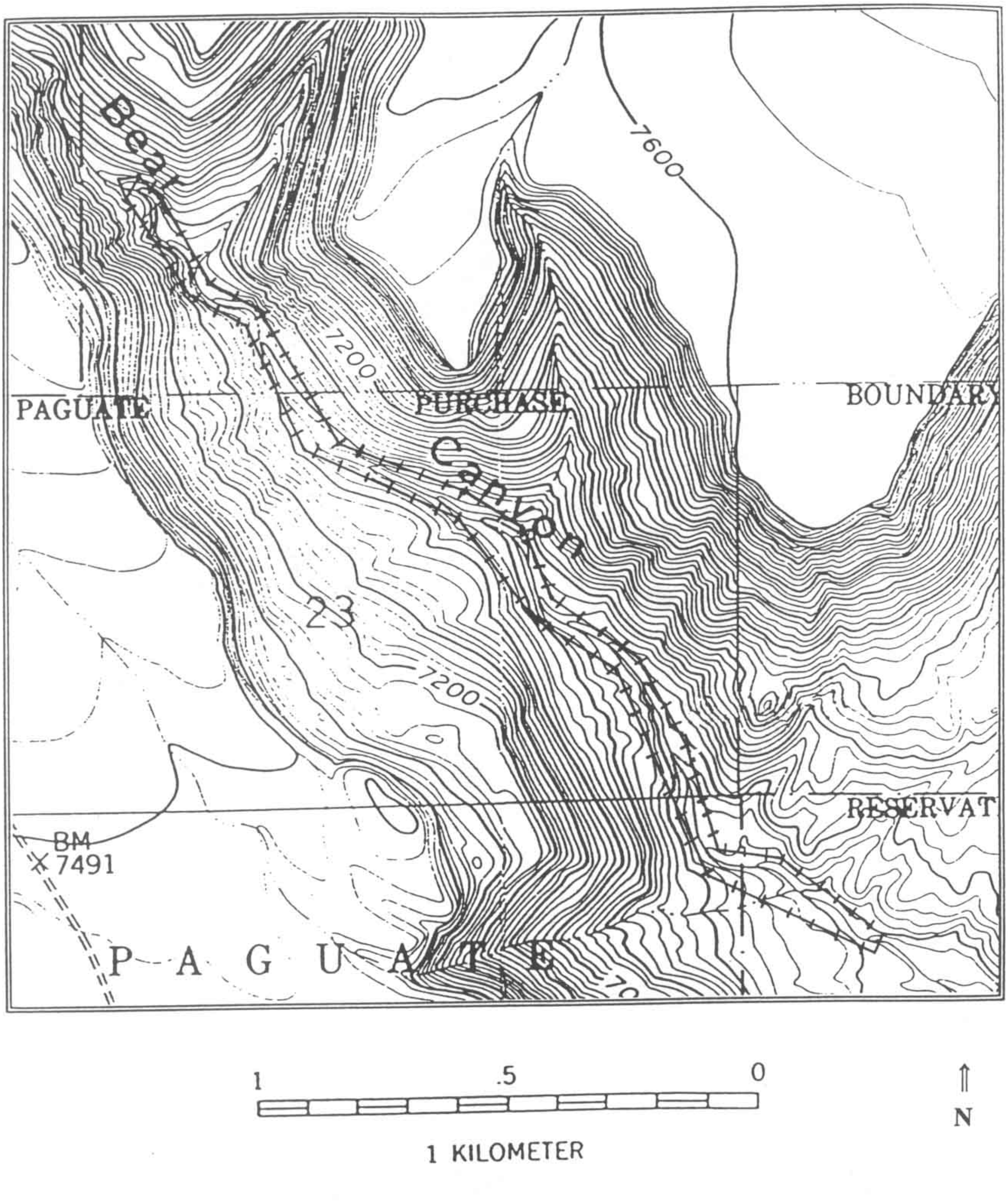

Figure D.39. Rio Paguate, Site 93

Legend

+++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Mike Bradley

Figure D.40. Broadleaf cattail and American bulrush marsh located at the upper reach of the Rio Paguate Site.

Site Name: Lower Palomas **Site Number:** 102

River: Palomas **County:** Sierra

Quad: WILLIAMSBURG **Basin Number** 13030101

Town 13S **Range:** 06W **Section** 4

Latitude: 331249W **Longitude:** 1072807N

Site Quality: high

Min Site Size: 7 Ha **Stream Length:** 570 m

Data Sources: Ground Reconnaissance

General Description: Palomas Creek at the lower Palomas Site is an unregulated stream that is allowed to move laterally within the floodplain. Flooding allows reproduction of riparian species at this site. Impacts here include evidence of beaver, horses, and cattle. Roads are minimal through much of the site.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	light grazing by horses and bison
Fuel Wood:	no	
Dumping:	no	
ORV Use:	no	
Roads:	yes	on the outer limits of the site
Mowing:	no	
Other Impacts:	yes	ranch located at west boundary of site

Cross Section: Palomas1

Site Plots:
94PD015 94PD014 94PD016 94PD013
94PD017

Jurisdiction: Private; Ladder Ranch

Survey Date: 6/8/94

Investigators: Bradley/Durkin/Carr

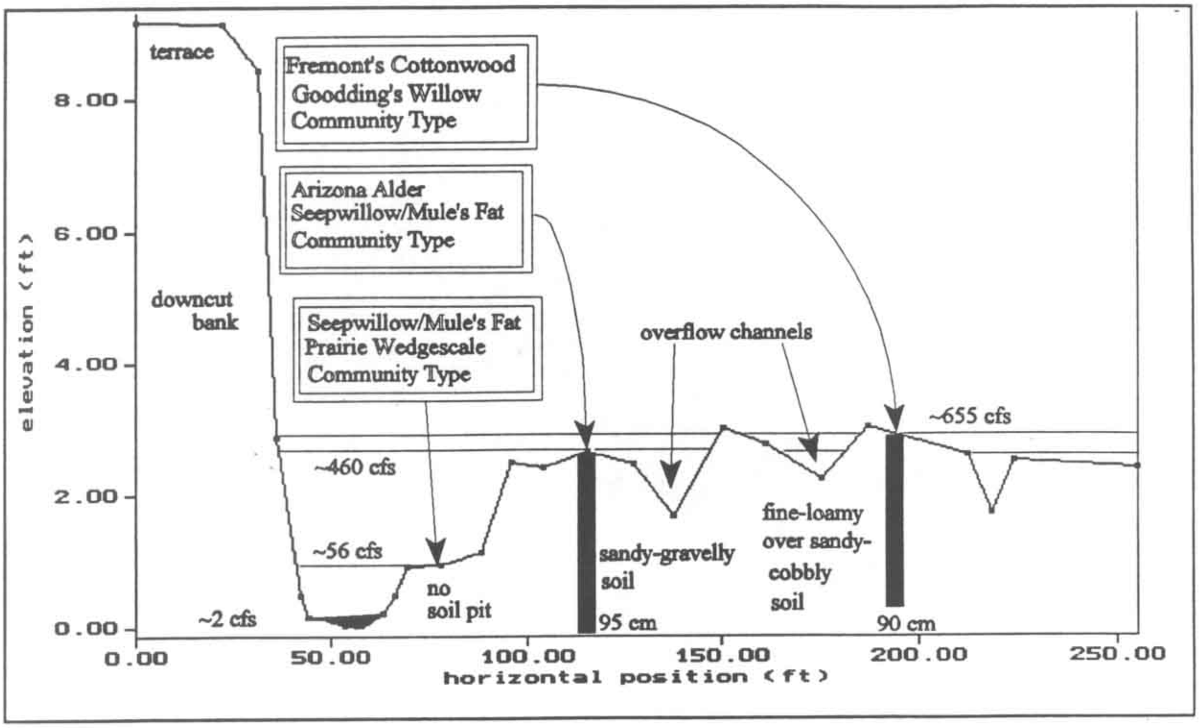

Figure D.41. Cross section of Palomas Creek at the Lower Palomas Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit, if present (black bar).

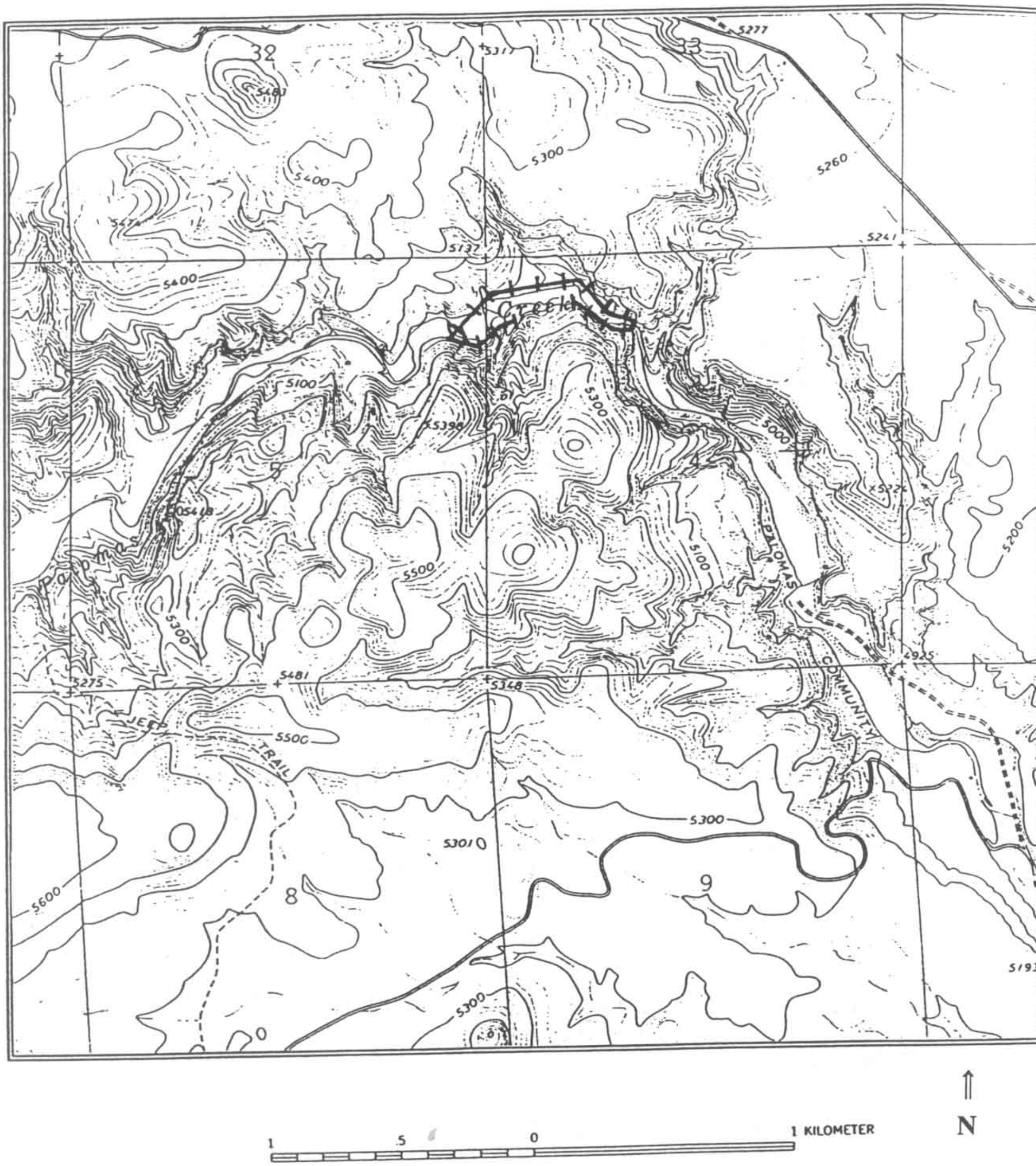

Figure D.42. Palomas Creek, Site 102

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Mike Bradley

Figure D.43. Fremont's cottonwood and Goodding's willow on Palomas Creek at the Lower Palomas Site. Seepwillow is also common along the side bar.

Site Name: North Seco Canyon **Site Number:** 103

River: Seco Creek **County:** Sierra

Quad: BELL MOUNTAIN **Basin Number** 13030101

Town 14S **Range:** 08W **Section** 6

Latitude: 330647W **Longitude:** 1074220N

Site Quality: high

Min Site Size: 9 Ha **Stream Length:** 600 m

Data Sources: Ground Reconnaissance

General Description: This site is located on Seco Creek on the western boundary of the Ladder Ranch. Seco Creek flows unregulated and without any other channel impacts (i.e. levees etc.). At this site the creek flows perenially for about one mile. Natural fluvial process occur and reproduction of riparian species occurs naturally. Impacts here include some light evidence of grazing and a dirt ranch road.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	yes	light grazing by bison
Fuel Wood:	no	
Dumping:	no	
ORV Use:	yes	by ranch hands
Roads:	yes	on the outer reaches of the floodplain
Mowing:	no	
Other Impacts:	no	

Cross Section: North Seco1

Site Plots:
94PD004 94PD005

Jurisdiction: Private; Ladder Ranch

Survey Date: 6/2/94

Investigators: Bradley/Carr/Durkin

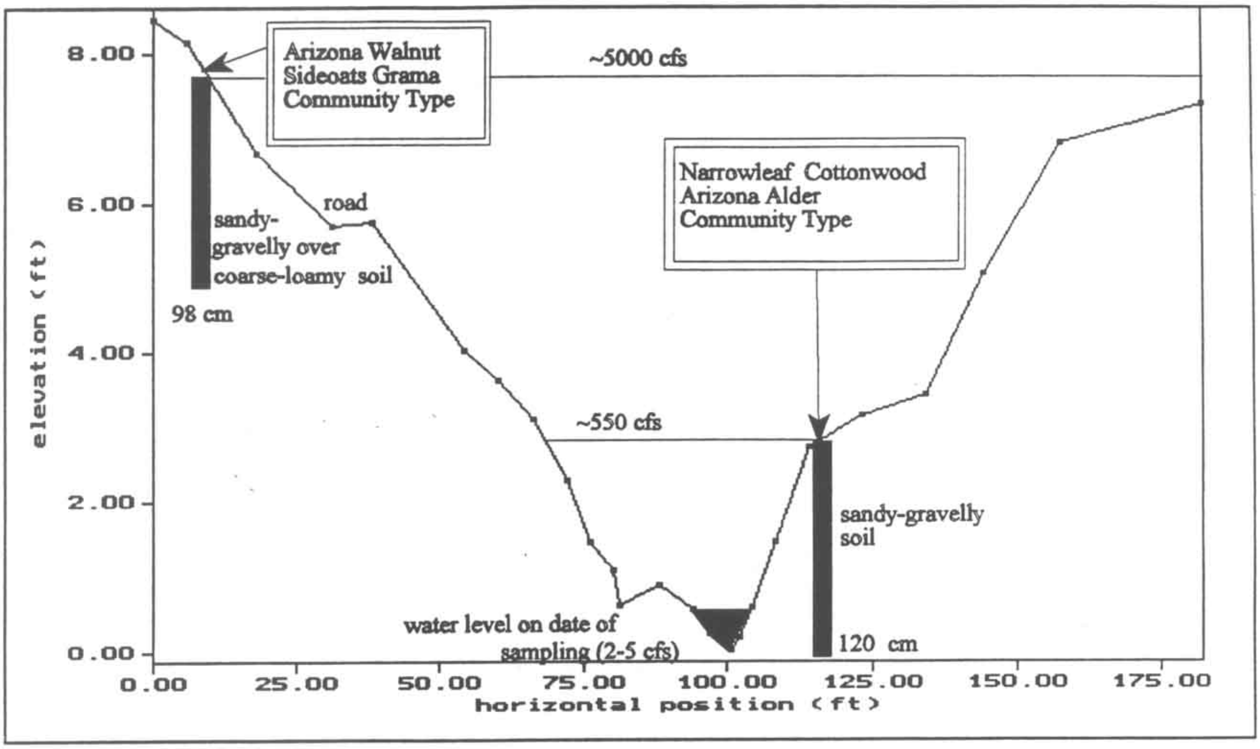

Figure D.44. Cross section of North Seco Creek at the North Seco Canyon Site showing locations of the communities, water levels required to flood them, the predominant soil texture and depth of the soil pit, if present (black bar).

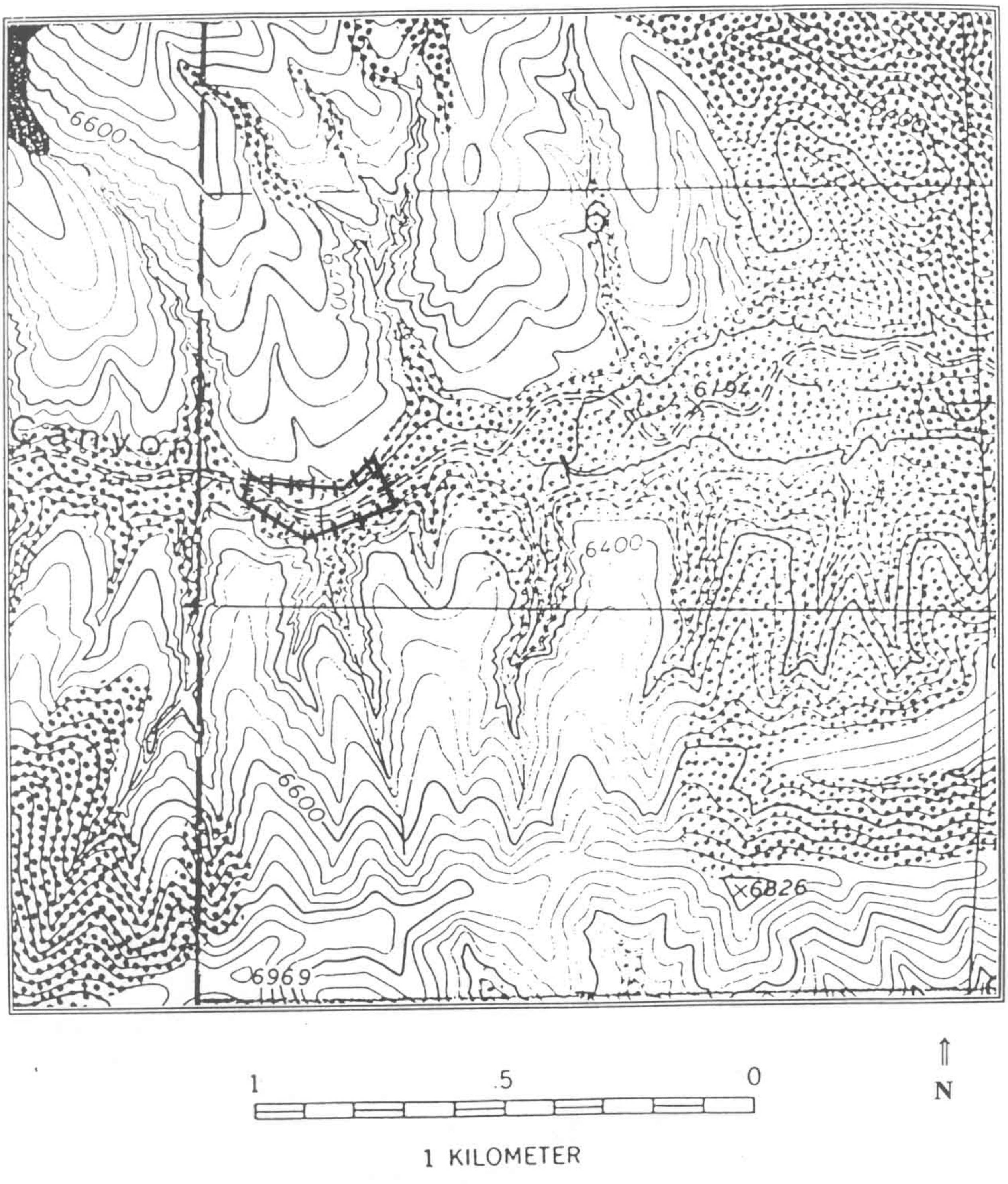

Figure D.45. North Seco Creek, Site 103

<u>Legend</u>

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

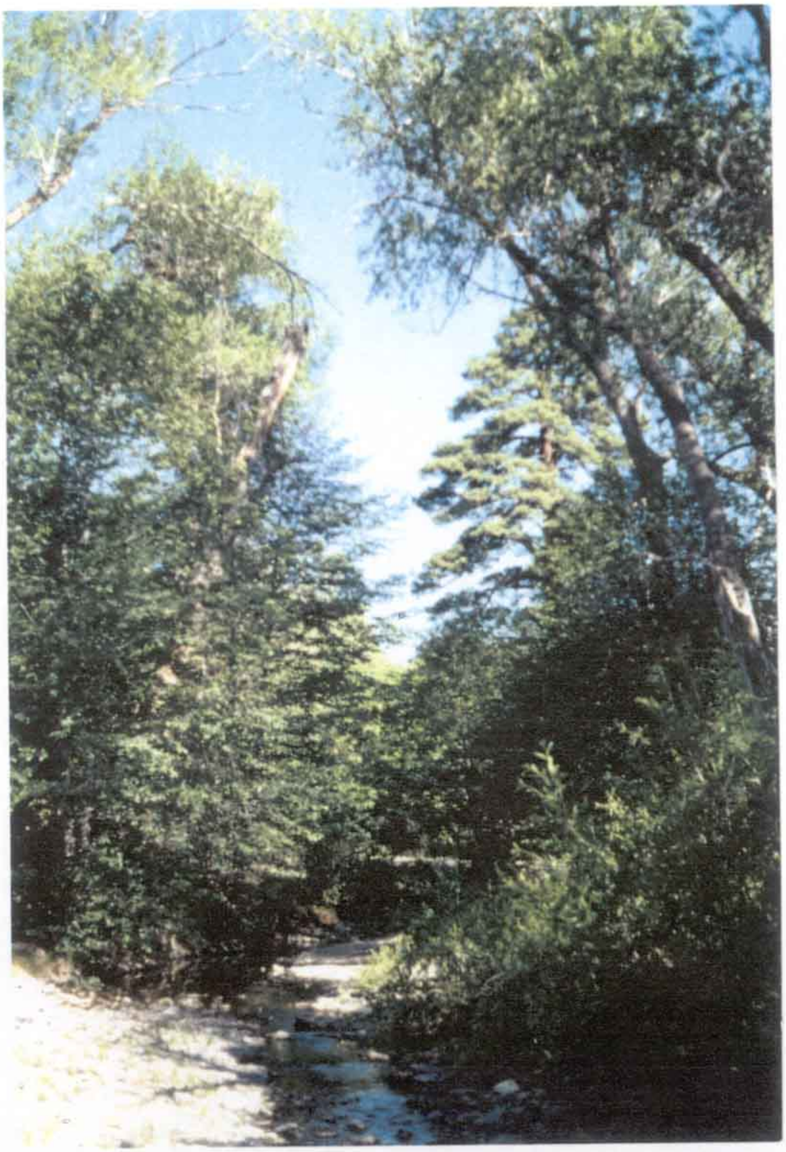

Photo: Mike Bradley

Figure D.46. Arizona alders and narrowleaf cottonwoods on North Seco Creek at the North Seco Canyon Site.

Site Name:	Lower Seco Canyon	**Site Number:**	104
River:	Seco Creek	**County:**	Sierra
Quad:	BELL MOUNTAIN	**Basin Number**	13030101

Town 14S **Range:** 07W **Section** 28

Latitude: 330451W **Longitude:** 1073155N

Site Quality: high

Min Site Size: 10 Ha **Stream Length:** 1830 m

Data Sources: Ground Reconnaissance

General Description: This site is located on the middle reach of Seco Creek on the Ladder Ranch. Throughout its entire length, Seco Creek flows unregulated and without any other channel impacts such as levees. Throughout this site, the creek flows perenially, but both upstream and downstream of the site flows are sub-surface. Natural fluvial process operate to succesfully regenerate riparian species. Because of difficult accessibility and management practices, bison grazing is minimal in this reach.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: yes light bison grazing

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: no

Mowing: no

Other Impacts: no

Cross Section: Seco1

Site Plots:
94PD006 94PD007

Jurisdiction: Private; Ladder Ranch

Survey Date: 6/2/94

Investigators: Durkin/Bradley/Carr

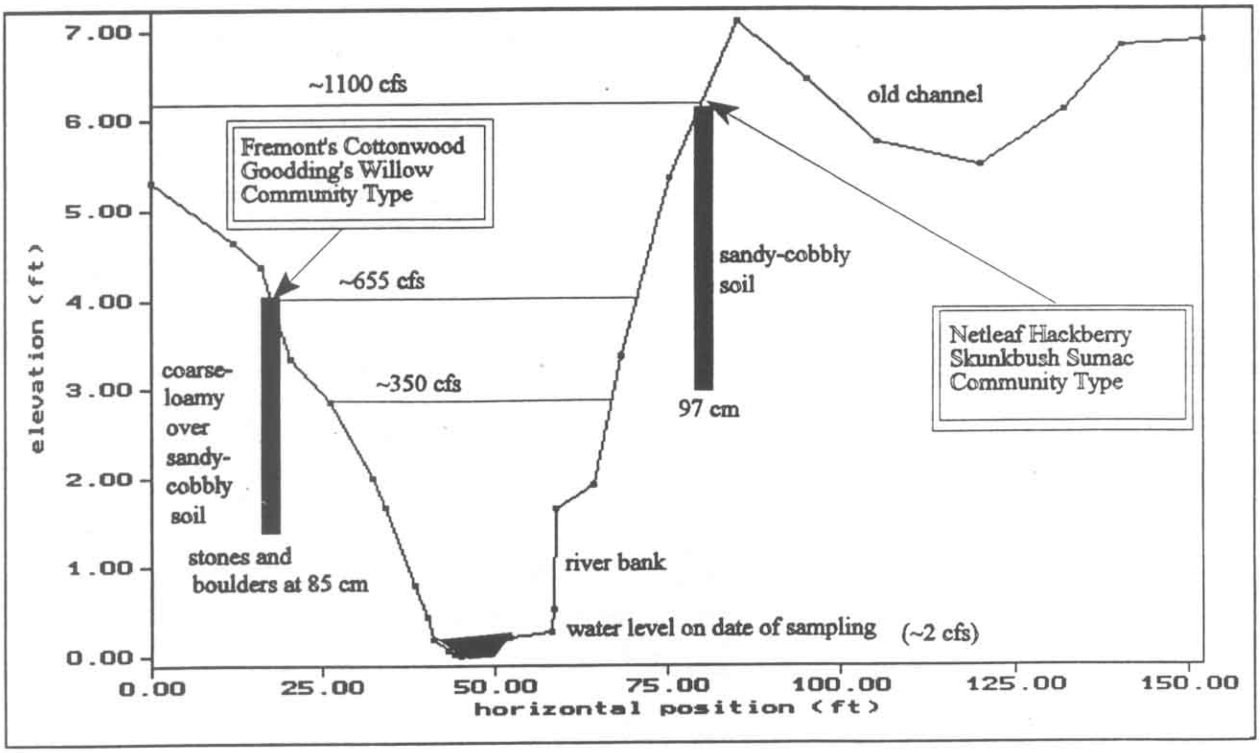

Figure D-47. Cross section of Seco Creek at the Lower Seco Canyon Site showing locations of the communities, water levels required to flood them, the predominant soil texture, and depth of soil pit, if present (black bar).

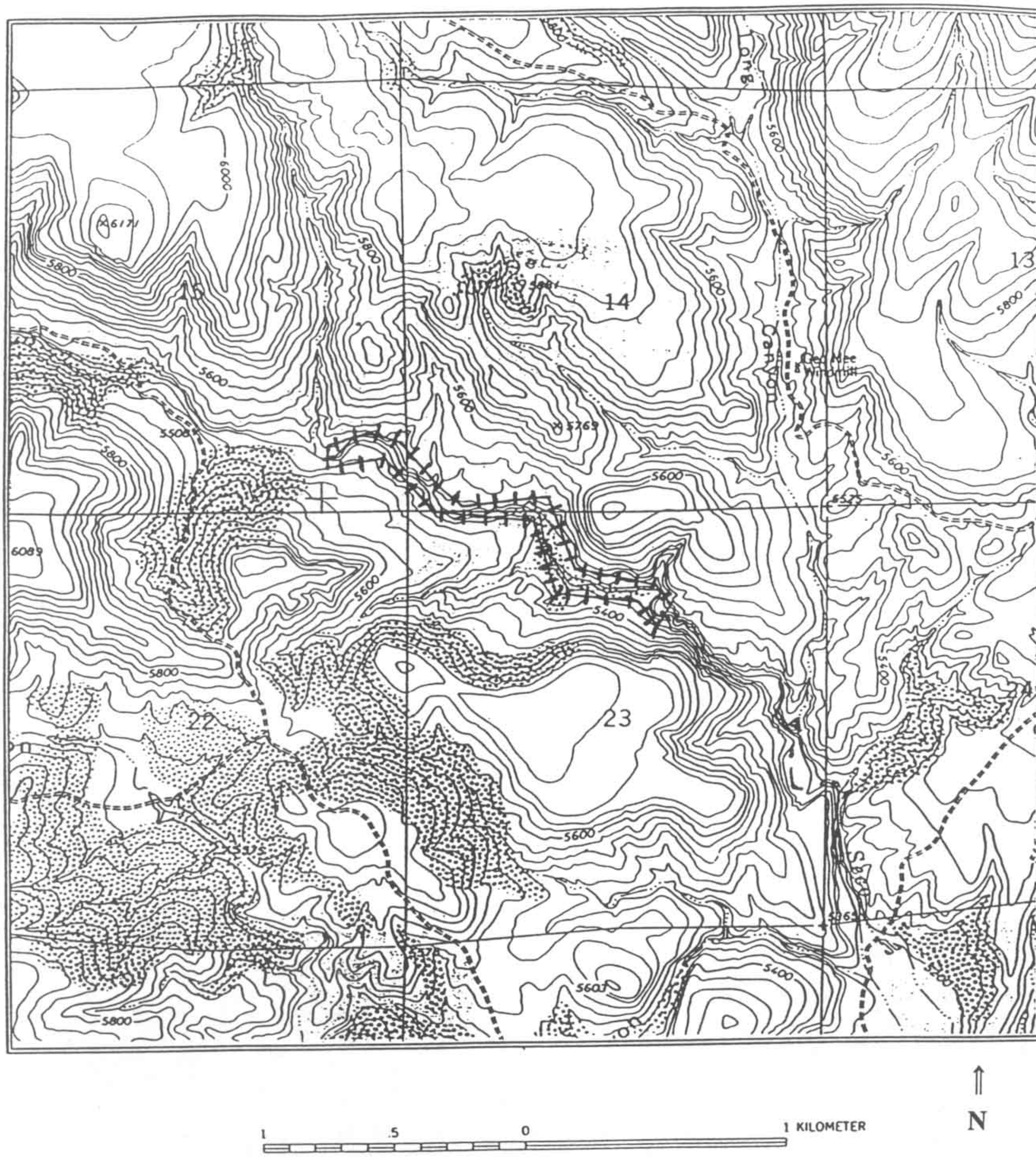

Figure D.48. Seco Creek, Site 104

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

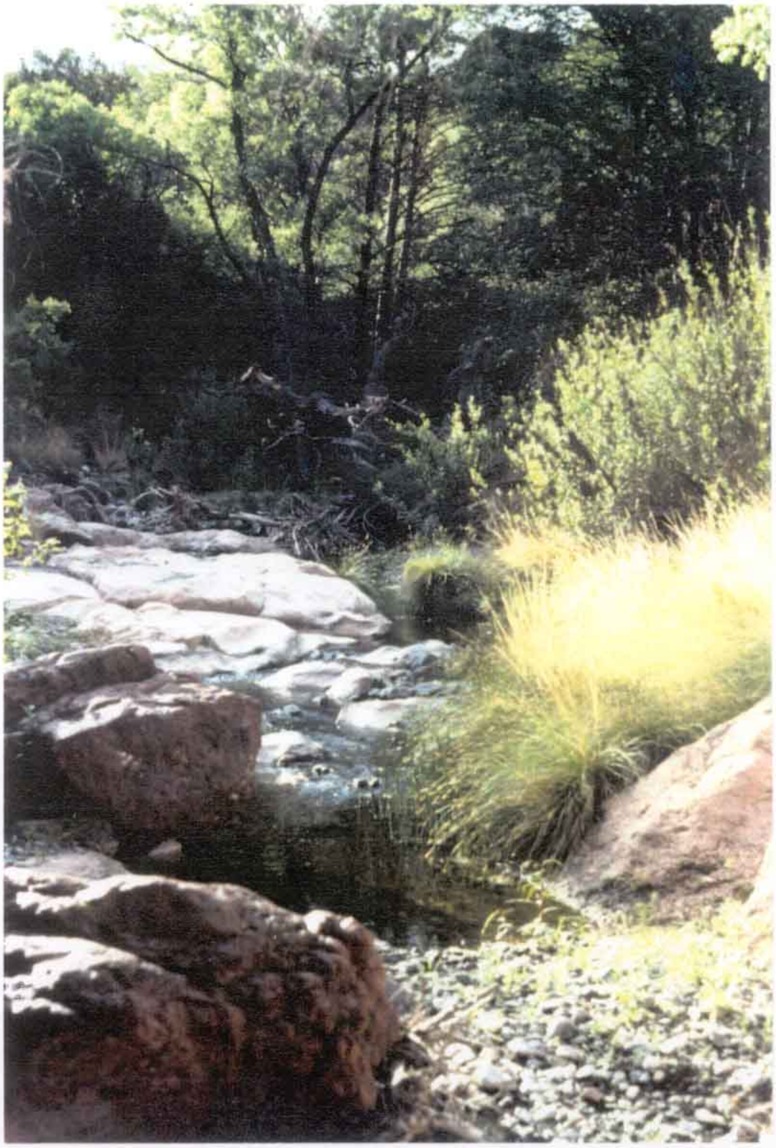

Photo: Mike Bradley

Figure D.49. Arizona alders (background) and deergrass (foreground) on Seco Creek at the Lower Seco Canyon Site.

Site Name: Warm Spring **Site Number:** 107

River: Las Animas Creek **County:** Sierra

Quad: BELL MOUNTAIN **Basin Number** 13030101

Town 14S **Range:** 07W **Section** 35

Latitude: 330240W **Longitude:** 1073145N

Site Quality: high

Min Site Size: 5 Ha **Stream Length:** 550 m

Data Sources: Ground Reconnaissance

General Description: Las Animas Creek in this reach flows with minimal impacts by humans or bison. Channel diversions and regulations are absent and natural fluvial process are allowed to operate. Flooding allows for the reproduction of riparian species, and the system seems to operate naturally.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing: no no evidence seen

Fuel Wood: no

Dumping: no

ORV Use: no

Roads: no

Mowing: no

Other Impacts: no

Cross Section: Las Animas1

Site Plots:
94PD008 94PD009

Jurisdiction: Private; Ladder Ranch

Survey Date: 6/3/94

Investigators: Bradley/Durkin/Carr

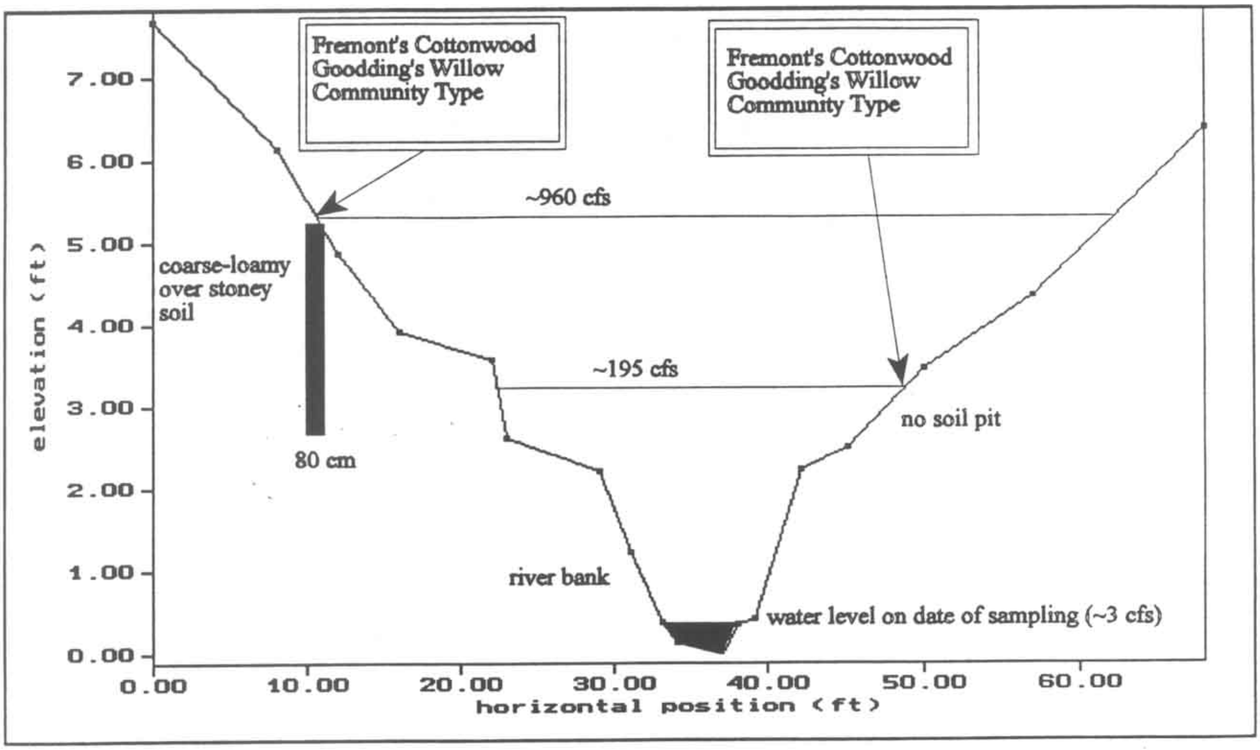

Figure D.50. Cross section of Las Animas Creek at the Warm Springs Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit, if present (black bar).

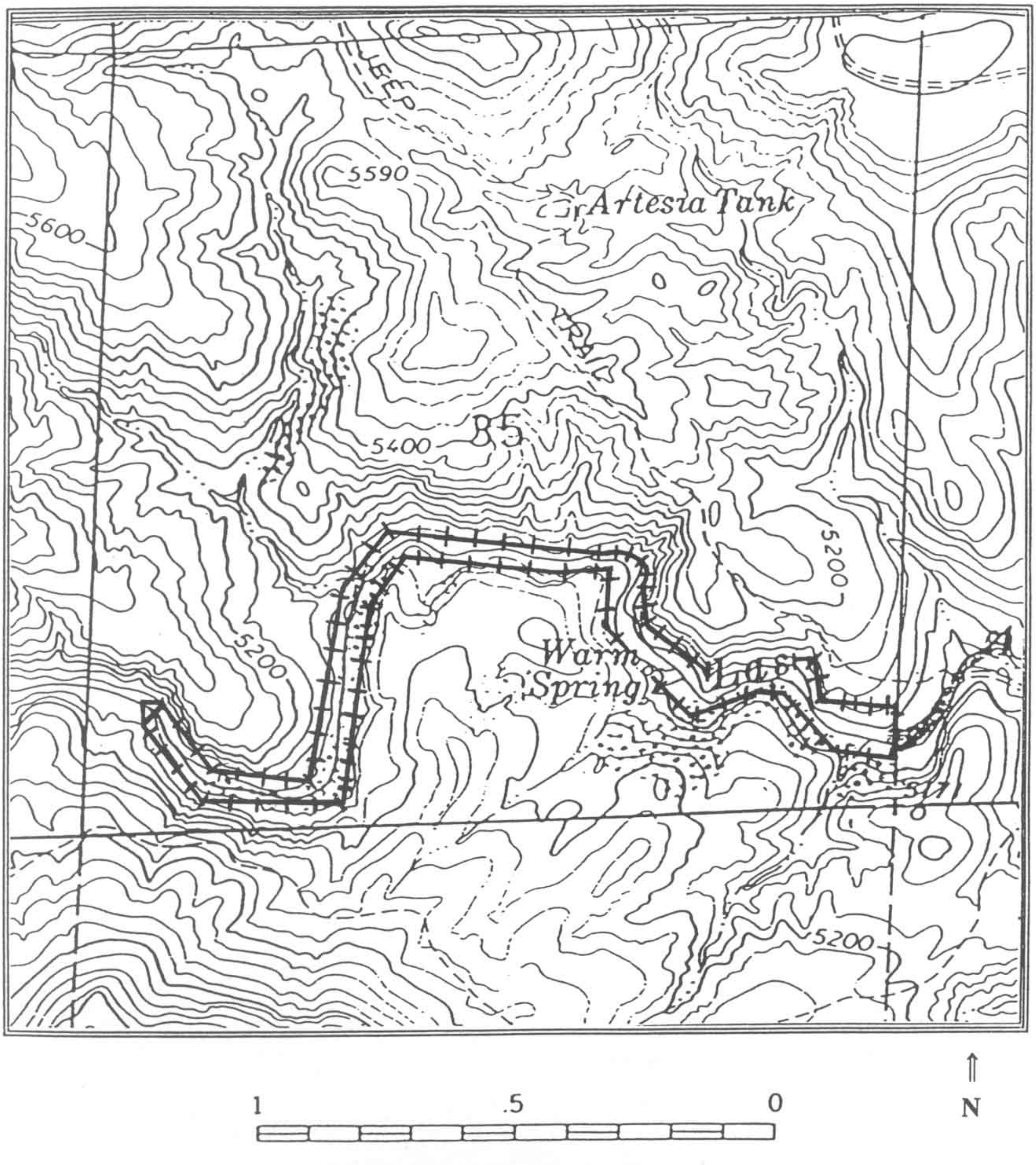

Figure D.51. Las Animas Creek, Site 107

Legend

++++++++ = primary boundary

◁ = indefinite upper or lower boundary

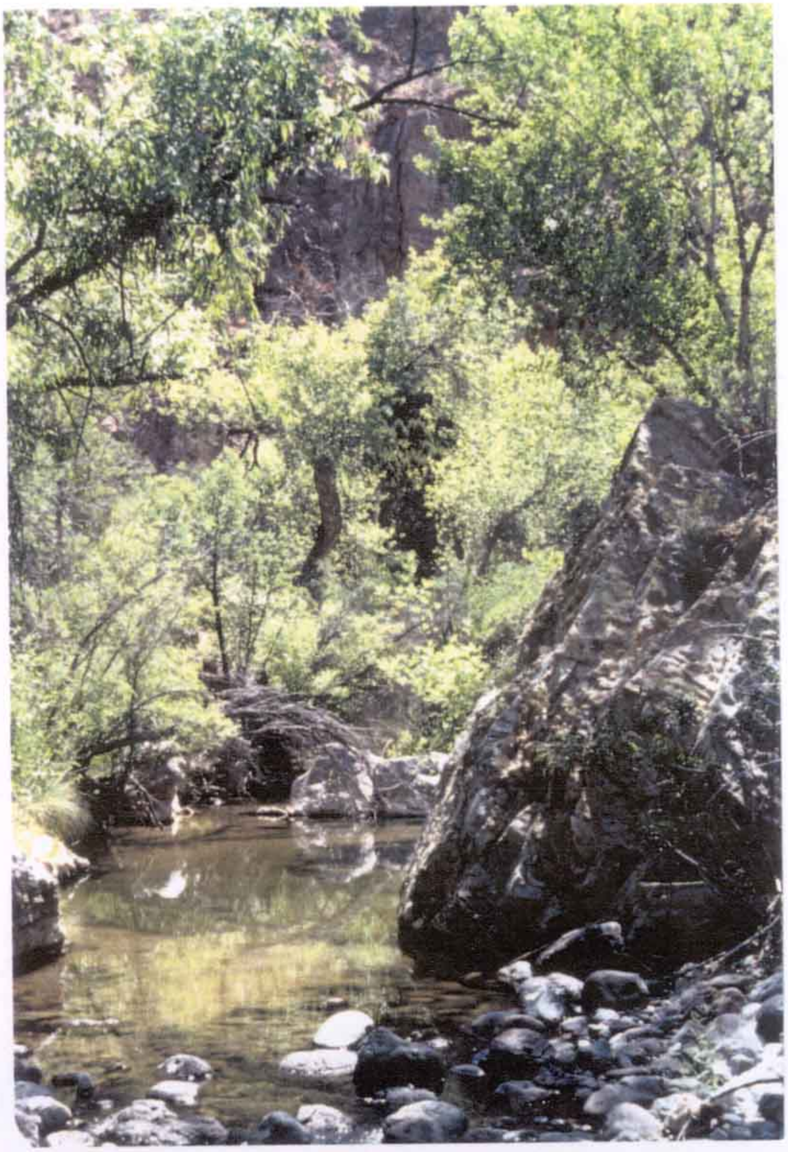

Photo: Mike Bradley

Figure D.52. Goodding's willow and Fremont's cottonwood on Las Animas Creek at the Warm Spring Site.

Site Name:	Dollar Mesa	**Site Number:**	106
River:	Las Animas Creek	**County:**	Sierra
Quad:	BELL MOUNTAIN	**Basin Number**	13030101

Town 15S **Range:** 07W **Section** 5

Latitude: 330212W **Longitude:** 1073505N

Site Quality: high

Min Site Size: 55 Ha **Stream Length:** 3760 m

Data Sources: Ground Reconnaissance

General Description: Las Animas Creek at this site flows unabated and without any channel impacts such as irrigation ditches. Natural processes operate to succesfully regenerate riparian species. The occasional fording of the river by a ranch road is the only impact to this reach.

Hydrologic Status **Flow Regulation:** No **Jetty Jacks:** No **Levee:** No

Dredging: No **RipRap:** No

Exotic veg dominant: no

Grazing:	no	no evidence
Fuel Wood:	no	
Dumping:	no	
ORV Use:	no	
Roads:	yes	dirt road along river; road crosses river a few times
Mowing:	no	
Other Impacts:	no	

Cross Section: Las Animas3,4

Site Plots:
94PD018 94PD019 94PD105 94PD106

Jurisdiction: Private; Ladder Ranch

Survey Date: 6/10/94

Investigators: Bradley/Durkin/Carr

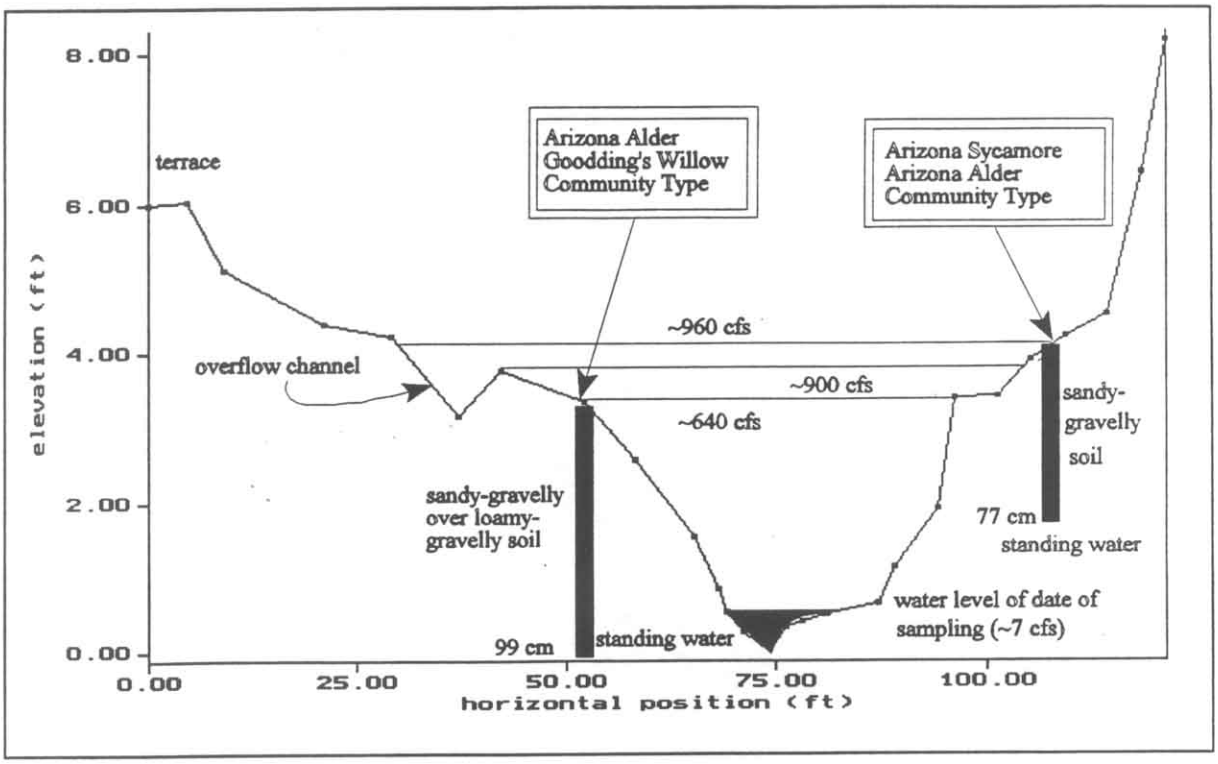

Figure D.54. Cross section of Las Animas Creek at the Dollar Mesa Site showing location of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit, if present (black bar).

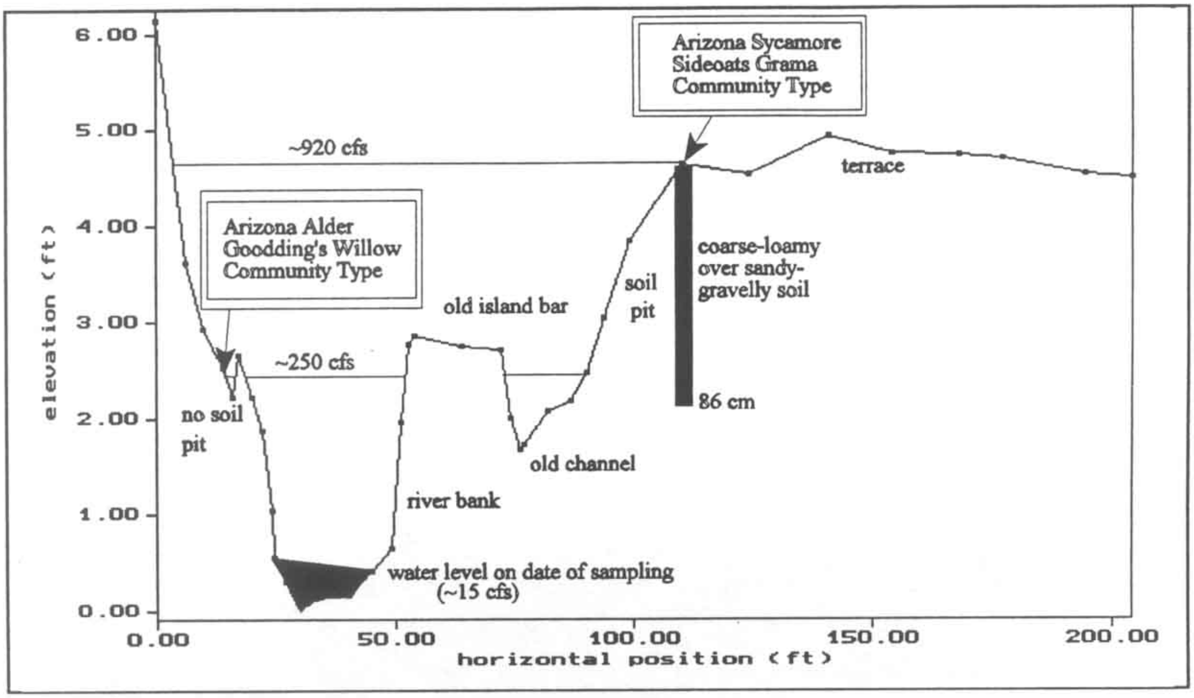

Figure D.53 Cross section of Las Animas Creek at the Dollar Mesa Site showing locations of the communities, water level required to flood them, predominant soil texture, and depth of the soil pit, if present (black bar).

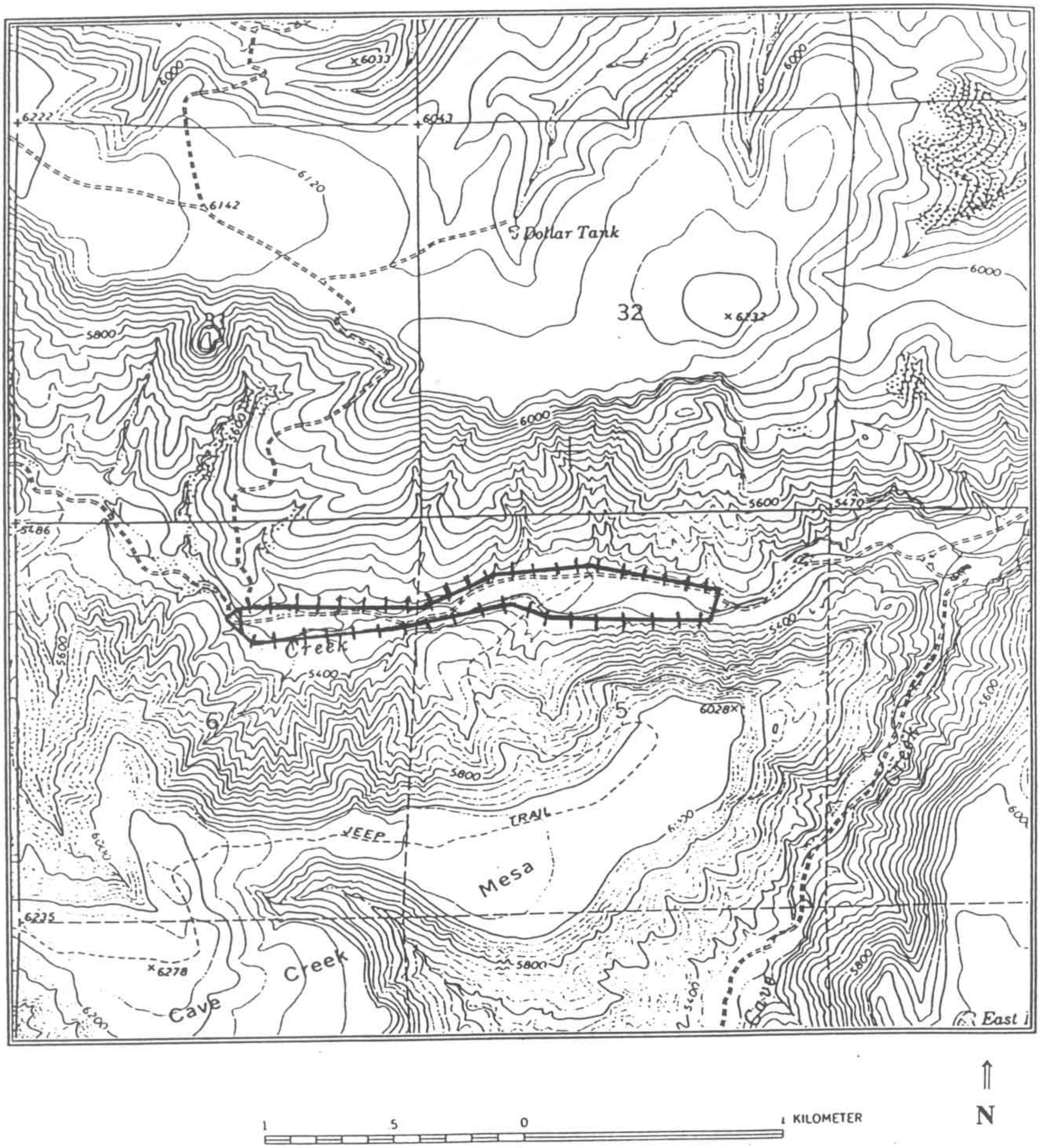

Figure D.55. Las Animas Creek, Site 106

Legend

++++++++++ = primary boundary

◁ = indefinite upper or lower boundary

Photo: Mike Bradley

Figure D.56. Las Animas Creek at the Dollar Mesa Site. Vegetation along the creek consists of Arizona alders and Arizona sycamores.

APPENDIX E. DIAGNOSTIC PROPERTIES OF SOILS CLASSIFIED IN THE UPPER AND MIDDLE RIO GRANDE BASIN FROM ORDER TO FAMILY CLASSES. Modified from Soil Taxonomy (Soil Survey Staff 1988).

CLASSIFICATION	DESCRIPTION
ORDER	
ENTISOLS	newly formed soils that lack pedogenic horizons.
SUBORDER	
A. Aquents	permanently saturated or have aquic conditions* between 40-50 cm of the soil surface.
GREAT GROUP	
1. Psammaquents	have a sandy texture between 25-100 cm.
SUBGROUP	
a. Typic Psammaquents	wet sandy soils.
b. Mollic Psammaquents	have a thick, dark organically rich layer at the surface.
GREAT GROUP	
2. Fluvaquents	have an irregular decrease of carbon content with depth due to alluvial deposits with slope is less than 25%.
SUBGROUP	
a. Sulfic Fluvaquents	have sulfidic materials within 100 cm of the surface.
b. Typic Fluvaquents	the wettest of the subgroup.
c. Aeric Fluvaquents	are lightest in color and the driest of the Fluvaquents.
d. Mollic Fluvaquents	have a thick, dark organic layer at the surface.
GREAT GROUP	
3. Endoaquents	aquents that do not have the characteristics of the Fluvaquents or Psammaquents.
SUBGROUP	
a. Mollic Endoaquents	have a thick, dark, organic layer at the surface.
b. Typic Endoaquents	other Endoaquents.
c. Aeric Endoaquents	are lighter in color and driest of the Endoaquents.
SUBORDER	
B. Psamments	have a sandy texture between 25-100 cm of the soil surface.
GREAT GROUP	
1. Ustipsamments	sandy soils with a limited moisture regime but occurs during active plant growth.
SUBGROUP	
a. Aquic Ustipsamment	have aquic conditions and are saturated within 100. cm of the surface for some time during the year.
b. Oxyaquic Ustipsamment	saturated within 100 cm for 1 month during most years.

SUBORDER
C. Fluvents . . . . have an irregular decrease in carbon content with depth due to alluvial deposits with slopes less than 25%.

GREAT GROUP
1. Ustifluvents . . . . have a limited moisture regime that occurs during active plant growth.

SUBGROUP
a. Aquic Ustifluvent . . . . saturated within 150 cm for some time in most years.

b. Oxyaquic Ustifluvent . . . . . . saturated within 150 cm for 1 month or more per year in 6 or more out of 10 years.

c. Typic Ustifluvent . . . . do not have aquic conditions within 50 cm of the surface.

GREAT GROUP
2. Udifluvents . . . . are moist throughout the profile for most of the year.

SUBGROUP
a. Mollic Udifluvent . . . . have a thick, dark, organically rich layer at the surface.

b. Oxyaquic Udifluvents . . . . . . saturated within 100 cm for 1 month in most years.

GREAT GROUP
3. Torrifluvents . . . . alluvial soils that are hot and dry.

SUBGROUP
a. Aquic Torrifluvent . . . . have aquic conditions within 100 cm of the surface
b. Oxyaquic Torrifluvents . . . . . . are saturated within 100 cm for 1 month in most years.

c. Typic Torrifluvents . . . . are the driest of the subgroup.

ORDER
INCEPTISOLS . . . . are moderately developed and display some pedogenic horizons; do not have a dry moisture regime.

SUBORDER
A. Ochrepts . . . . have a surface horizon that is light in color (Ochric epipedon); does not have rock structure and is not fresh sediment.

GREAT GROUP
1.Dystochrept . . . . have a moderate moisture regime and cool temperature regime; do not have carbonates, a duripan layer or a sulfuric horizon.

SUBGROUP
a. Fluventic Dystrochrept . . . . . . have an irregular decrease in organic carbon and a slope of less than 25%.

GREAT GROUP
1. Ustochrept . . . . plant available moisture is limited but present when conditions are suitable for plant growth.

SUBGROUP

a. Fluventic Ustochrept . . . . have an irregular decrease in organic carbon and a slope of less than 25%.

ORDER

ARIDISOLS . . . . are hot and dry soils that support xerophytic vegetation; pedogenic horizons form as a result of the movement and concentration of carbonates, salts, and clays.

SUBORDER

A. Orthids . . . . do not have a subsurface horizon that is saline (Natric horizon) or formed by the illuviation of clays (Argillic horizon).

GREAT GROUP

1. Camborthids . . . . do not have a duripan, calcic or gypsic layer.

SUBGROUP

a. Aquic Camborthid . . . . have aquic conditions within 100cm of the soil surface

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FAMILY CLASSES+

PARTICLE SIZE (determined from 25-100 cm)

Fragmental: any soil where the rock fragments (>2 mm) predominate (90% or more). Particles <2 mm account for up to 10% of the total volume.
Sandy-skeletal: any soil where 35% or more of the volume are rock fragments with a sandy texture. Particles <2 mm account for 10% or more of the total volume.
Loamy-skeletal: any soil where 35% or more of the volume are rock fragments, with a texture of fine sand or finer. Particles <2 mm account for 10% or more of the total volume.
Clayey-skeletal: any soil where 35% or more of the volume are rock fragments with 10% or more particles <2 mm. Clay particles represent 35% (by weight) or more the total weight.
Sandy: any soil with less than 35% rock fragments, with a texture of sand or loamy sand. The sandy family class in any Psamment soil is omitted. By definition, a Psamment is sandy, so the designation is omitted.
Coarse-loamy: any soil with 15% or more (by weight) sand and less than 18% (by weight) clay. Their texture is sandy loam.
Fine-loamy: any soil with 15% or more (by weight) sand and 18 to 35% (by weight) clay. They are sandy clay soils.
Coarse-silty: any soil with less than 15% (by weight) sand and less than 18% (by weight) clay. They are silty loam soils.
Fine-silty: any soil with less than 15% (by weight) sand and 18 to 35% (by weight) clay. They are silty clay loam soils.
Fine: any soil with 35 to 60% (by weight) clay. In Vertisols, 30 to 60% clay is required.
Very-fine: any soil with 60% (by weight) clay.

CALCAREOUS AND REACTION CLASSES

Calcareous: all horizons effervesce with 0.1 M HCl.
Nonacid: pH is 5.0 or more in some or all horizons in 0.01 M CaCl (2:1).
Acid: pH is <5.0 in all horizons in 0.01 M CaCl (2:1).

SOIL SALINITY LEVELS[#]

Conductivity Scale (milliSiemens/cm at 25°C)	Salinity Effects on Plant Growth
0 to 2	mostly negligible
2 to 4	very sensitive species restricted
4 to 8	many species restricted
8 to 16	only tolerant species fair satisfactory
16 and >	only few very tolerant species fair well

[*]Aquic conditions are redoximorphic features which include: redox concentrations (iron or manganese oxides), redox depletions (gray or blue mottles areas where Fe-Mn oxides have been reduced), and a reduced matrix (gley) (Vepraskas 1992). The presence of aquic conditions is indicative of longer periods of saturation. Oxyaquic subgroups have shorter periods of saturation.

[+]Only the family classes that were used are described. All mineralogy was mixed.

[#]Modified from Diagnosis and Improvement of Saline and Alkali Soils (US Salinity Laboratory Staff 1969).