United States
Department of
Agriculture

Soil
Conservation
Service

Albuquerque,
New Mexico

RIO CHAMA

FLOODPLAIN MANAGEMENT

STUDY

Rio Arriba County, New Mexico

RIO CHAMA FLOODPLAIN MANAGEMENT STUDY

Chama, New Mexico

February 1993

Prepared for and in cooperation with

Village of Chama

and

Upper Chama Soil and Water Conservation District

Prepared by
U.S. Department of Agriculture
Soil Conservation Service
Planning Staff
Albuquerque, New Mexico

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CHAMA FLOODPLAIN MANAGEMENT STUDY

INTRODUCTION

LOCAL STUDY NEEDS - The Village of Chama requested the Soil Conservation Service, through the Upper Chama Soil and Water Conservation District, to conduct a study of the Rio Chama and Rio Chamita. Residential and commercial development in the study area and the potential for continued expansion necessitate a responsible land management plan to ensure reduction of soil erosion and flood risk. This report presents map data, the 100-year flood zone delineation and recommendations for floodplain management. The implementation of a comprehensive management plan will promote the welfare of the community, ensure wise land use and provide a development process for the benefit of all residents.

STUDY AUTHORITIES - The study was conducted by the Soil Conservation Service in cooperation with the Village of Chama under the authority of Public Law 83-566, Section 6, Floodplain Management Studies. The program is designed to assist communities evaluate flood damage risks and measures that will reduce those flood risks.

The intent of this study is to provide flood hazard information and recommendations for the Village of Chama to help decrease drainage and sediment problems.

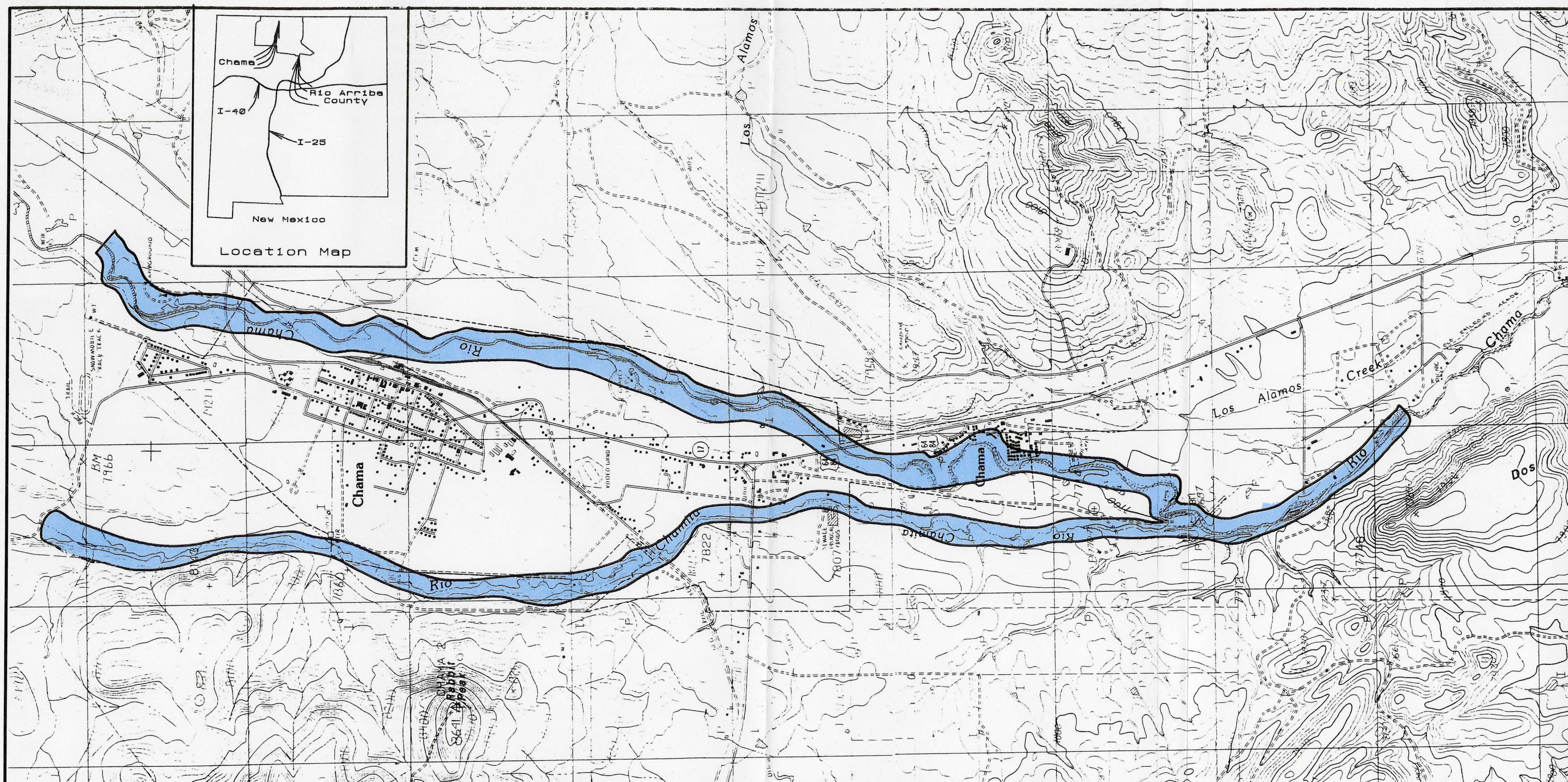
Specific objectives of this report include:

1. Define the flooding characteristics for the 2-, 5-, 10-, 25-, 50-, and 100-year frequency storm events.
2. Determine the impact of watershed development on future flooding.
3. Incorporate the TR55 model for Village use.
4. Incorporate a terrain management, zoning and planning model as a guide for regulating development.

DESCRIPTION OF STUDY AREA

LOCATION - The study area is located in Chama, New Mexico. The Village of Chama is in north central Rio Arriba County in northern New Mexico. Chama is 110 miles north of Santa Fe and six miles south of the Colorado - New Mexico state line. The two drainages studied, Rio Chama and Rio Chamita, are northern tributaries of the Rio Grande which flows south into the Gulf of Mexico. The area is within Hydrologic Unit 13020102-015.

The study area of the floodplain management evaluation extends from about one mile north of Chama for distances of seven miles on the Rio Chama and six miles on the Rio Chamita. The confluence of the Rio Chama and the Rio Chamita occurs one mile upstream of the end of the study area. The drainage basin above the study area extends into southern Colorado about 12 miles and includes parts of Conejos and Archuleta Counties. Elevations in the



LEGEND

Improved Road		State Route	(17)
Unimproved Road		Bench Mark	×
Trail		Village Boundary	
Interstate Route		Study Area	
U.S. Route			

2000 1000 0 2000 4000

Scale in Feet

Source Map - USGS Quadrangle 7.5 Minute Series

PROJECT LOCATION MAP

Rio Chama Floodplain Management Study

12-92

USDA SCS NATIONAL CARTOGRAPHY & GIS CENTER, FORT WORTH, TX 1993

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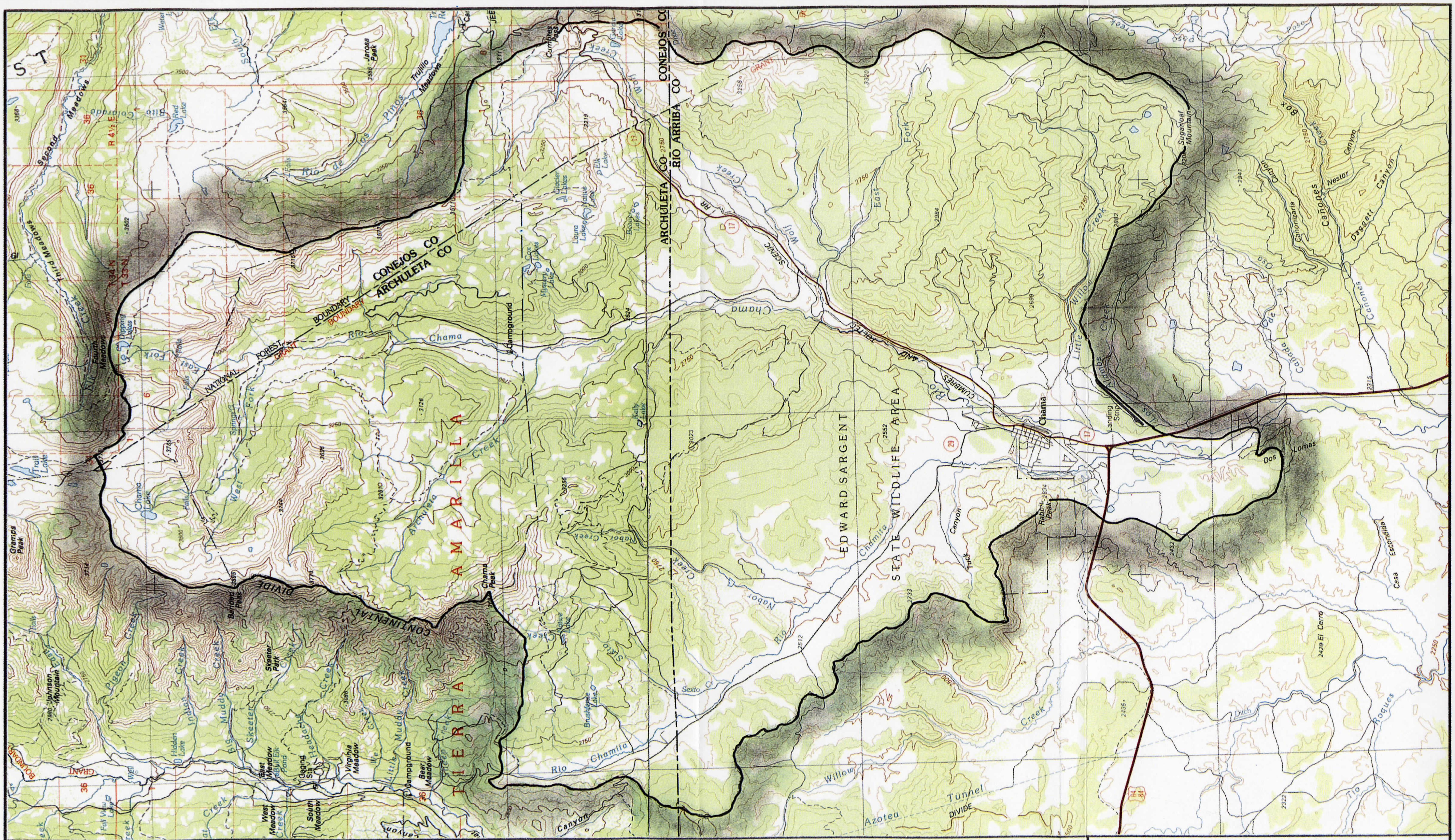

SCALE

1 : 100000

Source Map - USGS Quadrangle

LEGEND

Improved Road	
Unimproved Road	
Trail	
Interstate Route	
U.S. Route	
State Route	(17)
Bench Mark	×
Village Boundary	

WATERSHED MAP
Rio Chama
Floodplain Management
Study

12 - 92

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drainage basin range from 7,629 to 13,000 feet on Chama Peak in southern Colorado.

HISTORY - By Margret Palmer, Village Librarian and Historian - Chama is a railroad town, created by and for the railroad. There was very little activity in what is now Chama until news of a railroad route over Cumbres Pass brought in hundreds of speculators in 1879. Railroad track was completed to Chama in January 1881. The Village soon became an important railroad station, because it had a maintenance station with a large roundhouse and because snow removal operations over Cumbres Pass originated in Chama.

Land speculators had begun selling land about 1879, and buildings were begun in what is now downtown Chama shortly thereafter. By 1881, Chama was a boom town with a population of over 1,000 people. It was a rowdy little town with gangs of outlaws making regular appearances on the scene. People from all over the United States and from many foreign countries were attracted to the excitement and excellent job prospects promised by the fledgling town.

The original intention of the Rio Grande Railroad in putting a railroad line through northern New Mexico and Southern Colorado was to provide access to the silver mines in Silverton, Colorado. Almost immediately after installation, however, logging companies began using the railroad as a convenient means of getting their products to market. The area was rapidly stripped of its timber, and by 1916 the heyday of the logging industry in the Chama Valley had ended. It is said that at one time, because of the dense vegetation, it was difficult for a man on horseback to traverse the forests between Pagosa Springs and Chama.

Cumbres & Toltec Scenic Railway trestle over the Rio Chama at the north end of the Village

Lumberton, New Mexico, was heavily forested and even in the 1920's, one could see a forest of rotting stumps between Chama and Tierra Amarilla, the remains of what was once a dense and magnificent forest.

After the logging business slowed to a mere trickle of its former glory, the sheep industry took over in importance. Chama became an important shipping point for local sheep ranchers until the terrible winter of 1931-32 all but wiped out most of the herds of sheep in the Chama Valley.

The Chama Valley also had an important "moonshine" industry in the 1920's, and Chama was a major center of transporting bootleg liquor to other parts of the nation. This enterprise ended when the sale of alcoholic beverages was made legal in 1932.

Later, the train carried cattle, and tanker cars transported oil from the Hughes oil field near Chromo, Colorado, to refineries in Alamosa.

Today Chama, in large part, still owes its existence to the railroad. Tourism is the Village's main industry, and the train attracts over 50,000 visitors to the town each year.

CLIMATE - The wide range in elevation has a marked influence on the climate in the Chama River Basin. Elevations within the river basin range from 13,000 to 7,629 feet. The annual total precipitation ranges from 30 inches in the higher mountains to 15 inches in the lowest elevations. The average annual rainfall in Chama is 19.7 inches. Temperature is also affected by the elevation. The lower annual mean temperature is 38 degrees in the high mountains, and the higher mean temperature in the low elevations is 46 degrees.

Rainfall occurs generally during winter and early spring, with the maximum amount coming in July and August from thunderstorms.

Summers are hot and relatively dry at the lower elevations. The average maximum temperature in July ranges from 80 degrees to slightly more than 100 degrees, depending on elevation. The average daily maximum temperature for Chama is 75 to 80 degrees Fahrenheit in summer with the an average low range of 40 to 45 degrees.

Winters are long and relatively harsh. The average daily maximum temperature ranges between 35 and 55 degrees with the low averaging between 5 and 25 degrees. Precipitation ranges from over 30 inches in the mountains, usually in the form of snow, to less than 10 inches in the lower valleys.

The wide ranges of climatic conditions in the study area produce plant communities from cool season grasses to coniferous forest. Depending on the amount of water available, most crops can be grown in a single growing season.

GEOLOGY - The study area is in the eastern portion of the Colorado Plateau physiographic province. Chama is situated within the Chama Basin in the southern portion of the San Juan Mountains. The Chama Basin is bounded on the west by the Archuleta Arch and on the east by the Brazos uplift. The predominant geologic formation of the basin is the Cretaceous aged upper Mancos Shale. The Mancos Shale is a material which was deposited during the upper Cretaceous Period, but has been altered considerably in Quaternary time by massive landslides.

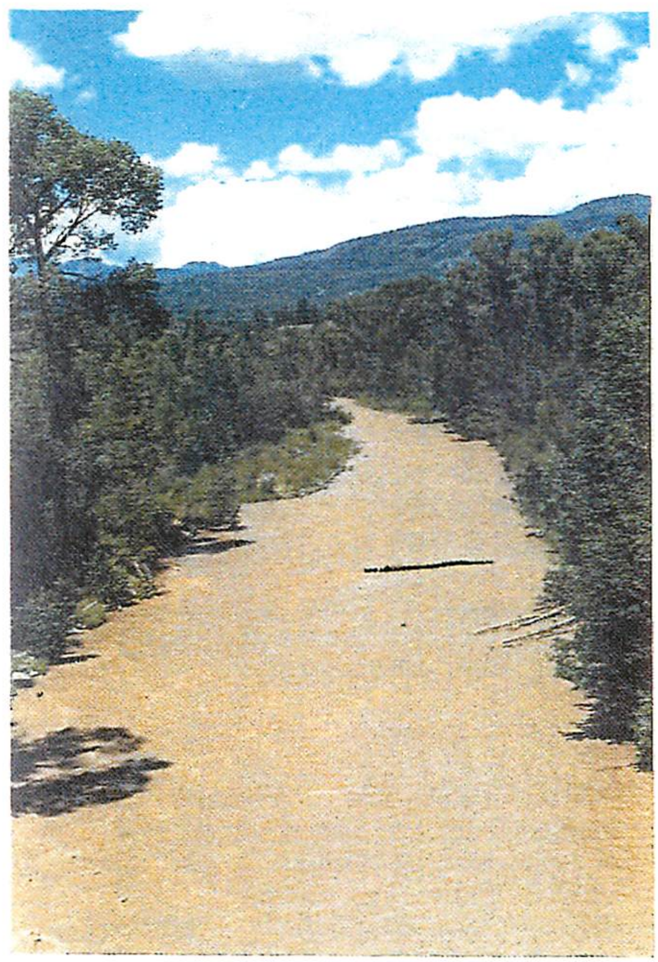
Landslides are still common and extensive in the mountainous portions of the region. Areas underlain by the Mancos formation are particularly susceptible to sliding. The involvement and burial of glacial deposits indicate that the main movement occurred in post-Wisconsin time, but parts of these slide masses are still active today. This continuing susceptibility to sliding and slippage causes a constant maintenance problem for roads and railroads.

Other rock formations in this vicinity are also of Cretaceous age and include the Dakota sandstone, Lewis shale and undifferentiated members of the Mesaverde group. Small areas of glacial morraine deposits occur in the higher elevations. The Cretaceous rocks are highly erodible andunstable. Soils derived from these parent materials are also often unstable.

The study area itself consists of Quaternary aged alluvium and colluvium overlying primarily Mancos Shale. The deposits are loamy to gravelly in texture.

<u>EROSION AND SEDIMENTATION</u> - The Pacific Southwest Interagency Committee (PSIAC) 1968, Sedimentation Yield Procedure was used as the model for estimating sediment yield rates.

The PSIAC determinations are based on nine factors: geology, soils, climate, runoff, topography, ground cover, land use, upland erosion and channel erosion. Five major sediment yield classes are determined by the PSIAC procedure. The areas are defined as sediment yield



Summer thunderstorms in the high country generate sediment loads primarily from stream bank erosion.

class 1 (high), 2, 3, 4 and 5 (very low). The lower case subscript letters for each numerical sediment yield class were assigned to aid in identifying the geographic position of each specific area; no hierarchical classification is implied with the use of the letters.

The overall net sediment yield [illegible]e for the Rio Chama Basin [illegible] low and is estimated at [illegible].225 acre-feet per square mile per year.

The sediment yield conditions for the river basin can be viewed in relationship to percent of total surface area compared to percent of total estimated sediment yield as follows:

WP2 CLASS 1 (high yield) - 10% of the total area is yielding 30% of the sediment.

WP2 CLASS 2 (moderate high yield) - 20% of the total area is yielding 35% of the sediment.

RM2 CLASS 3 (moderate yield) - 40% of the total area is yielding 30% of the sediment.

RM2 CLASS 4 (low yield) - 30% of the total area is yielding 5% of the sediment.

CLASS 5 (very low)

These ratings represent a targeting of approximately 10% of the total area in the river basin that is causing most of the accelerated erosion-sedimentation problem. These are geographic areas identified in Class 2, the high yielding category. Isolated areas in any yield category may merit detailed study.

In summary, the Chama River Basin is an area with a moderate degree of soil erosion activity. The sediment from 10% of the area is at least three times the background geologic rate due to human activities. This sediment yield is resulting in lower value wildlife habitat, degraded fishery values in the main streams, degraded water quality, increased sediment loading, degraded values of rangeland grazing and future degradation of the scenic values of large areas. This report identifies 13 high sediment yielding streambank areas (see plates 1-4, Appendix D).

<u>SOILS</u> - Soils in the study were mapped by the Soil Conservation Service as part of the Soil Survey of Rio Arriba County (completed in 1987, not yet in publication). Soils found in the study area are primarily of the Dula and Chamita Series on floodplains; Colomex, Doslomas, Hesperus and Pastorious Series on terraces; and Roques, Nusmag, Nabor and Elbuck Series on surrounding uplands and hills. Limitations addressed in this section are associated with urban development.

Dula map unit 64 (mu 64) and Chamita (mu 117) soils are found on floodplains. Both soils are poorly drained with seasonal water tables at less than two feet. They are rated as hydric soils and typically have hydrophytic vegetation, which means they are likely to be wetlands also. These soils occur immediately adjacent to the Rio Chama and Rio Chamita. They have loamy surface layers and are underlain by gravelly to extremely gravelly alluvium. These soils are used primarily as open land for wildlife habitat because of the occasional to frequent hazard of flooding. Some of the meadows are used for hayland or domestic livestock grazing. Where these soils occur near the southern part of the Village, they are used for commercial sites for motels and other businesses. The main limitations associated with urban development of these soils are flooding hazard and a high water table. Included in these map units are small areas of Riverwash, Colomex, Doslomas, Pastorious and Hesperus soils.

Colomex soil (mu 61) is the most common soil on the stream terraces in the study area. It is well drained and not subject to riverine flooding. It occurs primarily in and around the Village of Chama above the confluence of the Rio Chamita and Rio Chama. Typically the surface is a gravelly silt loam and is underlain by gravelly to extremely gravelly sandy clay loam and clay loam. The substratum is very gravelly loamy sand. Urban development is limited by coarse fragments in this soil. Included in this map unit are small areas of Dula, Doslomas and Chamita soils. Small areas of hydric soils can be found in this unit as inclusions. This soil is used primarily for urban development within the study area.

Doslomas soil (mu 65) occurs on stream terraces in the southern part of the study area. It is deep, well drained, and not subject to flooding. Typically, the surface is a loam to about seven inches. The upper subsoil is a clay loam to 12 inches and the lower subsoil is clay to 28 inches. The substratum is an extremely cobbly coarse sand to 60 inches or more. The main limitation of this soil is its slow permeability in the upper layers. However, the cobbly coarse sand layer beneath the clay presents a potential for ground water pollution when septic fields are installed. Included in this unit are Colomex and Encicado soils. This unit is used for grass hay and pasture for livestock grazing.

Hesperus and Pastorious (mu 118) soils occur on stream terraces at the upper end of the study area. Both soils are deep, well drained and have no flooding hazard. The Hesperus soil is typically loam textured to a depth of 60 inches or more and non-gravelly. The Pastorious soil has silt loam textures to a depth of about 12 inches and cobbly loam texture below. Major limitations are erodibility hazard and coarse fragments. Included in this map unit is Chamita soil as a named component. Contrasting inclusions are Abreu and Nabor soils on toeslopes. This soil is used primarily for livestock grazing.

Roques and Nusmag soils (mu 119) occur on valley sides and upper terraces and are well drained. The Nusmag soil is subject to rare flooding. The Roques soil has a clay loam surface and is underlain by clay to 60 inches or more. The Nusmag soil is similar in having a clay loam surface and underlain by clay to a depth of 60 inches or more. The Nusmag soil has a seasonal water table at 42 to 60 inches. The main limitations of this unit include erosion and flooding hazard, high shrink-swell potential, low permeability and high water table. Included in this unit are Rombo soils having bedrock above 40 inches and Tottles soils which have high water tables between six and 36 inches. This soil is used primarily for hayland, livestock grazing and urban development.

Rombo and Wiggler soils (mu 127) occur on hills above the stream terraces with slopes of five to 25 percent. Both soils are well drained and not subject to flooding. The Rombo soil typically has clay textures to a depth of 20 to 40 inches and is underlain by shale of the Mancos or Lewis Formations. The Wiggler soil has a channery clay loam surface and is underlain by shale at a depth of 20 inches or less. The main limitations of these soils are wind and water erosion hazard, depth to bedrock and slope. Included soils in this unit are Carrick soils on mesas, Mara soils on hills, Hogg soils on summits, and Roques soils on valley sides. These soils are used primarily for livestock grazing and urban development.

Nabor and Elbuck (mu 203) soils occur on depositional areas on the lower mountain slopes. Both are deep, well drained, and not subject to flooding. Slopes are five to 35 percent. These soils are forested with primarily ponderosa pine and oak species. The Nabor soil has silty clay loam and silty clay textures to a depth of 60 inches or more. The Elbuck soil has gravelly loam textures to about 14 inches and gravelly clay loam textures to 60 inches or more. This unit is used mainly for wood products and urban development. The main limitations of these soils include slope and water erosion hazard. Included in the area are Nusmag and Wiggler soils on hills and Tottles soils on stream terraces.

Other soils occur within the study area, but they are of minor extent and are similar to soils already described. Shale rock outcrop occurs occasionally in the stream-banks and streambeds of both the Rio Chama and Rio Chamita. The rock outcrop is typically Mancos shale. These areas are not very extensive and too small to delineate in the soil survey. Extensive gravel mining activity has occurred primarily along the Rio Chama, resulting in a loss of riparian areas and surface soil materials, leaving gravelly and cobbly coarse sand materials with shallow water tables. These excavated pits could impact flooding by providing temporary storage and thereby reducing down-stream flood damages.

<u>HYDRIC SOILS</u> - Hydric soils are defined as soils that are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions in the upper part. These soils are developed under conditions sufficiently

wet to support the growth and regeneration of hydrophytic (or water-loving) vegetation. Criteria for hydric soils reflect soil properties and features indicative of saturated conditions during the growing seasons, including poor drainage, high water tables, frequent flooding or ponding, and redoximorphic features such as mottling, gleyed colors or the presence of manganese concretions.

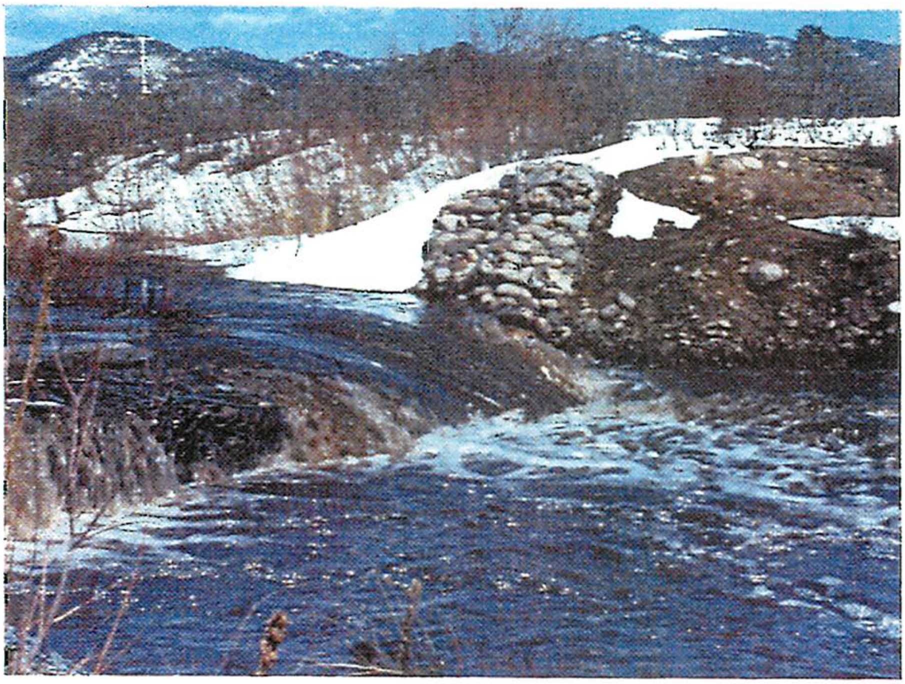
Hydric soils are an important component of wetlands, as described in the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Wetland areas are important wildlife habitats and also play important roles in flood protection and pollution control. However, a combination of hydric soils, hydrophytic vegetation and wetland hydrology is required to meet the criteria for wetlands. An area that meets the hydric soil criteria must also meet the hydrophytic vegetation and wetland hydrology criteria to be classified as a jurisdictional wetland.

Hydric soils of the Chama floodplain management study area are dominantly located adjacent to the major river drainages. These are the Dula and Chamita soil series in soil map units 64 and 117. Small inclusions of hydric soils (Dula, Chamita, and Tottles soils) sometimes occur within other soil map units further from the river channels (map units 61, 118, 119, and 203). These inclusions are too small in extent to delineate on the scale of maps used for this study.

Hydric soils have severe limitations for many land use considerations. Flooding hazards are concerns for any building or construction sites. High water tables have detrimental effects on soil strength and settlement. Septic tank absorption fields cannot function properly under saturated conditions. Water quality is a concern in preventing agricultural or municipal contaminants from reaching shallow water tables. High contents of organic material can cause subsidence and collapse upon drainage of some hydric soils. As a component of wetland areas, the use or disturbance of hydric soils should be discouraged to protect these valuable ecosystems.

Hydric soils are best suited for open space or recreational use. Soils subject to flooding are limited, in varying degree, for recreational areas by the duration of flooding and the season when it occurs. If water tables are below 30 inches, trafficability is only slightly limited for paths, trails and camping areas. Areas with higher water tables may require the construction of raised walkways or bridges. Onsite assessment of the soil and hydrologic properties is necessary in planning recreational facilities.

<u>SOCIAL AND ECONOMIC</u> - The Village of Chama is located in Rio Arriba County, which is one of New Mexico's larger counties. Rio Arriba County borders Colorado on the north. The Continental Divide bisects the county in a north-south



Diversions from the Rio Chama and Rio Chamita provide irrigation for 4,000 acres in the Upper Chama Valley

direction. To the east are mountains, foothills, narrow river valleys and generally broken terrain. To the west, the foothills give way to a semiarid plateau characterized by high mesas, sheer sandstone cliffs and formations, dry washes and canyons. More than half of the land in the county is federally owned. The Forest Service manages two wilderness areas and the Carson and Santa Fe National Forests. Economically, Rio Arriba is one of New Mexico's depressed, agriculturally based northern counties. Government spending in the form of construction projects, transfer payments and wages is often the most important source of personal income in the county. Tourism and some mining (petroleum and natural gas) provide additional economic activity.

The per capita income for 1989 was $8,948, which ranks Rio Arriba 30th among New Mexico counties, which compares to the state per capita income of $13,140 for the same period. The 1990 unemployment rate for Rio Arriba County was 13.4 percent, which compares to the state rate of 6.3 percent. The Government and services sector provides approximately 65 percent of the total employment in the county. The 1990 population for Rio Arriba County was 34,365, which represents a 17.4 percent increase from 1980.

Agriculture is a small portion of the economy of Rio Arriba County and ranks 20th among New Mexico counties in cash receipts from agriculture. There were 936 farms located in Rio Arriba County with an average size of 1,593 acres each. The following table (New Mexico Economic Development Department) illustrates how gross receipts from agriculture compare with receipts from other sectors in the county.

TABLE 1

GROSS RECEIPTS BY SECTOR

SECTOR	RECEIPTS (thousands $)	PERCENT
Agriculture	1,840	1
Mining	23,386	9
Construction	28,946	10
Manufacturing	6,380	2
Transportation, Utilities and Communications	42,601	15
Wholesale Trade	10,826	4
Retail Trade	119,177	43
Finance, Insurance and Real Estate	8,929	3
Services	35,378	13
Total	277,463	100

The Village of Chama is located in the north-central portion of Rio Arriba County. The 1990 Census data shows the population of Chama to be 1,048, which compares to a 1980 population of 1,090. Of the total population 70 percent or 734 are of Hispanic origin. The median age of Village residents is approximately 32 years. The following table (1990 Census) shows the 1990 population by age distribution.

TABLE 2

AGE OF POPULATION

AGE	POPULATION	PERCENT
Under 5 years	105	10
5 to 17 years	236	23
18 to 20 years	36	3
21 to 24 years	47	4
25 to 44 years	291	28
45 to 54 years	124	12
55 to 59 years	37	3
60 to 64 years	58	6
65 to 74 years	69	7
75 to 84 years	39	3
85 years and over	6	1
Total	1,048	100

RECREATION AND TOURISM

The tourism industry is very important to the Chama area. This industry includes hunting, fishing, cross country skiing, sightseeing, picnicking, camping, horseback riding, snowmobiling and hiking. Included as an attraction for tourism to Chama is the Cumbres and Toltec Scenic Railroad. This narrow-gauge steam railroad meanders 64 miles through the scenic Rockies from Chama to Antonito, Colorado. This railroad is the finest remaining example of a vast network which connected commercial outposts in the Rocky Mountain Region. Spiked down in 1880 as the San Juan Extension of the Denver & Rio Grande, the Cumbres & Toltec was built to serve the rich mining camps in the San Juan Mountains.

The railroad attracted 55,100 visitors in 1991, with an average ticket price of $29.46. This compares to 50,246 visitors in 1990, reflecting a 10 percent increase from 1990 to 1991.

Recreation and tourism impact the Chama and regional economy year round. For every recreation day spent in the Chama area, dollars are recirculated throughout the region. The following table estimates the average expenditure per person for a variety of recreation activities for New Mexico. These are the in-state expenditures only and do not include any expenditures that would occur outside of New Mexico. These values are statewide averages and would not be entirely spent in the region where the activity took place, such as Rio Arriba County. These expenditures are estimates from the U.S. Forest Service and U.S. Fish and Wildlife Service.

In addition to tourism, ranching and farming are major industries of the local economy.

3

RECREATION EXPENDITURES

RECREATION ACTIVITY	AVERAGE IN-STATE EXPENDITURE PER DAY PER PERSON (Dollars)
Nonresident Fishing	16.20
Resident Fishing	44.50
Nonresident Big Game Hunting	26.70
Resident Big Game Hunting	64.30
Nonresident Nonconsumptive Wildlife-Related Recreation	25.70
Resident Nonconsumptive Wildlife-Related Recreation	41.90
Resident Small Game Hunting	19.80
Developed Camping	40.60
Primitive Camping	25.60
Day Hiking	30.30
Picnicking	26.10
Sight Seeing	30.20
Cross Country Skiing	22.40
Horseback Riding	29.00
Snowmobiling	29.75

NATURAL RESOURCE INVENTORY

VEGETATION - The watershed area is in the Southern Rocky Mountain (RM 2) and Western Plateau (WP 2) major land resource areas.

Potential natural vegetation at the higher elevations of the Southern Rocky Mountain area includes Englemann spruce, alpine and corkbark fir, with alpine bluegrass, Thurber fescue, sedges and associated forb understories. Intermediate elevations support mixed conifers such as white fir, Colorado blue spruce, Douglas fir, bristlecone pine and aspen, with Letterman needlegrass, mountain brome, fescues and bluegrass understory. Lower elevations are characterized by ponderosa pine, Rocky Mountain juniper and motts of Gambel oak, with Arizona fescue and mountain muhly understories. Valleys have mountain big sage brush, junegrass, fescues and wheatgrasses.

The soils and climate in the Western Plateau area contribute to a grassland and mixed shrubland plant community. At upper elevational ranges, pinyon-juniper woodlands are characterized by alligator juniper, oneseed juniper, shrub oak, bullgrass, little bluestem, pinon ricegrass and blue grama. The grass-dominated lands occur on the deeper soils on relatively level to gently rolling terrain. They are characterized by western wheatgrass, spike muhly, blue

Maintenance and restoration of the riparian areas would benefit the fisheries habitat, wildlife diversity and recreational use.

grama and galleta. On shallow or stony soils on steeper slopes, juniper and pinyon pine become components of the plant communities.

RIPARIAN - The Rio Chama and the Rio Chamita within the planning area have developed riparian areas dominated by an overstory of narrowleaf cottonwood and/or black willow with a diversity of understory shrubs and grasses. These areas are significant because they provide a diverse plant community, which in turn provides ideal habitat for a diversity of wildlife species. In addition, these riparian areas provide habitat for fish by affecting water temperature and erosion control.

However, many riparian areas along the Rio Chamita have been degraded, negatively affecting biodiversity. In some areas, very little riparian vegetation remains along the eroding streambank, contributing sediment to the Rio Chamita.

WILDLIFE - The Rio Chama and Rio Chamita and the surrounding riparian, wetland and upland sites provide a diverse habitat for wildlife. Wildlife species adapted to these habitat types include songbirds, elk, deer, black bear, mountain lion, cottontail rabbit, beaver, muskrat, coyote, fox, porcupine, raccoon, skunk, other rodents, amphibians, reptiles, and fish from the sucker, minnow and salmon families.

THREATENED AND ENDANGERED SPECIES - U.S. Fish And Wildlife Service and the New Mexico Department of Game and Fish listings of threatened and endangered species indicates that no listed species would be affected by the proposed action. Federally listed threatened and endangered species that occur in this area as migrants include the bald eagle, peregrine falcon and the whooping crane. New Mexico endangered group 2 species that may occur in the planning area include the Jemez Mountains salamander, western toad, willow flycatcher, spotted bat, pine martin and meadow jumping mouse. Endangered group 2 is species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

NATURAL RESOURCE OPPORTUNITIES

The Soil Conservation Service Planning Team inventoried the natural and unique resources of the study area. The following is a discussion of this inventory.

Nature Trails, Cross Country Ski Trails, Snowmobile Trails- Trail routes need to be well identified, nature trails should preferably be hard surfaced with handicap access. Trails should be accessible from parking areas. They could extend the length of the study area in the bosque or on the uplands and have multiple uses. Some uses include bird watching, sightseeing, viewing wildlife, plant identification, wetlands study, exercise path and others. These trails could have spurs going down to the river at various locations to provide ready access for fishing and picnicking on the river. Trails through wetlands should be built on a platform to preserve the natural plant and animal community. Streams or ditches would require foot bridges or crossings. Constructed properly, these trails would have year round use. Trail development providing direct access to the Sargent Wildlife Area would be beneficial.

The Rio Chama has a tremendous potential for this type of development. Any trail system could readily tie into and utilize the green belt areas currently proposed along the river. If the green belt proposal is accepted, it should be discussed with adjacent landowners along the Rio Chama to carry this concept as far downstream as possible. Connecting any trail system to the hotels and motels along the Rio Chama would be very beneficial. A river walk concept might be considered to improve esthetics and recreational values.

Bosque Development - Most of the trees along the Rio Chama are mature narrowleaf cottonwood and black willow. Any areas along the floodplain that can be restored for recreation and wildlife should be planted to poles or potted plants of the desired species. Pole planting is a desirable and economical way to establish cottonwoods and willows. In most areas, planting would be preferred to natural regeneration because the type of species and spacing can be controlled. Poles could be obtained from local sources. In areas where there is little or no understory regeneration of cottonwood or willow, small openings could be created and poles could be planted, providing a new generation of trees to replace mature trees as they die.

As trees are removed in the bosque, they can be taken out of the area so they do not create an impasse for recreational uses or water courses. Stumps taken out of the ground should be removed from the area. In areas where they would not create a safety hazard along the trails, dead trees or snags can be left standing to provide habitat for birds such as woodpeckers, bald eagles and raptors. A density of three snags per acre within 500 feet of clearings and/or water and two snags per acre in the remaining forested area would be preferred.

Along the Rio Chamita, areas to be dedicated to recreation and wildlife should have poles planted to begin development of a bosque to improve the fisheries potential, control streambank erosion and improve the overall wildlife habitat of the area.

<u>Bird Watching and Sightseeing</u>- There is good potential for development of this area as a bird watching center. In addition to a diverse bird population in the bosque, several federally listed threatened and endangered species occur in this area on a regular basis. The bald eagle, peregrine falcon and whooping crane are among the threatened and endangered species that utilize this habitat. The area is a major migration route for many species.

It is recommended that migratory or resident bird species and likely birding locations in the area be inventoried to benefit those coming to the area for birding. Common birds in the area include magpie, raven, flicker, Steller's jay, robin, sparrow, finch, bluebird and various other song birds. Waterfowl in this area include mallard, Canada goose, teal and sandhill crane.

<u>Other Wildlife</u> - The Chama area supports a diverse population of big game and nongame species of wildlife. Big game that may utilize the study area include elk, mule deer, black bear and mountain lion. Small mammals common in this area are cottontail rabbit, beaver, muskrat, coyote, fox, porcupine, raccoon, skunk and possibly others. There are also numerous rodents, amphibians and reptiles in this area. Habitat development, such as foodplots and maintenance of travel lanes, could be incorporated into the bosque or upland areas to attract specific species or wildlife in general.

<u>Conservation Education</u> - Along any trails that would be developed, conservation education and outdoor class-room activities could be integrated. Alternatives include plant, fish and wildlife identification, and ecology, water quality, erosion control, soil interpretations and charac-teristics, and wetland and riparian ecology. Brochures could be developed to explain these topics and be made available to the public. Special emphasis could be placed on any or all topics for conservation education in the school system. An outdoor classroom could be developed for use by conservation groups or the schools within the Chama area.

Fishing - The fisheries habitat in the Rio Chama could be improved through several activities. Logs could be tied into the bank or in the streambed in strategic locations to create pools and other desirable areas for fish. These logs would have to be thoroughly secured and carefully placed so that a flood hazard would not be created. Large boulders could be used for the same effect as the logs. Large trees along the streambank should be maintained, or trees could be planted to enhance the stream shading and cool water temperatures. Development along the stream should be limited to at least 100 feet from the streambank to control erosion.

On the Rio Chamita, fisheries habitat needs to be developed and streambank erosion needs to be controlled. Streambank erosion could be controlled by limiting development within the 100-year floodplain and developing desirable riparian vegetation. Pole plantings of cottonwood and willow would create shade for the water and start development of a desirable bosque. Competition around pole plantings would have to be controlled.

Brush encroachment on the streambanks, for example, in the area of the bridge on US 84-64, should be controlled to allow the flood waters to flow out of the area. Currently, in many areas, the brush in the streambank is so thick it is slowing the water which will add to the flooding potential.

Recommendations to improve fisheries habitat on the Rio Chamita would be similar to those made for the Rio Chama. Sediment control would improve the entire stream ecology.

Wetlands - Wetlands in this area beneficial to improving biodiversity and water quality. Wetlands within the study area have not been specifically identified. The U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps and the SCS soil survey are excellent sources to start locating wetlands. Delineation of specific wetlands would require an onsite investigation. According to the Rio Arriba County Area Soil Survey, many of the soils in the river bottoms and first terraces as well as other areas are hydric, which is one of the criteria for wetlands. The NWI maps identify specific locations that may be wetlands. But neither of these sources is complete. No activity that would alter any wetland is recommended. In many cases, alteration of a wetland requires a 404 permit from the Corps of Engineers. Private lands are not exempt from 404 permit requirements.

The commercial-recreation-open space zoning district (CRO) zoning is suitable for development of archery, campgrounds, public parks, playgrounds, playfields and some other recreational facilities as long as all other resources are considered during their development. Any structures, such as picnic tables, campsites and trails, should be located so they will not cause any streambank erosion or interfere with the stream ecology. Any structures, other than trails going to the river, should be a minimum of 100 feet away from the streambank.

HISTORICAL, ARCHEOLOGICAL AND CULTURAL RESOURCES

A cultural resources file check of the Chama Floodplain Management Study area was conducted to ascertain cultural resources recorded in and around the Village of Chama. This information is to be used for planning purposes and should be considered preliminary. As specific actions and locations are decided upon, more intensive checks for cultural resources should be undertaken.

Information sources for this review were the Archaeological Records Management System, the New Mexico State Register of Cultural Properties, the National Register of Historic Properties and Soil Conservation Service field office records. A total of 15 prehistoric and historic archaeological sites in the vicinity of Chama have been recorded. These sites range in size from 0.02 to 2.4 acres. Site types range from chipped stone scatters to very large historic military installations. All sites previously recorded range in elevation from 6,560 feet to 8,450 feet. Of note are five sites, including prehistoric and historic types, that have been recorded on floodplains or along valley bottoms. These sites indicate that there are cultural resources even in areas of relatively recent colluvium and that few or no areas can be considered to be void of cultural resources. At least some of the sites noted would be significant, and all such historic properties must be mitigated for federally funded or assisted activities.

In the area of Chama-Los Brazos-Tierra Amarilla, there are three historic districts and 12 properties on the state and/or national registers. Of particular interest are three historic irrigation (acequia) systems. All three of these systems cross the floodplain from their diversion points, and any work along the Rio Chamita or Rio Chama could affect these significant properties.

A relatively high number of significant historic properties are already on the state and national registers in the Chama area, yet the amount of extensive archaeological survey in the area is relatively low. There are probably a high number of significant historic properties that have yet to be recorded or evaluated. This data indicates that caution should be exercised when planning ground disturbing activities in the area.

Should any federal funding, permit, or assistance be used the National Historic Preservation Act, as amended, requires, that cultural resources must be accounted for prior to any ground disturbing activities. The data in this report are intended to provide a preliminary assessment of the cultural resources currently known in the study area and are by no means exhaustive. Intensive record and field surveys and consultation with the New Mexico State Historic Preservation Officer must be undertaken prior to any project activity.

FLOOD HISTORY

Three types of storms produce flooding in the area. These are the general winter storm occurring between November and April, the general summer storm occurring between May and October, and the summer thunderstorm which normally occurs between July and October.

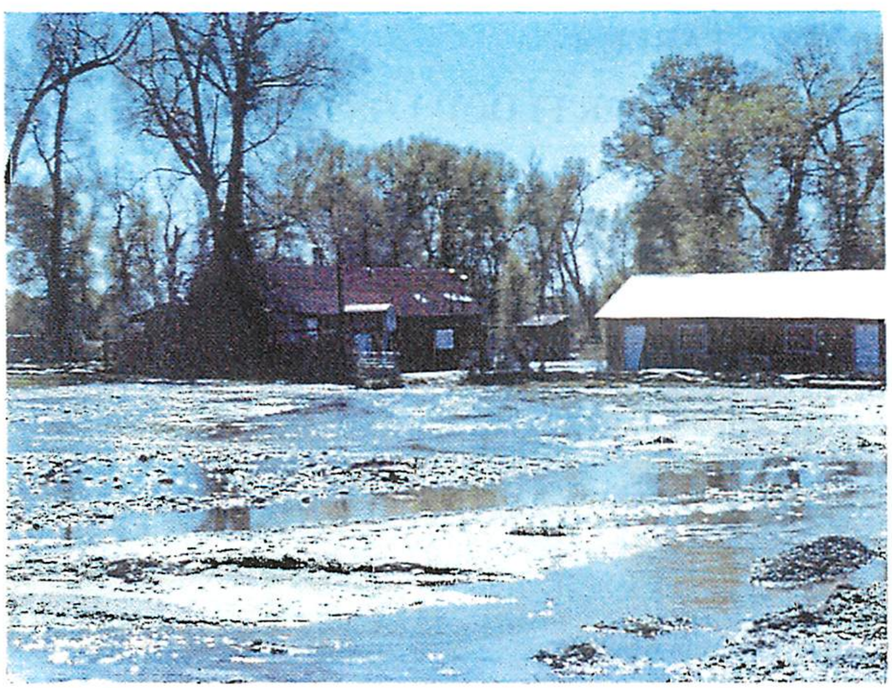
Major flooding along the Chama River is normally a result of the large general storms. The thunderstorms cover comparatively small areas and are usually a major factor in the flooding of the smaller tributaries to the Chama River.

The factors affecting flooding are natural obstructions to flood flow which include brush, large trees, and other vegetation growing along the streambanks in the floodplain. Manmade obstructions in the study area include bridges that cross the Rio Chama and Rio Chamita. In general, obstructions restrict flood flows and can cause overbank flows; unpredictable areas of flooding; destruction of or damage to bridges, homes and businesses; and increased velocity of flows immediately downstream.

Damaging floods on major water courses are known to have occurred in the vicinity of the Village of Chama in 1858, 1904, '11, '17, '26, '32, '37, ' 41, '52, '65, '79, '86, and 1991.

EXISTING STORM WATER MANAGEMENT

Current floodplain management regulation is contained in the "Zoning Ordinance of the Village of Chama, New Mexico" dated June 1974. Under this ordinance, the Village has jurisdiction for a distance of



Damaging floods in the Chama Valley have routinely occurred every eight years on the average.

three miles beyond the corporate limits. The ordinance establishes nine zoning districts, seven of which are designated on the official zoning map. Zoning districts are shown only within the corporate limits. Most of the Rio Chamita channel and the upper and lower reaches of the Rio Chama are consequently not zoned. The CRO (Commercial-Recreation-Open Space) district is generally associated with the stream channel riparian corridor. The CRO district includes such uses as archery, campgrounds, driving range, parks, recreation fields and riding stables. No permanent commercial or residential structures are permitted. Two and a half acres is the minimum lot size. The Village clerk is designated as the zoning enforcement officer. The primary emphasis of the zoning ordinance is to control new construction and location. It is a good foundation for regulating growth and has served the Village well.

However, a more comprehensive watershed management plan and 100-year floodplain map are recommended for inclusion in the zoning ordinance.

RECOMMENDATIONS FOR FLOODPLAIN MANAGEMENT

The primary objectives of floodplain management are the reduction of flood loss and the preservation (or restoration) of natural floodplain values. The Village of Chama is in a relatively good position to develop and adopt a much needed comprehensive watershed management plan. Fortunately there has not been a lot of development in the floodplain along the Rio Chama and Rio Chamita. Many communities are faced with costly remedies such as having to floodproof and/or remove existing structures in order to reduce repetitive flood damages. Preventing development in the floodplain is the preferred and least costly

TABLE 4

STRATEGIES AND MEASURES FOR FLOOD LOSS REDUCTION

Modifying Flooding
- dams and reservoirs
- levees and walls
- channel alterations
- diversions
- land treatment
- on site detention

Modify Susceptibility to Flooding
- floodplain regulations
- development and redevelopment
- warning and preparedness
- floodproofing

Modify Impact of Flooding
- flood insurance
- relief and recovery

solution. It also promotes the maintenance of the natural resources of the floodplain. The following information has been edited from FLOODPLAIN MANAGEMENT HANDBOOK, US Water Resources Council, September 1981.

The three general strategies for reducing flood losses are:

Modifying the flood

Reducing the danger and susceptibility to damage

Reducing the financial and social impacts of flooding

<u>Modifying Flooding</u> - The first strategy involves keeping flood waters away from developments and populated areas by decreasing runoff, by increasing channel capacity; or by containing, diverting, or storing floodwaters. These measures typically mean high capital costs in large public project activities. It is recommended that the Village concentrate its efforts on the other two strategies, specifically flooplain regulations and flood insurance.

<u>Measures Modifying Susceptibility to Flooding</u> - A diverse range of measures is available to reduce the danger and susceptibility to damages from flooding. By and large, they involve little or no construction and have a low capital cost.

Floodplain Regulations:

Floodplain regulations designate flood-prone areas and limit their uses to those compatible with the degree of flood risk. They serve several purposes including:

Preventing new development in flood-prone areas that could result in loss of life and excessive damage to property, or reducing the potential for such losses and damages.

Protecting unwary buyers from purchasing land or homes in flood-prone areas.

Preventing encroachments that decrease the flood carrying capacity of floodplains, increase flood heights, or otherwise aggravate flood problems.

Reducing public costs for emergency operations, relief, evacuations and restoration.

Reducing the need for future expenditures for construction, operation and maintenance of reservoirs, levees and other flood control measures.

Preserving natural floodplain values.

Development and Redevelopment:

Utilities, streets, schools and other community facilities attract developers and purchasers to an area. Public policies that limit the extension of services and construction of community facilities in floodplain areas discourage unwise private development. Actions to adopt this kind of public policy must usually be taken well before development pressures occur and should be supplemented with other regulatory measures to ensure success. Limiting extension of utilities and other public facilities into flood-prone areas also limits the need for their repair and replacement after floods.

Redevelopment programs can also be undertaken to correct existing problems. They can include relocating existing buildings to safe sites or demolishing undesirably located structures and providing replacements in a flood-free site. Areas vacated in either way are usually converted to a suitable open space use. Remaining structures may be modified to make them more resistant to flood damage.

Warning and Preparedness:

The National Weather Service makes flood forecasts for about 2,500 locations, mostly along major streams. The availability of specific flood warnings for other locations depends on the development of flood warning systems by local authorities.

In local flood warning systems, measurements of precipitation, temperature or stream levels upstream of an area are used to predict whether flooding will occur, when it will arrive and its severity. Local flood warning programs must provide for collecting data, making flood predictions and disseminating warnings. Warning systems are normally established on a community, county or watershed basis.

Floodproofing:

The concept of floodproofing (or more accurately, flood resistant construction practices) is to modify buildings, their sites or their contents to keep water out or reduce the damage caused by water entry. Floodproofing can also be used to reduce disruption to activities, to maintain vital services in operation during a flood and to permit faster recovery from flooding.

Unlike dams and other measures protecting large areas or long sections of streams, floodproofing is used to protect individual buildings or small groups of buildings. The most frequently used method of floodproofing is the elevation of buildings above expected flood levels. Small flood walls or levees can be used to protect single buildings or small groups of properties, such as the motel strip at the south end of the Village. They have the advantage of protecting the whole enclosed area rather than just the building. These measures are also useful for protecting buildings for which other floodproofing measures cannot be used because of the building's size or lack of structural strength.

<u>Measures Modifying the Impact of Flooding</u> - Some flood losses are likely to take place in developed areas despite measures to control flooding and reduce susceptibility to damages. The primary means for reducing the catastrophic financial impact of flooding on individuals and communities are flood

insurance and provisions for relief and recovery.

Flood Insurance:

The National Flood Insurance Program (NFIP) provides an opportunity for owners and renters of flood-prone properties to insure against some flood losses. The insurance is available to all persons in areas in which the local government is participating in the Federal program. Currently Rio Arriba County is participating; however, the Village of Chama is not. To become eligible for participation, the Village must formally apply for enrollment in the program and must agree to regulate new construction and development in areas subject to inundation by the 100-year flood. The Village would be required to adopt the Flood Hazard Boundary map dated August 1974 (Revised 12/12/75). The 100-year floodplain map provided by the Soil Conservation Service in this study could also be adopted as long as it is more restrictive than the NFIP map. The SCS map could also be submitted to the Federal Emergency Management Agency with a request that it replace the Flood Hazard Boundary map.

Flood insurance is applicable to all areas subject to flooding. It can be used along with other floodplain management measures which act directly to reduce losses. Owners and renters of existing structures have the option of purchasing flood insurance. However, financial institutions making loans for purchase of new or existing buildings in flood-prone areas often require the purchaser to buy the insurance.

The major costs to local government for participation in the National Flood Insurance Program are those for developing and enforcing the required floodplain regulations. The cost to policyholders depends on the amount of coverage purchased and the degree of flood risk.

Relief and Recovery:

The impact of floods on individuals and communities can be reduced by relief and recovery measures. Losses caused by disruptions and interruptions to businesses, industry, utilities and transportation facilities can be reduced if these activities are quickly returned to normal operation after a flood. This situation requires advance planning for debris clearance, pumping of flood water, and restoration of utilities and other community services. This planning can be included in flood preparedness plans.

Simply returning a community to its preflood condition reestablishes the original risk of flooding. In many cases, opportunities arise after floods to eliminate unsuitable developments which have been damaged or to rebuild essential structures in a way that will minimize future flood losses.

INVESTIGATION AND ANALYSIS

HYDROLOGY - Several hydrologic models are available to estimate existing and future runoff volumes (acre-feet) and peak flows (cubic feet per second or cfs). TR20 - Computer Program for Project Formulation, Hydrology - by the Soil Conservation Service was selected because of familiarity with the program, multiple subwatershed and routing capabilities, and ability to model reservoir routing and channel modifications. TR55 - URBAN HYDROLOGY FOR SMALL WATERSHEDS - will be made available to the Village to estimate runoff for subdivisions and development sites. Although not as complex as TR20, TR55 will provide a close approximation to the TR20 results.

Rainfall values for the 2-, 5-, 10-, 25-, 50- and 100-year 24-hour events were used to develop the existing runoff hydrology. Precipitation values were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Frequency Atlas of the Western United States. Soils information was derived from Soil Conservation Service soil surveys. Runoff curve numbers were assigned for existing conditions based on field investigations, aerial photography, stream gage frequency data and the soil survey. Time of concentration was computed by the Modified Kirpich Equation. This method was deemed reasonable since well-defined drainage channels are normal throughout the subwatersheds.

The SCS TR-20 computer model was used to develop the peak flows and runoff volumes for the Rio Chama and Rio Chamita. Stream gage data from several watersheds in the Southern Colorado and Northern New Mexico region were analyzed. In the process of refining the hydrology to accurately account for the rain on snow event, the Wolf Creek and Park View gages were especially useful. The watershed was divided into six subareas. Time of concentration is the time in hours that it takes runoff to travel from the most distant point to the sub-watershed outlet. Time of concentration values were computed with the Kirpich equation. The SCS-NM Type II-60 rainfall distribution was used with the appropriate 24-hour precipitation values from NOAA Atlas 2. Curve numbers are used in the computer model to define the infiltration/runoff phenomena for various soils, cover types and conditions. The curve numbers were adjusted to account for snowpack runoff by calibration with stream gage data (Table 5). Most flooding and annual peak flows in Chama are due to the coincidence of high snowpack water content, sudden spring warming and precipitation.

In the following tables the "Return Period" designates the estimated frequency, in years, that a storm of this magnitude would occur. For example, in Table 8 a storm event with a peak flow of 1,962 cubic feet per second is expected on an average every five years in subarea 1-1.

TABLE 5
SUBWATERSHED CURVE NUMBERS

Subarea	Frequency in Years 100	50	25	10	5	2
1-1	58	60	62	65.6	66.5	66.5
1-2	58	60	62	65.6	66.5	72.2
1-3	58	60	62	65.6	66.5	66.5
1-4	58	58	58	58	58	58
2-1	58	58	58	62	62	62
2-2	58	58	58	58	58	58

TABLE 6
SUBWATERSHED HYDROLOGY DATA

Subarea		Area Sq. Mi.	Length Ft.	Elevation Ft.	Tc Hrs.
1-1	Upper Chama	65.15	80203	3150	2.7
1-2	Wolf Creek	28.33	53323	3100	1.7
1-3	Middle Chama	12.1	31258	400	1.8
1-4	Little Willow Cr. and Lower Chama	15.1	43316	3043	1.4
2-1	Upper Chamita	43.02	66897	1365	3.03
2-2	Lower Chamita	4.76	15101	148	.19

TABLE 7
24 - HOUR PRECIPITATION

Subarea	Return Frequency (Years) 2	5	10	25	50	100
1-1	2.0	2.3	2.5	3.0	3.3	4.2
1-2	1.6	2.2	2.4	2.9	3.2	3.5
1-3	1.5	1.9	2.1	2.5	2.8	3.0
1-4	1.6	2.0	2.2	2.7	3.0	3.2
2-1	1.6	2.2	2.5	3.0	3.2	3.3
2-2	1.3	1.5	1.9	2.4	2.7	3.0

TABLE 8
SUBAREA PEAK FLOWS

Subarea	Peak Flows in CFS for Various Return Frequencies					
	Q100	Q50	Q25	Q10	Q5	Q2
1-1	6610	3547	3128	2422	1962	1052
1-2	2112	1892	1643	1223	962	585
1-3	452	445	355	277	193	34
1-4	905	668	377	80	30	4
2-1	1705	1503	1134	893	461	44
2-2	789	379	109	6	1	0

SUBAREA RUNOFF VOLUMES

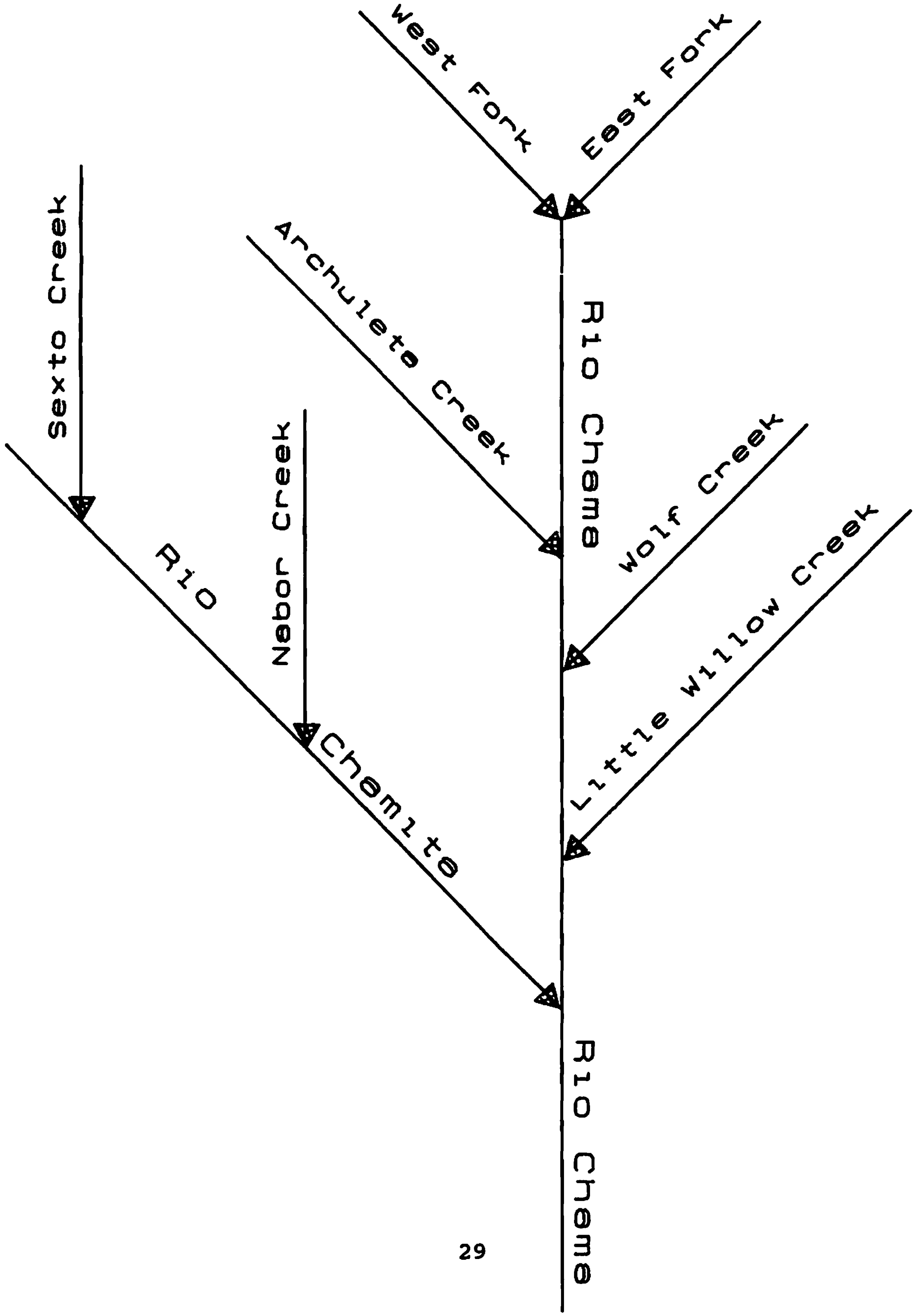
Subarea	Runoff Volumes in Acre-Feet for Various Frequencies					
	Q100	Q50	Q25	Q10	Q5	Q2
1-1	2632	1556	1383	1093	917	567
1-2	684	617	543	418	345	222
1-3	177	171	141	113	87	28
1-4	275	220	149	57	31	3
2-1	865	782	628	503	306	49
2-2	70	47	28	7	0	0

TABLE 9
PEAK FLOWS BY STREAM REACH AND RETURN PERIOD

Return Period (Yrs)	2	5	10	25	50	100
Location						
Junction of Rio Chama & Wolf Creek	1503	2727	3395	4434	5051	8267
Hwy 17 Bridge	1180	2035	2691	3680	4271	7196
Hwy 84 Bridge	1084	1953	2608	3656	4305	6709
Upstream of Junction with Rio Chamita	1023	1873	2512	3545	4182	6537
Downstream of Junction	1057	2243	3235	4508	5413	7952
Upper Rio Chamita	44	461	893	1134	1503	1705
Rio Chamita upstream of Junction w/ Rio Chama	35	402	798	978	1231	1430

<u>HYDRAULICS</u> - The Rio Chama and Rio Chamita study reaches were analyzed using numerous cross sections and the U.S. Army Corps of Engineers HEC-2 Water Surface Profile computer program. Sheets 1 through 8, Appendix E show the 100-year floodplain and channel profiles. Only the present condition of the watershed was analyzed, due to the significant amount of federally owned land in the watershed and the impact of snow melt on flood flows. Because of land ownership and snowpack influence, the future hydrologic condition will remain unchanged for many years. Flow depths and widths were computed for the 2-, 5-, 10-, 25-, 50- and 100-year floods.

Rio Chama Watershed Schematic



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APPENDICES

APPENDIX A

DEVELOPING FLOODPLAIN MAPS AND PREPARING AND ENACTING A FLOODPLAIN MANAGMENT ORDINANCE

INTRODUCTION

This appendix has been edited from Regulating Floodplain Development - A Handbook for Local Officials, by Department of Community Affairs, Commonwealth of Pennsylvania; the Cameron Park Watershed Area Study, El Dorado County, CA, and the Soil Conservation Service, Davis, CA, July 1985. It summarizes procedures local governments can use for watercourse and floodplain management. The first half of this appendix describes the steps that this study undertook to develop floodplain data. The second half of this appendix describes the most important aspects of preparing and enacting local floodplain management ordinances.

WATERCOURSE MANAGEMENT

Watercourse management may be defined as the full range of carefully planned public policy and action designed to promote the wise use of watercourses and to reduce future flood damages. A comprehensive watercourse management program includes corrective measures to rectify existing problems and preventive measures to keep new problems from developing as listed below:

WATERCOURSE MANAGEMENT TECHNIQUES

I. Actions to Protect Existing Watercourse Development and to Correct Existing Problems:

-flood control devices such as dams, levees and floodwalls

-floodproofing of existing structures

-clearance and/or relocation of existing structures

-public works projects to remove or minimize water obstructions or to control stormwater runoff

-regulation of existing nonconforming uses or structures

-flood forecasting and warning

-evacuation planning

II. Actions to Guide Future Watercourse Development:

-public acquisition of undeveloped land

-local building and land development regulations

-flood insurance

-comprehensive planning

-compatible public improvements

-public awareness

Local governments have the primary responsibility for establishing watercourse management programs. They have the authority to guide land use and development within their jurisdictions and are more familiar with their own flooding problems and what might be done about them. State and federal governments can play a significant role in helping communities develop the necessary financial and technical assistance which local governments might not otherwise have.

LOCAL REGULATION

This section is directed at just one aspect of local watercourse management - the regulation of construction and development within flood-prone areas. Communities are encouraged to develop and administer regulations as part of a broader watercourse management plan or program that establishes defined goals and objectives, within which plan specific regulatory actions can be guided.

Local land use regulations can be an important part of an overall watercourse management program. Zoning regulations can control the type, density and location of uses within flood-prone areas. Subdivision regulations can be used to ensure that known flood-prone areas are clearly described on plans for effective management and for adequate notification to potential buyers.

Building codes set forth floodproofing design and construction standards to lessen the vulnerability of new buildings to flood damage. Each type of regulation achieves a slightly different objective and all are important in reducing future flood damages.

The limitations of local regulations must be recognized, however. While they are important in an overall program of watercourse management, they are almost exclusively aimed toward future construction. That is, although they can be used effectively to help prevent the problem from becoming any worse, they will not be very useful in reducing damage potential to existing structures. This situation emphasizes the need for both corrective and preventive measures to achieve adequate watercourse management.

NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was created by the National Flood Insurance Act passed by Congress in 1968. The purpose of the NFIP is twofold:

1. To provide the general public with the opportunity to obtain flood insurance at reasonable rates to cover damages to buildings and their contents due to flooding; and

2. To reduce future flood damages by requiring the regulation of new development in flood-prone areas.

The NFIP is administered by the Federal Insurance

Administration (FIA) within the Federal Emergency Management Agency (FEMA). The insurance is sold through local insurance agencies. A property owner may buy flood insurance if the community within which the property is located participates in the NFIP. The community must adopt and enforce local land development regulations which, at a minimum, meet NFIP requirements.

MAPPING METHODS

A number of different methods can be used to map flood-prone areas, including the analysis of soils, vegetation, physiography, flood of record and hydrologic and hydraulic factors. The type of mapping needed by a community will depend on many factors, but most importantly, it will depend upon the ultimate use of the map.

For regulating watercourse development, a map developed through hydrologic and hydraulic analysis is preferable. The advantage of this method is that specific frequencies of flooding can be selected for delineating flooded areas. It is often difficult to associate the delineation of a floodplain based on soils, physiography or vegetation with a particular frequency of flooding. If applied properly, this method provides a sound technical and legal basis for adopting and administering watercourse management regulations for urban areas. However, if it is too costly to do so or if adequate flood data are lacking, other types of maps can be used. Communities utilizing other types of maps are encouraged to incorporate ordinance provisions which require that floodplain data be refined when considering individual permit applications.

Since the National Flood Insurance Program uses hydrologic and hydraulic analysis in preparing Flood Insurance Studies, it is helpful for those involved in the preparation and administration of floodplain management ordinances compliant with NFIP requirements to have a general understanding of how these maps are developed.

Simply stated, the science of hydrology is used to determine the amount of water an arroyo or river must convey for a given storm. This involves calculating the amount of runoff that can be expected to drain from the surrounding watershed. The principles of hydraulics are applied to help determine how the arroyo or river will handle the flow and to what extent the excess water will spread over the floodplain when the flood is at its peak. Specialized computer programs are used to perform most hydrologic and hydraulic computations.

The following subsections give a brief description of the procedures involved in applying these techniques to prepare floodplain maps.

STEP 1

SELECTING A FLOOD

Step 1 in preparation of a floodplain map is to select a flood of a certain frequency of occurrence. The 100-year frequency flood is the standard typically used throughout the United States. For this type of flood there is one percent or 1 in 100 chances of this size of flood being equalled or exceeded in any given year. A flood of this size could strike twice in the same year, but over a long period of time it should occur on an average of once every hundred years. In more practical terms, a property owner having a 30-year mortgage on a house located within a 100-year floodplain has a 25 percent chance of experiencing a flood equal to, or greater than, a 100-year flood before the final mortgage payment is due.

STEP 2

CALCULATING FLOOD FLOWS

Various techniques can be used to estimate flood flows. Preferred techniques use statistical analysis of actual stream gage data. If stream gage data is not available, other methods which consider the measurable characteristics of the drainage basin can be applied, depending on the size of the watershed.

Stream Records

The data collected from rivers and streams with stream gaging systems can be used to compute flow in the stream for a 100-year flood. For example, it can be computed by using the highest peak flow each year in a statistical analysis. Data points are plotted on a special type of graph paper (log probability), and a line is drawn through these data points. From that graph the flow for a particular frequency flood can be determined. The flow is usually given in the number of cubic feet of water that passes a given location in one second (cfs).

Estimating Flow

When stream gage records are not available or are incomplete, flood peaks must be estimated. Numerous equations for estimating the flood peak have been developed. Their applicability can vary over a wide range. Thus, it is important to choose a procedure that best fits the size and locality of the drainage basin. The techniques for large watersheds are usually based on gaged stream data that have been correlated to physical characteristics of the drainage basin. For example, the Federal Highway Administration method takes into consideration drainage area, rainfall, difference in elevation of the main channel between the most distant point in the watershed and the location of interest, the climatic zone, and the percentage of surface water storage area in the watershed such as lakes and swamps.

The procedures for small ungaged watersheds are usually simpler in nature. An example is U.S.D.A.-Soil Conservation Service TR-55 "Urban Hydrology for Small Watersheds." TR-55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs and storage volumes required for channel design and floodwater storage. These procedures are applicable to small watersheds (up to 20 square miles), especially urbanizing watersheds in the United States.

Whatever technique is used, a combination of the rainfall or stream flow records and the physical characteristics of the drainage basin, such as soils, slope, vegetation and land use, should be taken into consideration.

STEP 3

PREPARING FIELD MEASUREMENTS

Once the flow is known, the particular slope and shape (cross section) of the stream channel and adjoining floodplain are determined at numerous points. A cross section is a graphic picture of a section of the stream and adjoining floodplain cut at right angles to the direction of flow. The best method is by actual field measurement, but the data may be taken from topographic maps. Measurements of manmade encroachments such as dams, bridges and culverts are also obtained.

STEP 4

ESTIMATING RESISTANCE TO FLOW

The resistance to the flow is then needed to complete the data required to calculate the height of water. The resistance to flow, or roughness factor (called roughness coefficient) is determined by analyzing the character of the landscape. For example, a wooded floodplain would tend to hold back the water, causing a higher flood level than a grassed floodplain. A smooth concrete-lined channel will obviously convey water with less resistance than a channel with large rocks and fallen trees. Manmade objects such as buildings, fences, highways and bridges will all have an effect on resistance to the flow.

Since each situation is unique, it is often difficult to estimate the roughness coefficient. However, if there are known high-water marks, the roughness coefficient can be adjusted so the calculated water surface profile agrees with the high-water mark elevation. The equation then would give more reliable elevations for the 100-year flow.

STEP 5
CALCULATING FLOOD HEIGHT

Factors, such as stream slope, shape of channel and floodplain, manmade obstructions and natural obstructions, are then used in conjunction with the frequency of flood flows (such as the 100-year flow) to compute the flood height.

STEP 6
PREPARING A PROFILE

The flood elevations for each crossection are then plotted on a profile and the points are connected. A profile is a graphic picture of a section of the stream as if it were cut lengthwise down the centerline giving a side view. The profile shows the water surface for a given flood frequency. Locations of points on the profile can be identified on the aerial map showing the floodplain. (See Appendix C).

STEP 7
DELINEATING THE FLOODPLAIN

The final step is to translate from the profile the height of the flood at each cross section onto a topographic map. The flood elevation for each cross section is plotted on both sides of the stream and the points are connected by lines following contours to show the boundary of the floodplain.

The reliability of the floodplain delineation is dependent on the accuracy of the data used to calculate the elevation and on the accuracy of the topography and features shown on the floodplain map. For example, if the topographic map has five-foot contour intervals and the flood elevation was calculated to the nearest foot, a judgment has to be made where that elevation is located on the map. If that judgment causes a building to be in the floodplain, more accurate data should be obtained to check the validity of the decision. This example indicates the importance of knowing generally what data was used in preparing the floodplain map.

FIA MAPS

Floodplain mapping has been performed for some years by different agencies of federal and state governments. It was not until passage of the National Flood Insurance Act of 1968, that floodplain mapping became a major effort nationwide. The Federal Insurance Administration (FIA) is responsible for preparing maps of flood hazard areas as part of its duties in administering the NFIP. The remainder of this appendix explains the type of mapping FIA provides to municipalities.

FLOOD HAZARD BOUNDARY MAPS

The time and cost involved in preparing detailed floodplain maps made it impossible for the FIA to provide accurate mapping immediately for every flood-prone community throughout the country. Consequently, the initial effort was aimed at providing Flood Hazard Boundary Maps (FHBM). Because of the lack of detailed flood data and topographic information to serve as a basis for mapping, FHBMs only show the approximate area of the floodplain and do not show 100-year flood elevations. In addition, not all flood hazard areas may be delineated. For example, FIA does not usually delineate flood hazard areas along streams with drainage areas less than one square mile or flood hazard areas having widths of less than 200 feet. The FHBM also shows the location of roads and highways, railroads, streams and municipal boundaries. Since the FHBM is designed to be used for insurance purposes as well as for municipal use, it identifies "A" Zones (flood hazard areas) and "C" Zones (areas of minimal flood hazard) which are used by insurance agents to determine insurance rates.

When a community receives an FHBM from FIA, it must enact an ordinance regulating all future construction and development within the floodplain based on the requirements of Sections 60.3 (a) and (b) of the NFIP.

OBTAINING MAPS AND STUDIES

When FIA prepares maps for a community, copies are sent to the municipal secretary or to the chairman of the governing body. Additional copies of FHBMs may be obtained by completing and submitting a map order form to the NFIP map depository in Bethesda, MD. Map order forms may be obtained by contacting the regional office of FIA.

LOCAL FLOODPLAIN OR WATERCOURSE MANAGEMENT ORDINANCES.

An ordinance is the legal means by which communities can set standards and procedures for regulating floodplain development. To comply with the National Flood Insurance Program (NFIP) a community must adopt an ordinance that:

* includes all necessary federal and state floodplain management requirements
* is legally enforceable
* applies uniformly to all floodplain areas
* takes precedence over any less restrictive conflicting local ordinances or codes

THE LEGALITY OF REGULATING FLOODPLAIN DEVELOPMENT

The courts have generally upheld challenges to local floodplain management ordinances as long as the degree of regulation can reasonably be related to the danger posed to the public interest. If a definite danger exists, even strict regulations have been upheld.

Court decisions on floodplain ordinances support local regulations when it can be proven the ordinances:

* comply with statutory procedures to adopt, administer, and to enforce the regulations
* properly balance public interests with private rights
* treat similarly situated landowners according to the same standards
* do not go beyond the powers granted in the enabling legislation

Therefore, it is important to review carefully what is proposed and to follow closely the enacting procedures which apply.

DEGREE OF REGULATION

Communities are required to adopt development controls which, at a minimum, meet federal and state floodplain management requirements.

The extent to which a community may want to regulate floodplain development beyond the federal and state minimum requirements is a local matter and will depend on a number of factors, including the following:

* the extent and severity of flooding

* the amount of land subject to flooding

* the type, amount and location of existing floodplain development

* future growth and development patterns

* the detail to which floodplains are mapped

* the need to protect natural resources and environmental quality

Floodplain regulations should be part of an overall floodplain management program designed to guide and promote the wise use of floodplain lands and resources. In this respect, floodplain regulations become one of several management techniques employed to attain the goals and objectives of a broader effort to reduce or avoid future flood damages. Having a floodplain or watercourse management plan or program will help communities design regulations which meet local needs and conditions rather than regulations which simply copy state and federal minimum requirements.

Communities that decide to take stronger measures to control future floodplain development have several options. Some of the more commonly applied regulatory approaches are described in the following subsections.

PROHIBITING CERTAIN TYPES OF DEVELOPMENT

Some communities prohibit certain types of development within the floodplain, especially those which present a significant hazard to people or property. Examples include schools, nursing homes, hospitals, jails, mobile home parks, landfills, sewage treatment plants, cemeteries, chemical plants and warehouses, as well as other similar kinds of development that could cause widespread public health and safety problems in the event of flood damage. Emergency facilities, such as fire stations, ambulance services, and emergency management offices, which are critically needed in times of flooding should also be excluded from the floodplain or any other area where they would be cut off in case of flood.

PROHIBITING FLOODWAY DEVELOPMENT

Some communities prohibit development only within the floodway portion of the floodplain, since this is the area which conveys the bulk of the floodwater downstream and is the area where water velocities and forces are the greatest and most destructive. Communities having Flood Insurance Studies are likely to have floodway areas delineated on the Flood Boundary and Floodway Map and can readily use the map description as a basis for prohibiting development. Communities which do not have detailed studies can establish a simulated floodway by the use of a setback distance from the stream.

Some communities use a 50-foot setback measured landward from the top of the channel to regulate encroachments along watercourses which do not have an identified floodway. A community could decide to use a lesser or greater distance, depending on the size and direction of flow of the stream and other features of the floodplain area.

MAINTAINING THE FLOOD FLOW CAPACITY OF STREAMS

Communities which do not have identified floodway areas should consider including ordinance provisions that would only allow future floodplain development if it would not cause an increase in flood heights above a stated limit. The maximum allowable increase is usually one foot above the base flood elevation. This provision would be administered on a case-by-case basis evaluating the effect of a proposed project and other anticipated floodplain development on flood flows.

Communities which have Flood Hazard Boundary Maps (FHBM) or which have detailed Flood Insurance Studies showing approximate flood-prone areas should seriously consider this option. Section 60.3(b) requirements of the NFIP are specifically designed to protect structures and not the carrying capacity of streams and adjacent floodplains. Excessive filling and developing of a floodplain without regard to effects on flood flows can result in greater flood velocities and increased flood heights.

SELECTING A REGULATORY FLOOD

Many communities use the 100-year flood as the minimum standard for regulating floodplain development. Under certain circumstances, communities have found it advantageous to regulate development using a flood of greater magnitude, such as any larger flood of record. Some communities with detailed Flood Insurance Studies have adopted the 500-year flood as the regulatory flood. Still other municipalities have used the county soil surveys to regulate development on floodplain soils.

Again, the 100-year flood is a minimum standard. Where it makes sense to do so, larger floods can and should be used.

FURTHER INFORMATION

These are just a few examples of the things that can be done to develop an ordinance which best meets local needs. The local official should ask, "What needs to be done to protect the community?" The following publications and reports provide additional information on this subject matter:

* A Perspective on Floodplain Regulation for Floodplain Management (U.S. Army Corps of Engineers)

* Regulations for Floodplains (ASPO Planning Advisory Service)

* Regulation of Flood Hazard Areas to Reduce Flood Losses (U.S. Water Resources Council)

SELECTING THE TYPE OF ORDINANCE

Once the regulatory approach is selected, the next step before actually drafting an ordinance is to decide which type of ordinance is best suited for the community to regulate floodplain development. Floodplain requirements may be contained in a single ordinance or may be incorporated into building permit ordinances.

SPECIAL PURPOSE ORDINANCES

One option is to develop a special purpose ordinance, a local law designed to address a particular problem affecting the general health, safety and welfare of the community. Junkyard, weed and nuisance ordinances are examples of special purpose ordinances.

Certain advantages of special purpose ordinances make them a commonly used means for regulating floodplain development. Perhaps the greatest advantage is that a special purpose ordinance contains all the watercourse or floodplain management provisions in one document, making the ordinance easier to understand and administer. Some people think dividing the provisions among the zoning, building codes, subdivision and land development ordinances can complicate the matter, especially for communities without full-time ordinance administrators. Furthermore, a special purpose ordinance can be enacted in less time and with less expense. Since zoning is often a controversial issue at the local level, the enactment of a special purpose ordinance may avoid the problems and delays associated with the adoption of zoning ordinances.

ZONING, SUBDIVISION AND LAND DEVELOPMENT ORDINANCES AND BUILDING CODES

Another option to regulating watercourse or floodplain development is to include provisions in zoning and subdivision and land development ordinances and in building codes. Communities having enacted or proposed ordinances may find it advantageous to incorporate watercourse or floodplain management provisions into these regulations. Since the legal and administrative framework is already set up and functioning, it may be best to try to mold the floodplain regulations into the existing system rather than trying to enact an entirely new and distinct ordinance.

ENACTMENT PROCEDURES

The procedure for enacting floodplain ordinances is basically the same, whether it is for zoning or subdivision ordinances or for special purpose ordinances. However, minor variations between the two types of ordinances should be recognized. In either case, the District Attorney should be involved to ensure that proper procedures are followed. Generally, the following steps are involved in adopting an ordinance:

* Advertise the ordinance in a community newspaper outlining the proposed action and notice of when the ordinance will be considered in a public meeting.

* Readvertise if significant changes are made as a result of the first meeting and before adoption.

* Vote to adopt by the governing body.

* Record the ordinance in the official records.

CONCLUSIONS

Local ordinances regulating development are one of the most important aspects of an effective watercourse or floodplain management program. If they are properly written and administered, they can accomplish the objectives of making available to residents the protection offered by the National Flood Insurance Program and helping to reduce future losses to the community and to others downstream.

ORDINANCE ADMINISTRATION

Once enacted by the governing body, the responsibility for administering the watercourse or floodplain management ordinance is usually assigned to the zoning officer, code enforcement officer, permit clerk, municipal secretary or some other appointed individual. This person is usually referred to as the permit officer.

In regard to administering a watercourse or floodplain ordinance, the permit officer should be familiar with the objectives and policies that were used as a basis for adopting the ordinance. This will help him or her explain the reasoning behind the building restrictions to applicants who may question the need for them.

The permit officer should also have a thorough understanding of the contents of the ordinance, especially the procedural provisions and the technical standards. Not following the proper procedures or misinterpreting the technical requirements can lead to problems for the applicant and the local government.

Local watercourse or floodplain ordinances establish permit systems as the means for ensuring that all watercourse or floodplain development activities conform with the applicable ordinance provisions. Unlike conventional building permit ordinances which only require permits for the construction of buildings and other structures, watercourse or floodplain management ordinances require permits for all construction and development within the watercourse zone or floodplain. Development covers any activity considered a manmade change to real estate, including but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavating or drilling operations.

PERMIT APPLICATION

A person planning to do any construction or development in a watercourse zone or floodplain must apply for a permit. Ordinances usually specify the type of information which the applicant must provide. Most ordinances require the applicant to fill out a permit application form.

A standard application has two parts. The first part is an administrative form which serves as an official record of certain facts, such as name and address of the applicant, a brief written description of what is to be done, and the final action of the permit officer. The most important piece of information is the elevation of the 100-year flood and the elevation of the lowest floor (including the basement) of any structure.

The second part of the application is a map or drawing which clearly illustrates the location of the project, all proposed structures, property lines, rights-of-way and setback distances. For floodplain management purposes, the location of the floodplain boundary, the stream channel, and, if applicable, the boundary of the floodway should also be shown along with the direction of flow and approximate water velocities. There may be instances when, because of the type or size of a proposed development, the permit officer will need additional information to make a complete and adequate review of the project. In these cases, he or she should notify the applicant as soon as possible of the nature and detail of this supplemental information so it can be submitted along with the application package.

Upon receipt, the application should be checked to make sure it is complete. An incomplete application should be returned to the applicant immediately with a written explanation of any deficiency. When satisfactorily completed, the applicant should provide a sufficient number of copies for the local government to initiate its review.

APPLICATION REVIEW

Once a completed application is received and recorded, copies should be submitted to all other reviewers as required in the ordinance. The reviewers may include the official engineer, planning commission, local conservation district or water and sewer authority.

Even if it is not actually required by the ordinance to have others involved in the review of permit applications, permit officers can seek the help of other agencies with expertise in these matters.

Next, the permit officer should read the application form and study the accompanying plan carefully. Any discrepancies or conflicting information should be noted.

CHECKING THE ELEVATION

Most important, the elevation of the 100-year flood should be checked. This matter is relatively simple where a detailed FIS has been prepared. In this case, the flood profiles are used to determine the elevation at the point along the stream adjacent to the proposed development.

The procedure is more complicated when the community has only a Flood Hazard Boundary Map. With this type of map, elevations are not provided. In these instances, where elevation information is available from other sources, such as the Corps of Engineers, Soil Conservation Service, U.S. Geological Survey, New Mexico Department of Transportation, or others, it should be used. If other elevation information is not available, an elevation can be obtained by using the Flood Hazard Boundary Map and a field survey.

Some communities with Flood Hazard Boundary Maps require the applicant to determine the 100-year flood elevation using accepted hydrologic and hydraulic engineering techniques. If an applicant submits an elevation based on an individual engineering analysis, the permit officer should request a copy of the engineering documentation.

In any event, the permit officer should carefully check the 100-year flood elevation and determine whether the applicant's figure is correct.

VISITING THE SITE

Another important step in the review of any application is visiting the site. It will give the permit officer a better understanding of the proposed project and its relationship to the flood hazard.

It will also give the permit officer an opportunity to verify the location of the property in question and to determine to what extent the proposed project may affect adjacent properties.

In some cases, visiting the site may be necessary or helpful in determining the elevation of the 100-year flood.

DETERMINING COMPLIANCE

The purpose of the permit system is to ensure that the proposed construction or development is designed and constructed in a manner which complies with the technical standards and specifications of the ordinance. It is the most important aspect of the application review procedure.

APPROVAL OR DISAPPROVAL OF PERMIT REQUEST

Once the review and evaluation of the permit application is completed, the permit officer must approve or disapprove the permit request. If approved, the applicant is issued a permit. If denied, the permit officer should explain the reasons for denial in a letter to the applicant. Keeping careful notes throughout the review of the application will be helpful in the event a disapproval letter must be prepared. The letter should include references to the specific sections of the ordinance which have not been met.

INSPECTIONS

Site inspections must be conducted to make sure that the actual construction of the proposed project is performed according to the approved plans. Inspections should be done in a timely manner to avoid construction delays.

APPENDIX B

ELEMENTS OF TERRAIN MANAGEMENT PLANS

Appendix A provides details specific to floodplain management and regulation of development within the floodplain. However, many of the problems associated with flood damages are a direct result of manmade changes beyond the floodplain but within the watershed. Sediment producing activities within a watershed should be a major concern of any floodplain management office. One means of controlling sediment producing activities as well as flood damages is with terrain management plans. This appendix has been edited from the New Mexico Subdivision Review Guide (USDA-Soil Conservation Service). Elements of a terrain management plan include:

1. Soils
2. Grading
3. Floodplain Management
4. Storm Drainage
5. Roads
6. Erosion Control
7. Revegetation or Landscaping

Listed under each element are the essential features which should be included in the plan and a description of how these features should be planned.

It should be noted if the terrain management plan does not contain sufficient information about particular features, the needed information should be obtained from the developer.

1. SOILS

Soil Conservation Service single phase interpretation sheets are available for many of the soils in the state. These interpretations may be used in reviewing terrain management plans. Published soil surveys will also provide the needed information. An advance copy of the Rio Arriba County Soil Survey is available for reference at the Chama SCS Field Office until the published report becomes available. In this reference the principal detrimental or unfavorable features of the soils are listed. Limiting features are described by one of three terms:

Slight - Good suitability, a rating given soils with properties favorable for the intended use. The degree of limitation is minor and can be overcome easily.

Moderate - Fair suitability, a rating given soils with properties moderately favorable for the intended use. This degree of limitation can be overcome or modified by special planning, design, or maintenance. Some soils rated Moderate require treatment such as artificial drainage.

Severe - Poor suitability, a rating given soils that have one or more properties unfavorable for the rated use, such as steep slopes, bedrock near the surface, flooding hazard, high shrink-swell potential, a seasonal high water table, or low bearing strength. This degree of limitation generally requires major soil reclamation, special designs, or intensive maintenance.

Soils having several limitations or which are shown as unsuitable for the intended purpose should not be used for the purpose unless the developer has clearly shown in the plan how these limitations will be overcome.

Below are the major categories used in reviewing the terrain management plan:

A. Building Site Development
B. Construction Material
C. Local Roads and Streets
D. Underground Utilities
E. Water Control Structures
F. Erosion Control Structures

Evaluation of suitability provided by an SCS soil survey is limited to a five-foot depth. These are general suitability estimates and are not to be used for foundation design.

2. GRADING

Land grading, filling and clearing operations can cause many problems when performed incorrectly, such as leaving large bare areas subject to wind or water erosion. Grading should not proceed beyond actual development needs. Topsoil should be replaced to aid in revegetation of construction sites. Operations should be planned and designed to enhance natural scenic beauty of the area. Special erosion control measures are usually necessary on sandy soils. The following is a list of questions and requirements that should be addressed in the plan:

A. Preserve, match or blend with the natural contours of the land.

1. Does the plan adequately describe how grading operations will be performed to blend slopes and fills into the natural contours of the land?

2. Does the plan retain or replace trees and other native vegetation, to stabilize hillsides, retain moisture, reduce erosion, reduce runoff and preserve the natural scenic beauty?

3. Have cuts and fills been designed to minimize the area of exposure and reduce the sharp angles at the toe and sides?

4. Does the plan prevent the deposit of sediment into floodplains, drainage channels, watercourses, and water bodies?

B. The following discharges attributable to grading are prohibited whether the discharge is direct or indirect:

1. Sediment and other organic or earthen materials discharged into a watercourse, water body, drainage channel or flood-plain.

2. Materials placed in any position which would make it susceptible to erosion and deposition into a watercourse, water body, drainage channel or floodplain.

   a. Does the plan for grading, land forming, and protective cover provide for the prevention of sedimentation?

   b. Does the plan call for temporary or permanent structural mea sures to prevent damaging runoff waters originating on the slope itself?

   c. Do planned structural measures adequately provide for the limitations of the site?

C. Whenever the native ground cover is removed or disturbed or whenever fill material is placed on a site, does the plan call for the exposed surface to be treated to the extent necessary to prevent dust from blowing off the construction site?

D. Does the work schedule for grading and filling operations limit the soil exposure period to the shortest possible time before cover is established?

E. What provisions are made for diposal of vegetation during clearing operations?

F. What is the disposition of earth removed during grading operations?

G. Are the maximum cut and fill slopes compatible with soil stability or erodibility as shown on the soil survey or city regulations?

H. What provisions were made to prevent runoff from flowing over the face of the slope?

I. Are mechanical stabilization measures planned for slope containment?

J. If a borrow area is shown, is revegetation planned for the disturbed area?

K. If arroyos or other overfall areas are in the planning area, are rundowns to a safe outlet planned?

L. Are provisions made for water and erosion control in borrow ditches along streets and roads?

3. <u>FLOODPLAIN MANAGEMENT</u>

Subdivisions and developments shall be planned, constructed, and maintained so that:

   A. Dwellings are not located within the 100-year floodplain.

B. Structures, material deposits, or excavations, alone or in combination with present or future works, do not adversely affect the capacity of the floodplain.

C. Roads are not located in the floodplain unless specifically approved by the State Highway Department and the road does not conflict with B. above.

D. Structures with a potential for high flood damage and confined animal shelters are not located in the floodplain.

E. Existing utilities and proposed utilities will be free from the threat of flood damage.

4. <u>STORM DRAINAGE - DRAINAGE PLAN</u>

Subdivisions and developments shall be planned, constructed and maintained to:

A. Protect and preserve existing natural drainage channels except where erosion and water control measures are approved.

B. Provide temporary measures to prevent damaging runoff waters from leaving the site until construction is completed and permanent control measures are installed.

C. Protect structures and other works from flood hazards using the 100-year frequency storm for calculating flood levels.

D. Provide a system in which runoff water within the subdivision is removed without causing harm or damage to the environment, property, or persons inside or outside the subdivision area.

E. Assure that waters drained from the subdivision does not contain pollutants or sedimentary materials of any greater quantity than would occur in the absence of the subdivision.

F. Assure that waters are drained from the subdivision in such a manner that they will not cause erosion outside of the subdivision to any greater extent than would occur in the absence of the subdivision.

If the drainage basin in which the subdivision is located is only partially developed, it should be required that the design and construction of the drainage system have sufficient inlet flow capacities and inlet flowline elevations to adequately serve the entire drainage basin. This suggested requirement is based on the assumption that the entire basin will eventually be developed.

5. ROADS

Roads shall be located and designed to:

A. Preserve natural features, vegetation, and topography and to protect the natural environment.

B. Create conditions to ensure proper drainage.

6. EROSION CONTROL

The plan should clearly indicate that installed measures will prevent or control erosion. As a minimum the following items should be considered:

A. Are designed road grades flat enough to prevent erosion based on the soils involved?

B. Are borrow areas or drainage features designed to prevent erosion or sediment deposition?

C. Are culvert inlets and outlets properly protected from erosion and sedimentation?

D. Will critical area treatment or special plantings be needed? If so, are the plans adequate?

E. Will temporary soil stabilization be needed? If so, is it adequately planned?

F. Is adequate soil stabilization planned on permanent slopes?

7. LANDSCAPING AND REVEGETATION

Revegetation is an important part of any subdivision plan. A definite time schedule for installing plant cover is necessary to prevent erosion, particularly in areas with sandy soils. The need for revegetation is an integral part of several of the other sections.

APPENDIX C

TAPS Station : CHAMA, 1664
start yr. - 1949 end yr. - 1991

Month	Temperature						Precipitation			
				2 years in 10 will have		avg no. of grow'n degree days*		2 yrs in 10 will have		average number of days with 0.10 inch or more
	avg daily max	avg daily min	avg	max temp. >than	min temp. <than		avg (in.)	less than (in.)	more than (in.)	
January	36.6	5.8	21.2	52	-21	0	1.90	0.60	2.97	5
February	40.2	9.5	24.9	56	-19	1	1.46	0.59	2.20	4
March	45.7	15.7	30.7	63	-8	9	1.82	0.79	2.70	5
April	56.1	23.6	39.9	73	3	72	1.32	0.53	2.05	3
May	65.5	31.3	48.4	80	15	248	1.19	0.43	1.82	3
June	76.5	38.9	57.7	89	24	475	0.99	0.29	1.65	3
July	80.6	46.2	63.4	90	35	667	2.05	1.14	2.86	6
August	77.6	45.2	61.4	89	31	640	2.61	1.44	3.65	7
September	71.9	38.1	55.0	84	22	428	1.92	0.70	3.01	4
October	61.6	28.5	45.1	83	8	173	1.77	0.60	2.98	3
November	47.6	17.7	32.7	68	-9	14	1.52	0.72	2.34	4
December	38.7	9.7	24.2	55	-16	0	1.57	0.62	2.66	4
Yearly :										
Average	58.2	25.9	42.0	----	----	----	---	---	---	---
Extreme	103	-30	---	92	-25	----	---	---	---	---
Total	---	---	---	----	----	2728	20.13	13.98	24.92	51

*A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minumum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold : 40.0 deg. F)

FROST Station : CHAMA, 1664
start yr. - 1949 end yr. - 1991

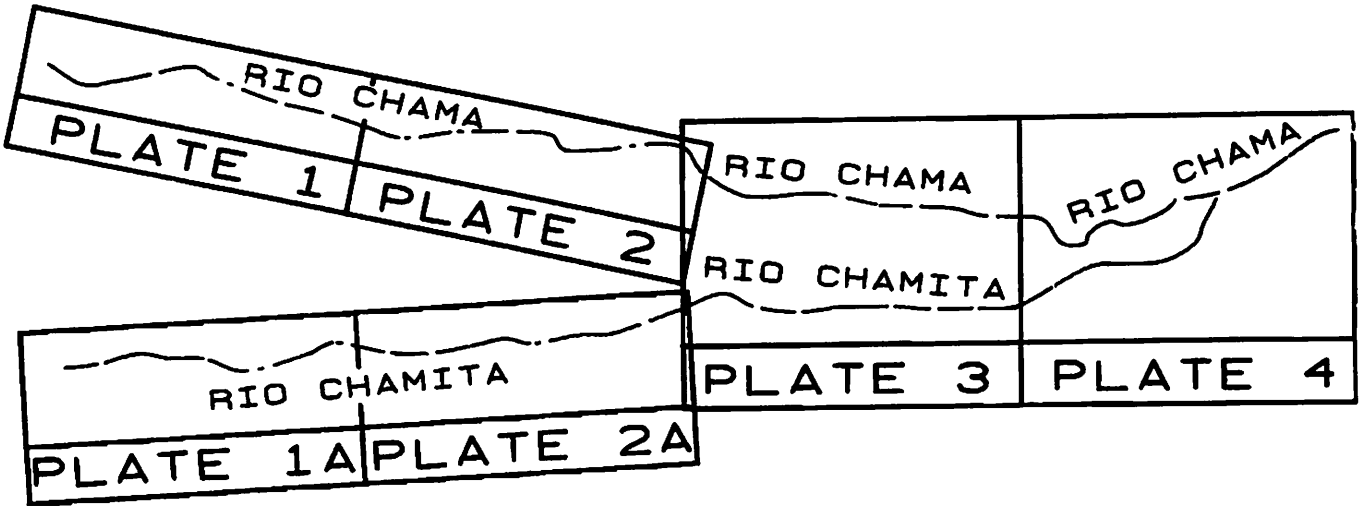
Probability	Temperature 24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	June 6	June 22	July 3
2 year in 10 later than--	May 31	June 15	June 27
5 year in 10 later than--	May 19	June 3	June 17
First freezing temperature in fall:			
1 yr in 10 earlier than--	September 18	September 8	August 27
2 yr in 10 earlier than--	September 24	September 15	September 2
5 yr in 10 earlier than--	October 6	September 27	September 13

GROWTH Station : CHAMA, 1664
start yr. - 1949 end yr. - 1991

Probability	Daily Minimum Temperature # days > 24F	# days > 28F	# days > 32F
9 years in 10	99	82	61
8 years in 10	108	90	69
5 years in 10	125	105	85
2 years in 10	142	120	101
1 year in 10	151	127	109

APPENDIX D

INDEX SHEET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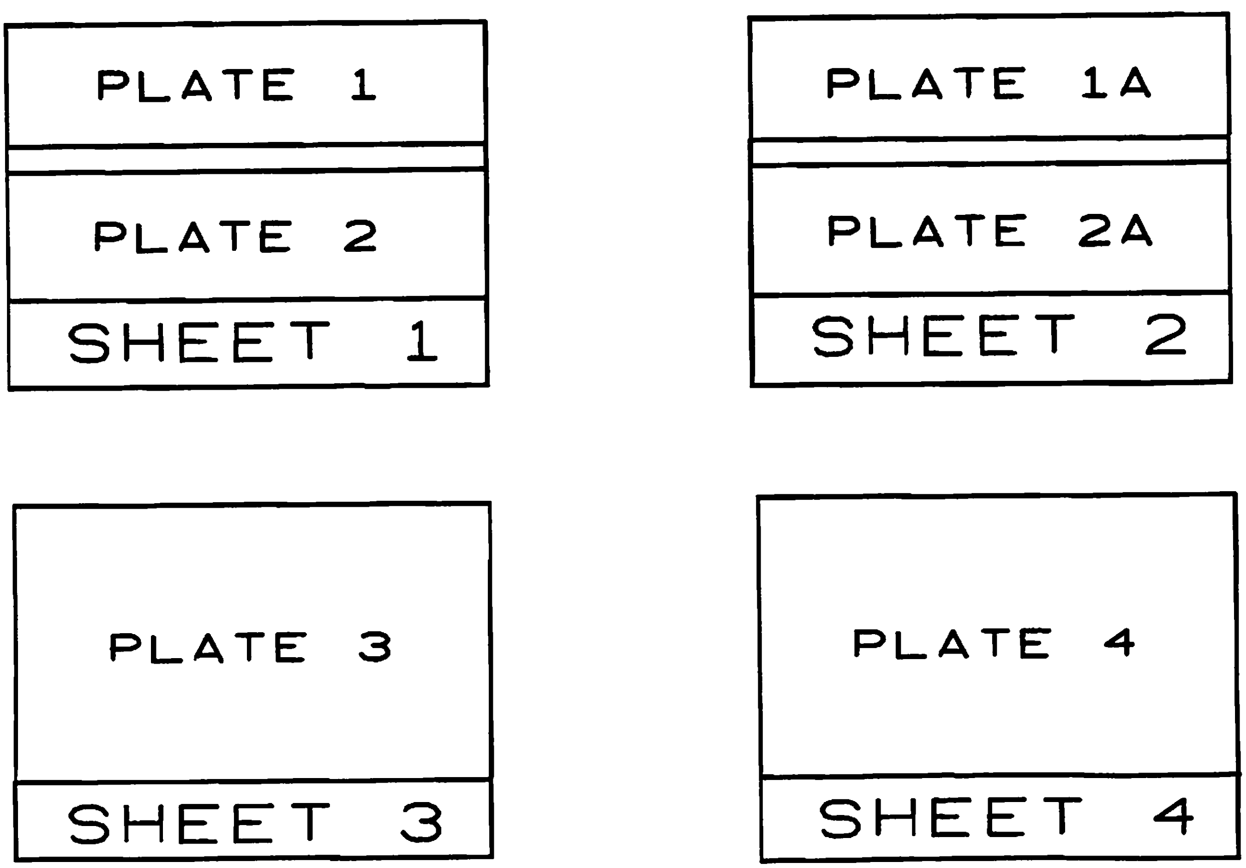
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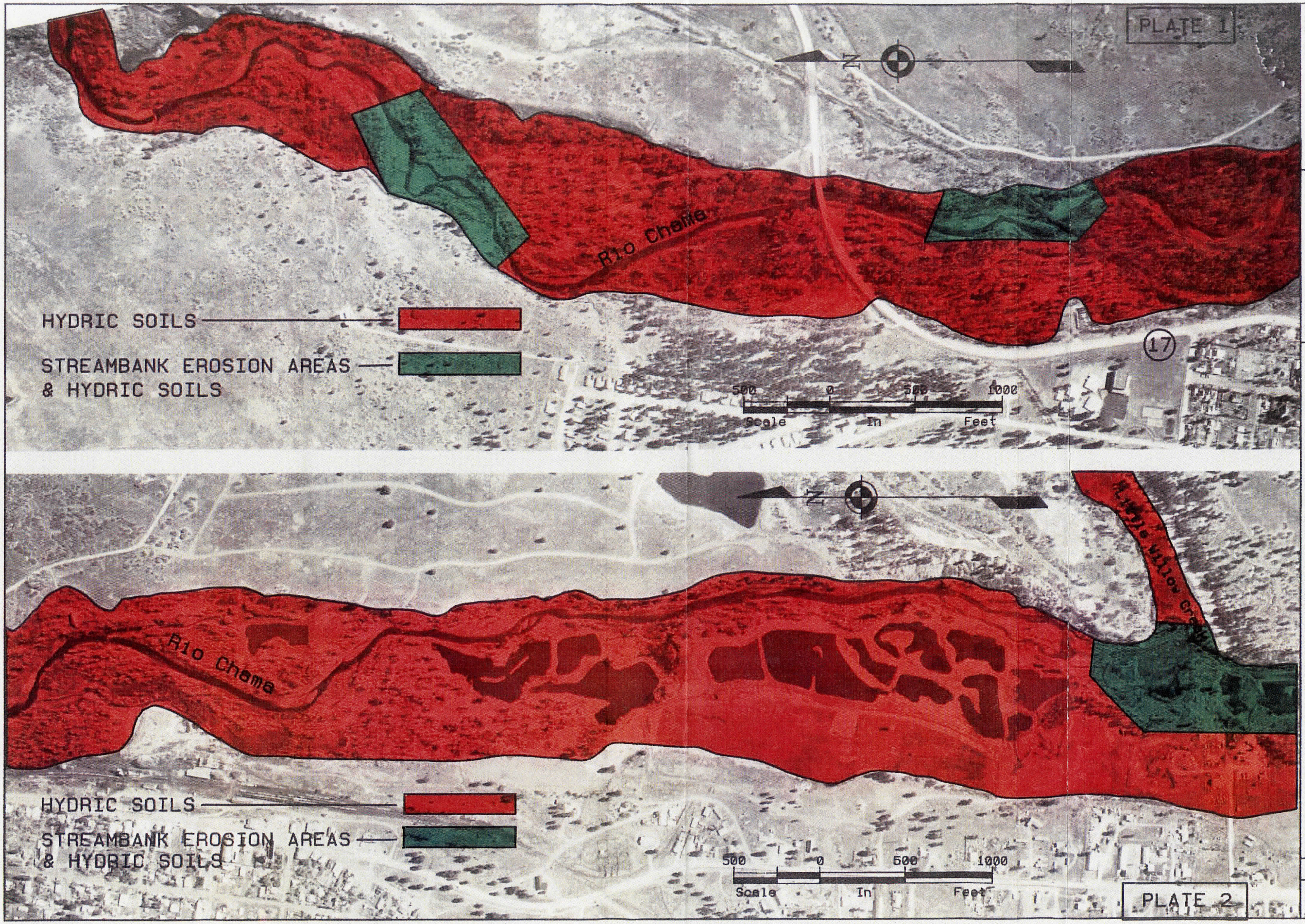


HYDRIC SOILS & STREAMBANK EROSION AREAS

RIO CHAMA

FLOODPLAIN MANAGEMENT STUDY

NEW MEXICO

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Designed L. Sandoval Date 7/92

Drawn R. Armijo Date 11/92

Traced ____ Date ____

Checked ____ Date ____

Approved by ____ Title ____

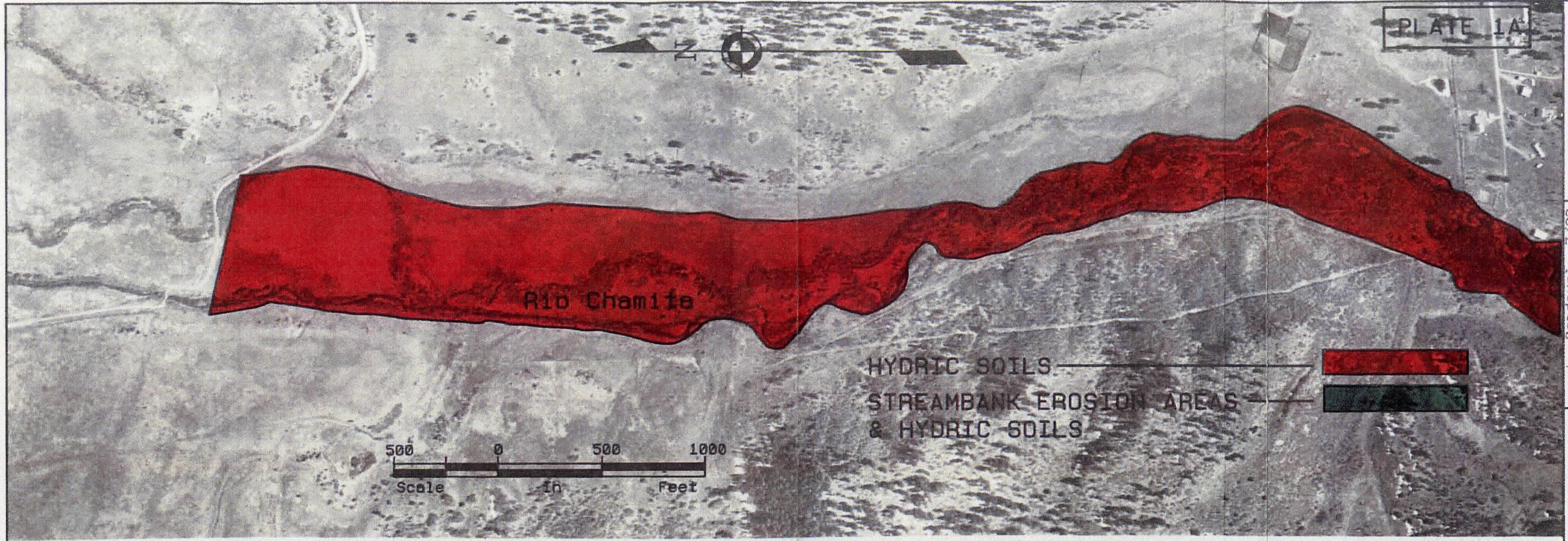
Title ____

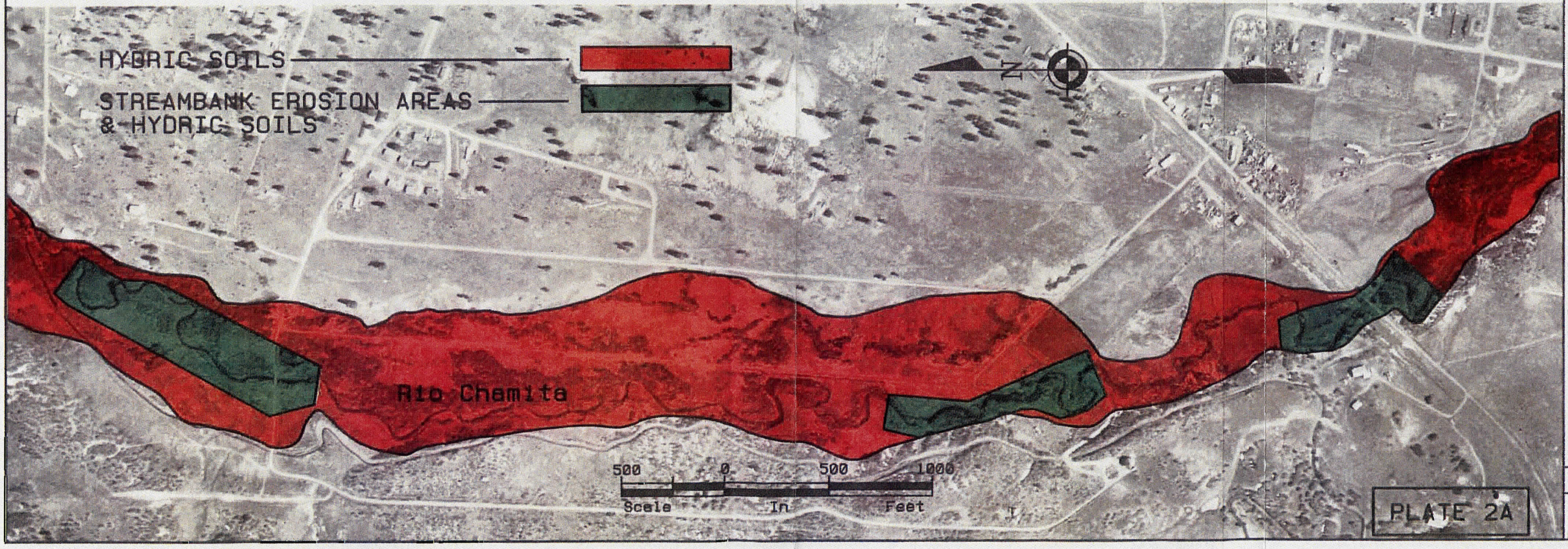
Drawing No.

Sheet 1

Sheet No. ___ of ___

JUNE 1993 1007739





HYDRIC SOILS & STREAMBANK EROSION AREAS
RIO CHAMA
FLOODPLAIN MANAGEMENT STUDY

NEW MEXICO

U.S. DEPARTMENT OF AGRICULTURE   SOIL CONSERVATION SERVICE

Designed L. Sandoval Date 7/92
Drawn R. Armijo Date 11/92
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Sheet 2
Sheet No. ____ of ____

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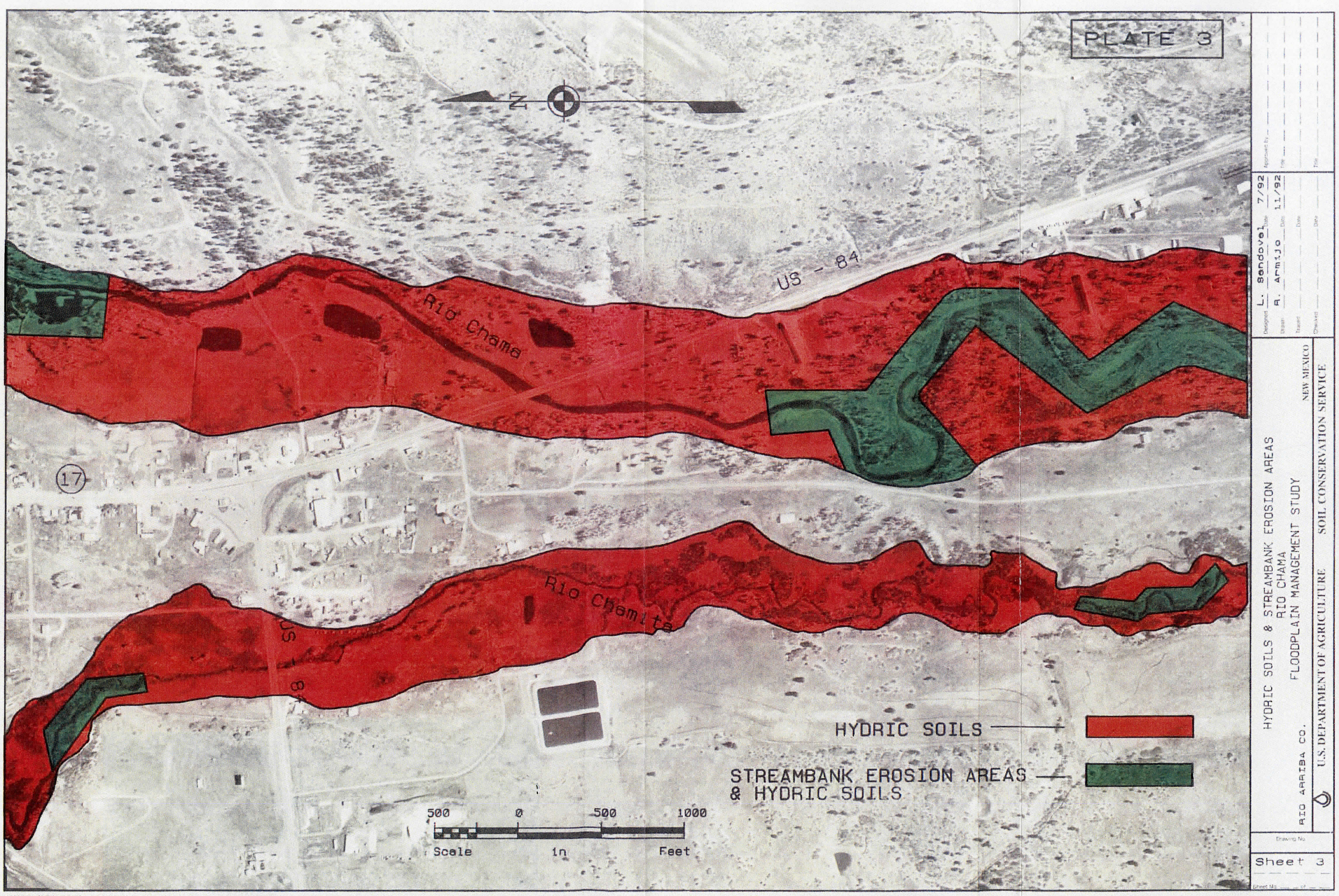

PLATE 3
N
US - 84
Rio Chama
Rio Chamita
17
HYDRIC SOILS
STREAMBANK EROSION AREAS & HYDRIC SOILS
500 0 500 1000
Scale in Feet
HYDRIC SOILS & STREAMBANK EROSION AREAS
RIO CHAMA
FLOODPLAIN MANAGEMENT STUDY
RIO ARRIBA CO.
NEW MEXICO
U.S. DEPARTMENT OF AGRICULTURE
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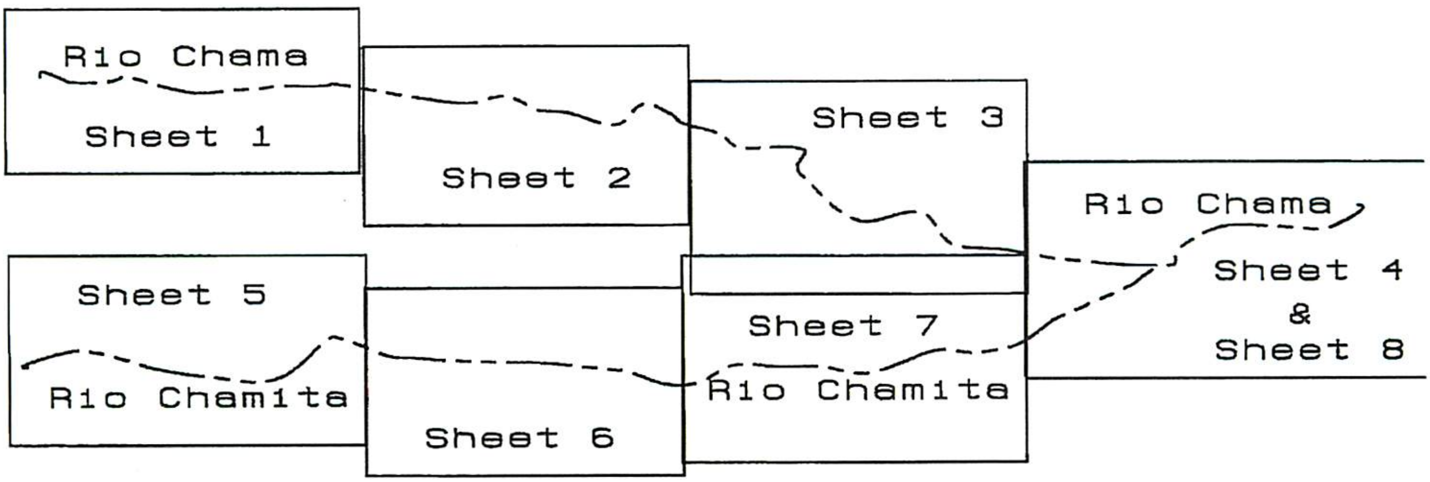
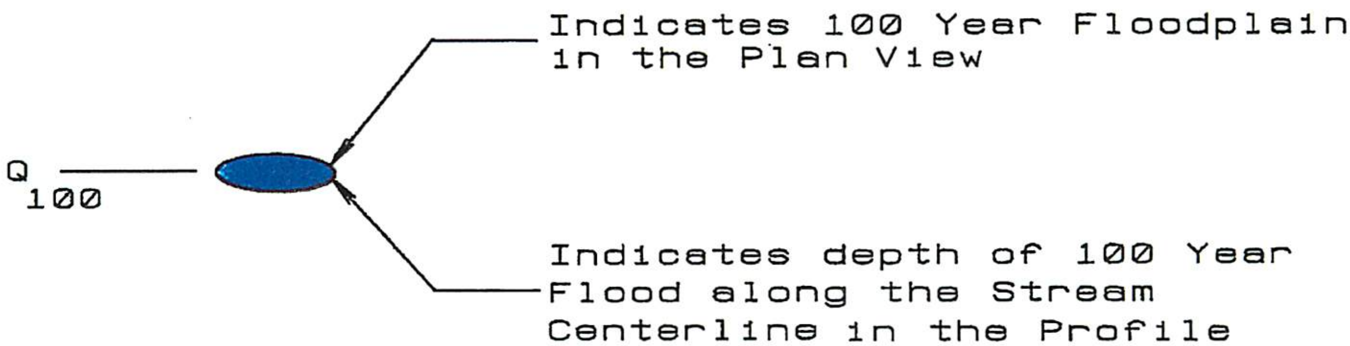
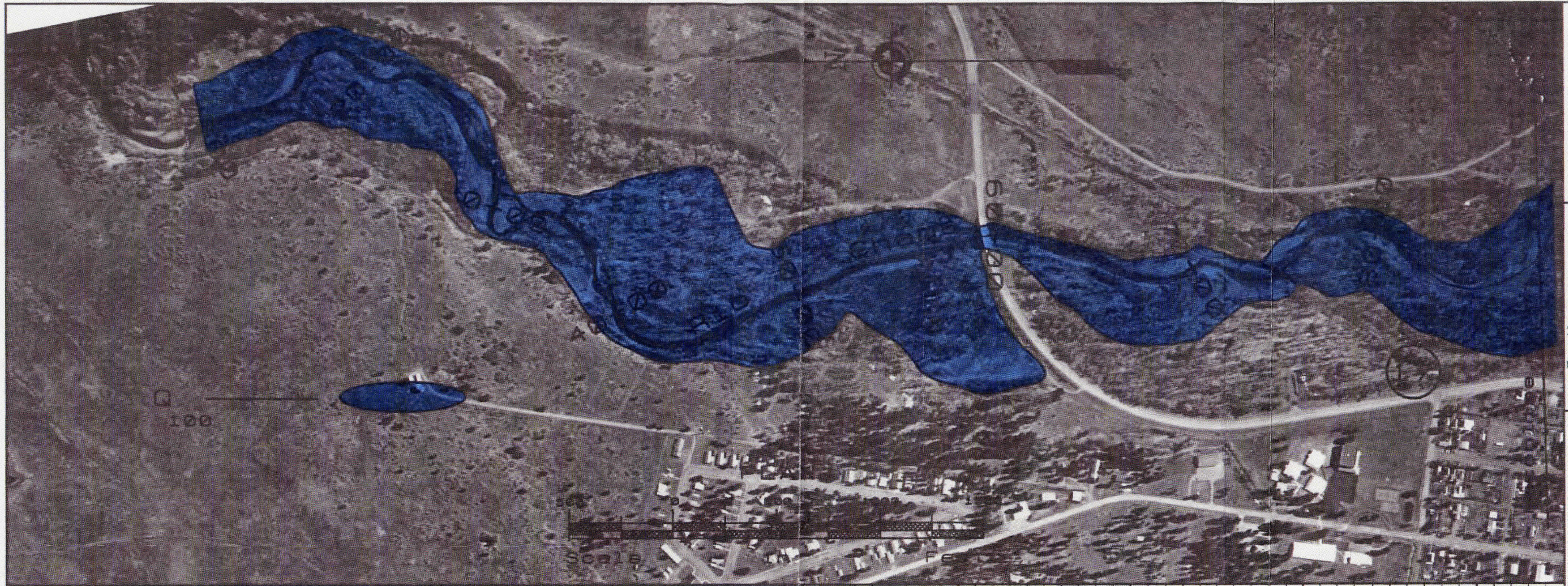
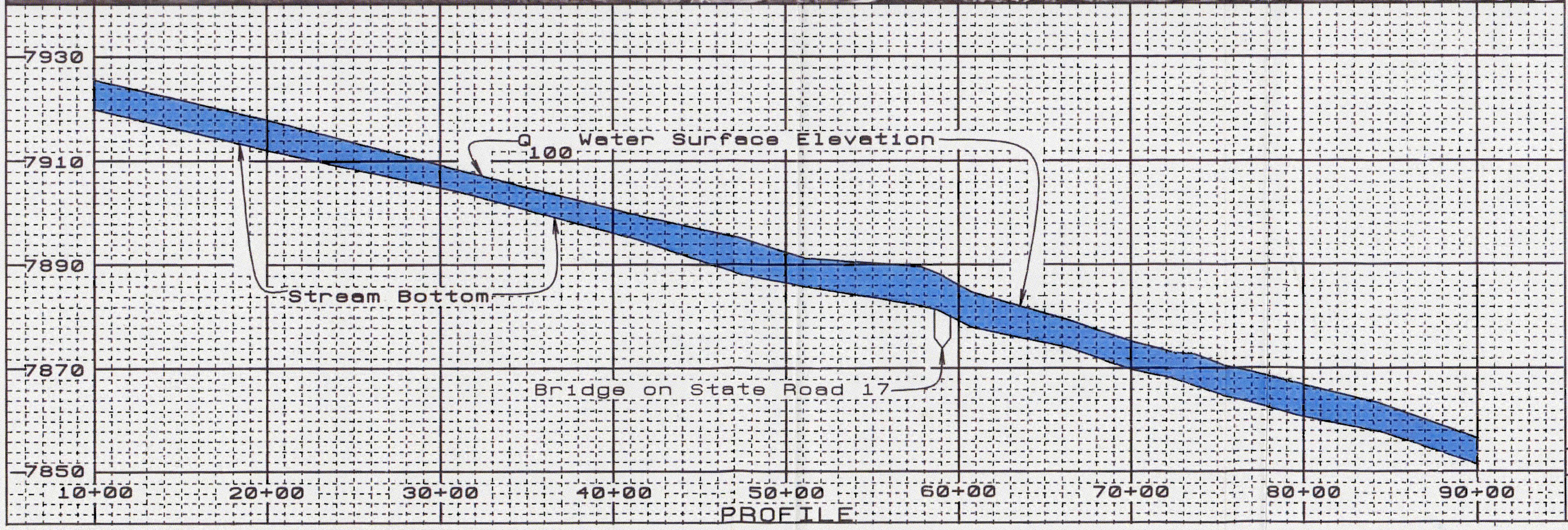
APPENDIX E

INDEX SHEET


Rio Chama
Sheet 1
Sheet 2
Sheet 3
Rio Chama
Sheet 4
&
Sheet 8
Sheet 5
Rio Chamita
Sheet 6
Sheet 7
Rio Chamita


Indicates 100 Year Floodplain in the Plan View
Q 100
Indicates depth of 100 Year Flood along the Stream Centerline in the Profile





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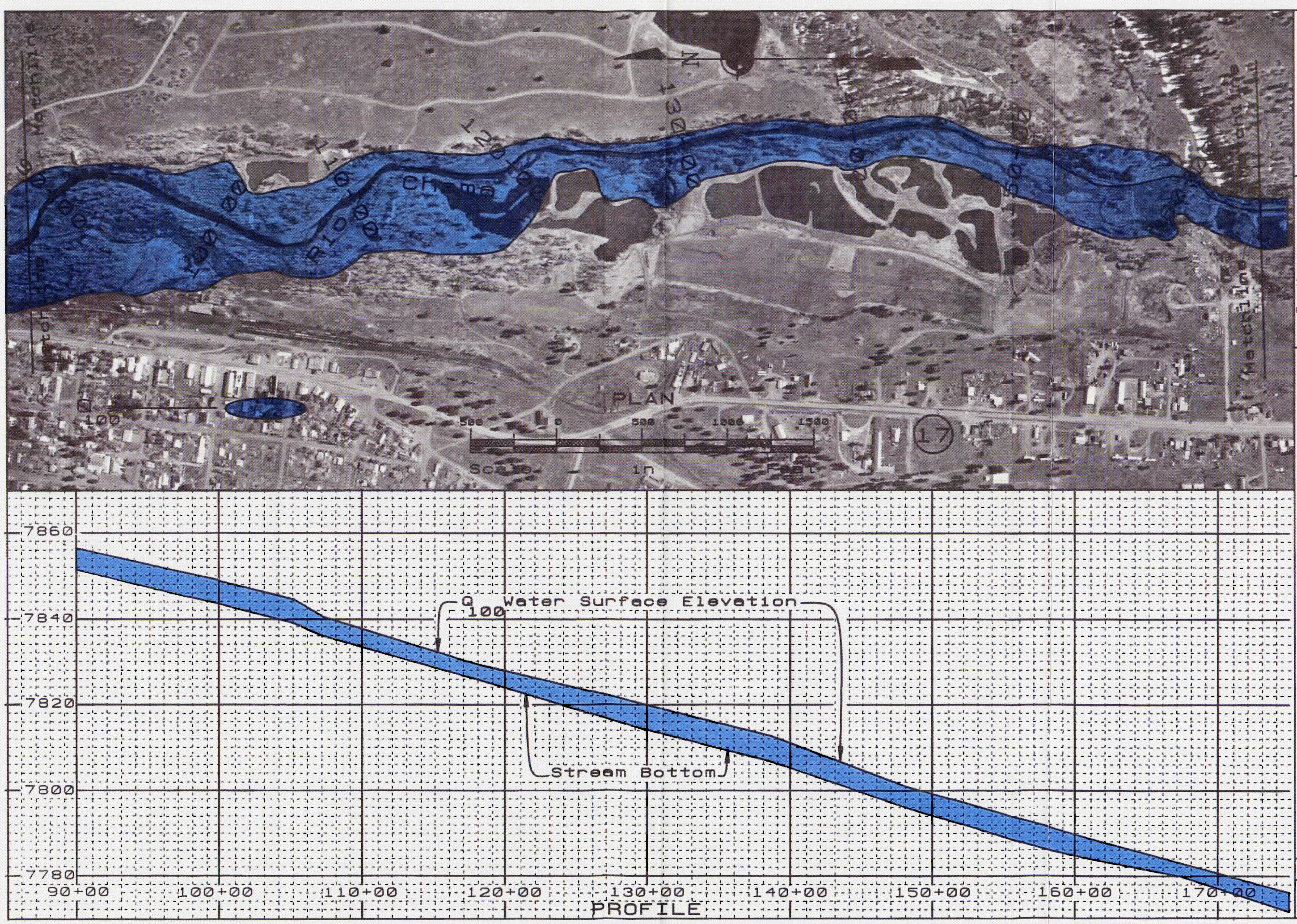

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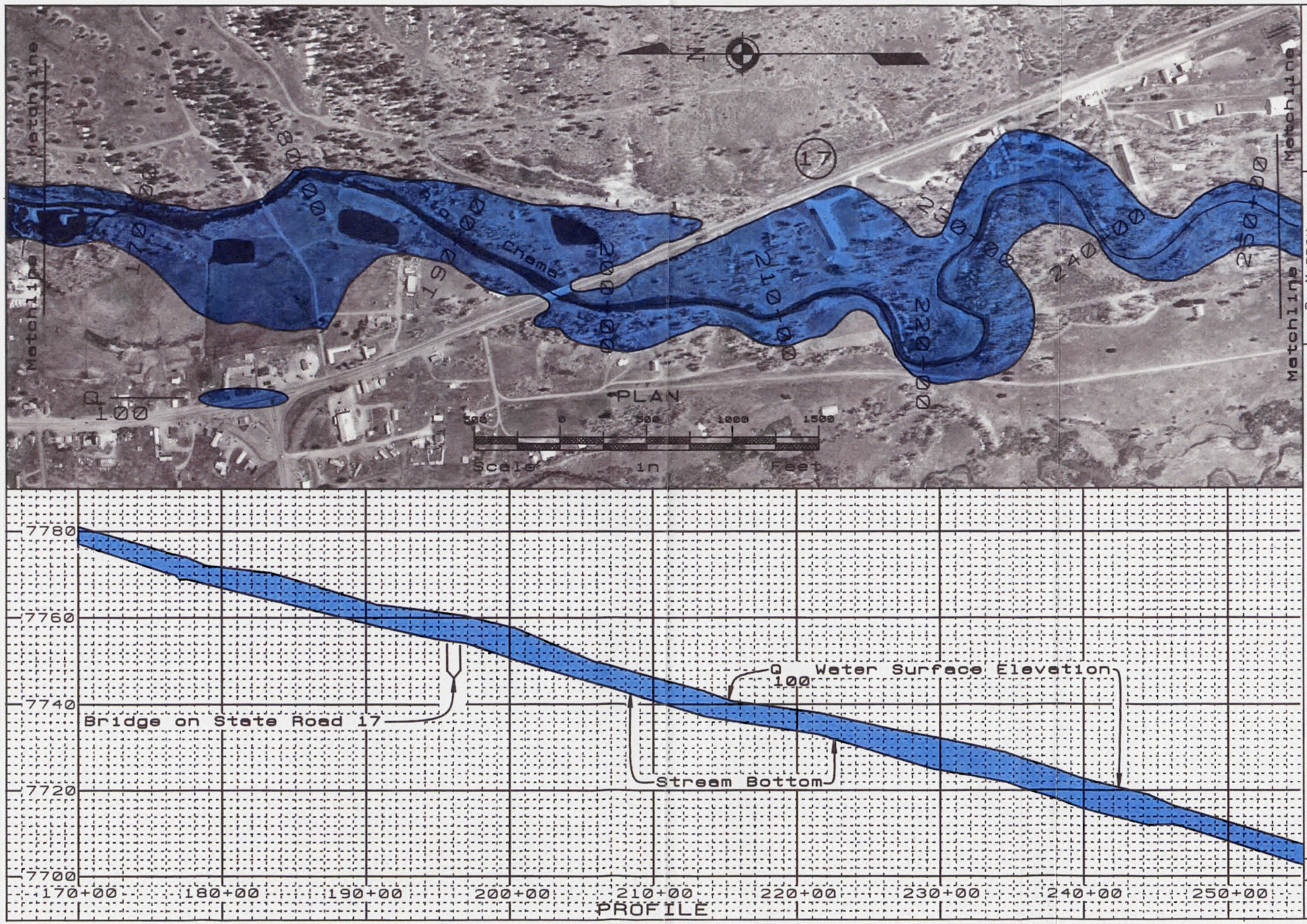

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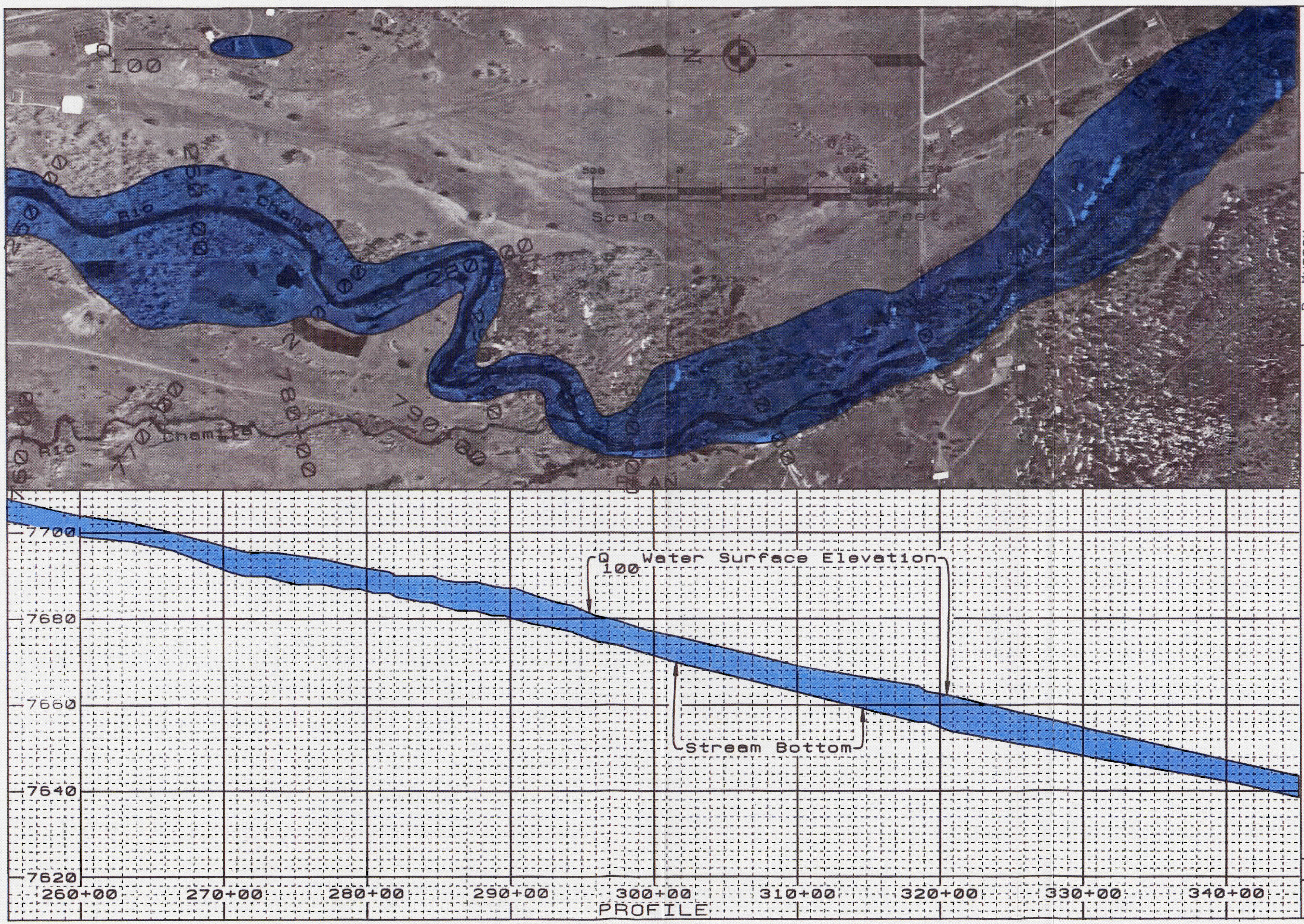

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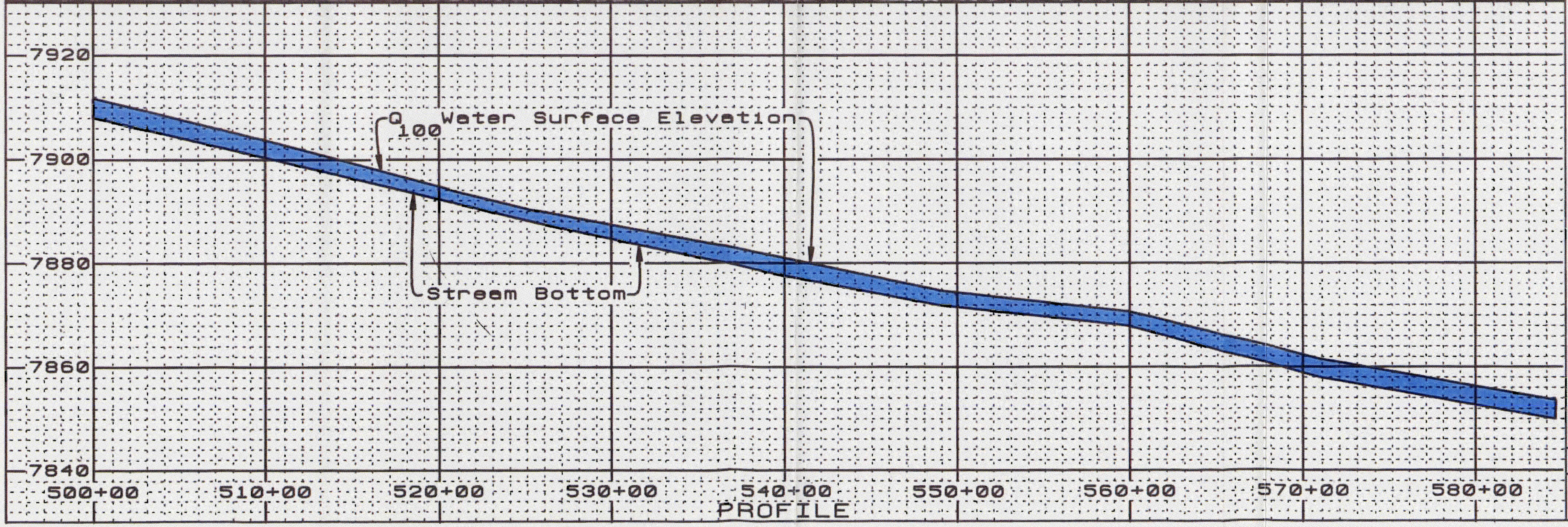

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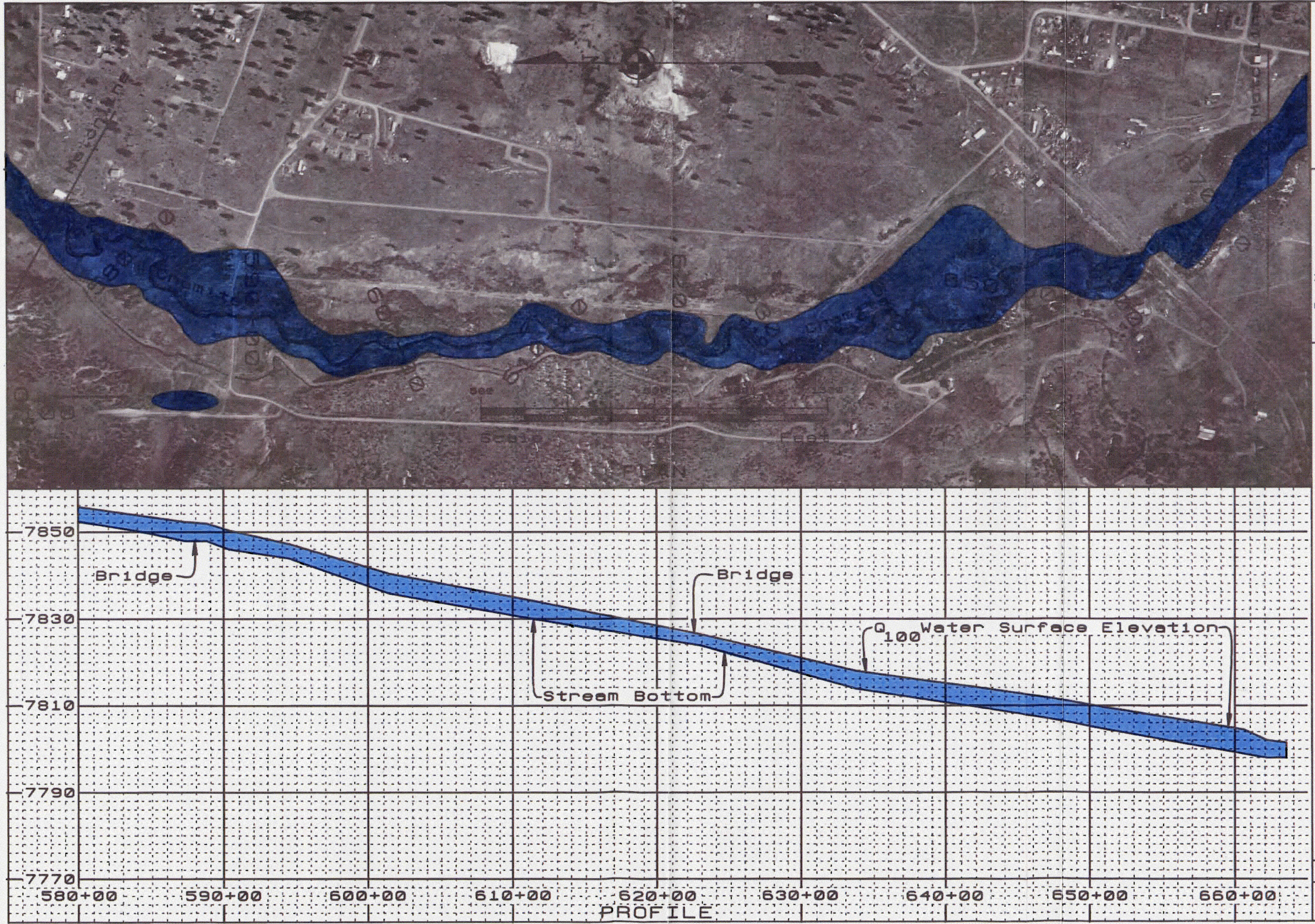

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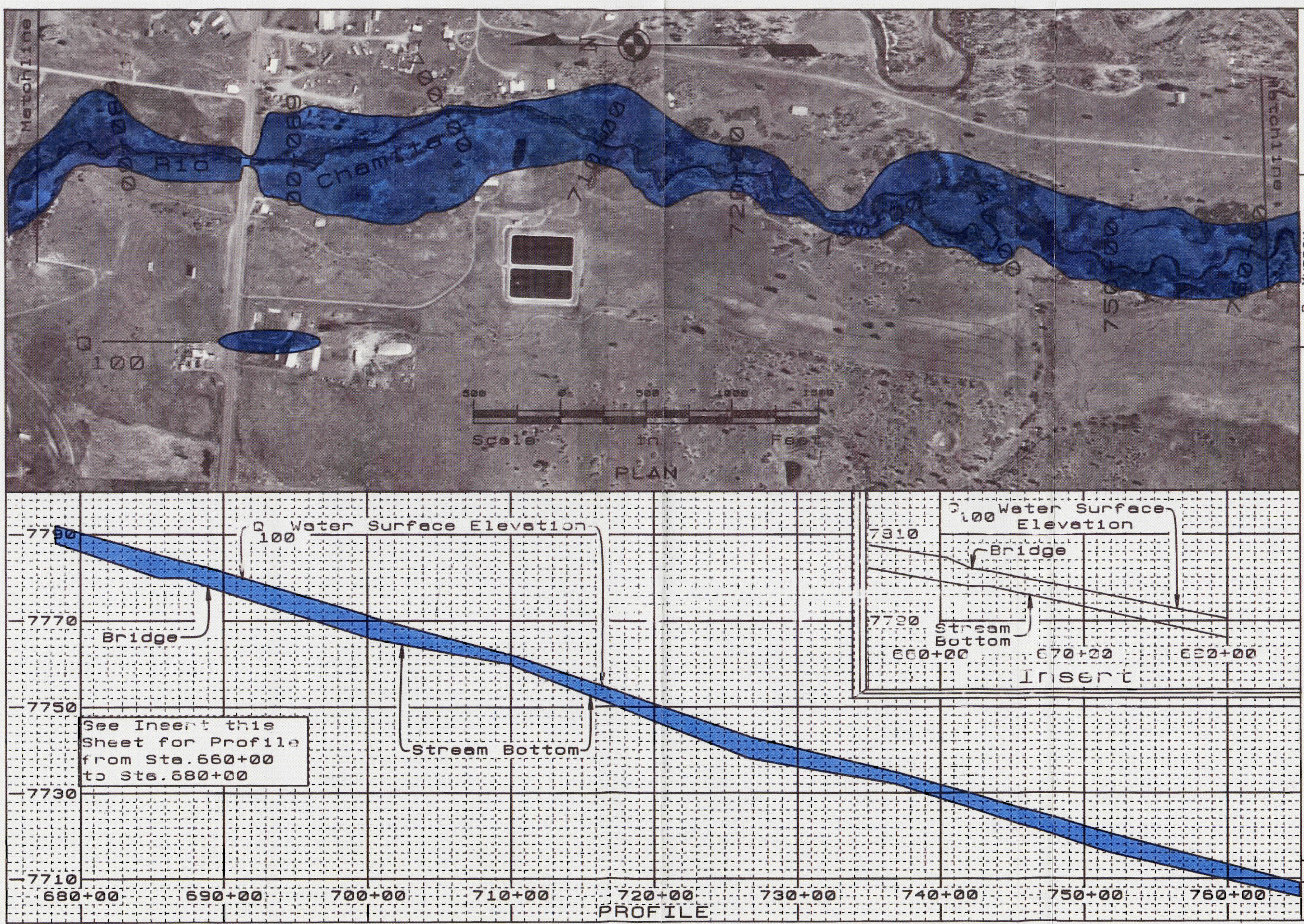

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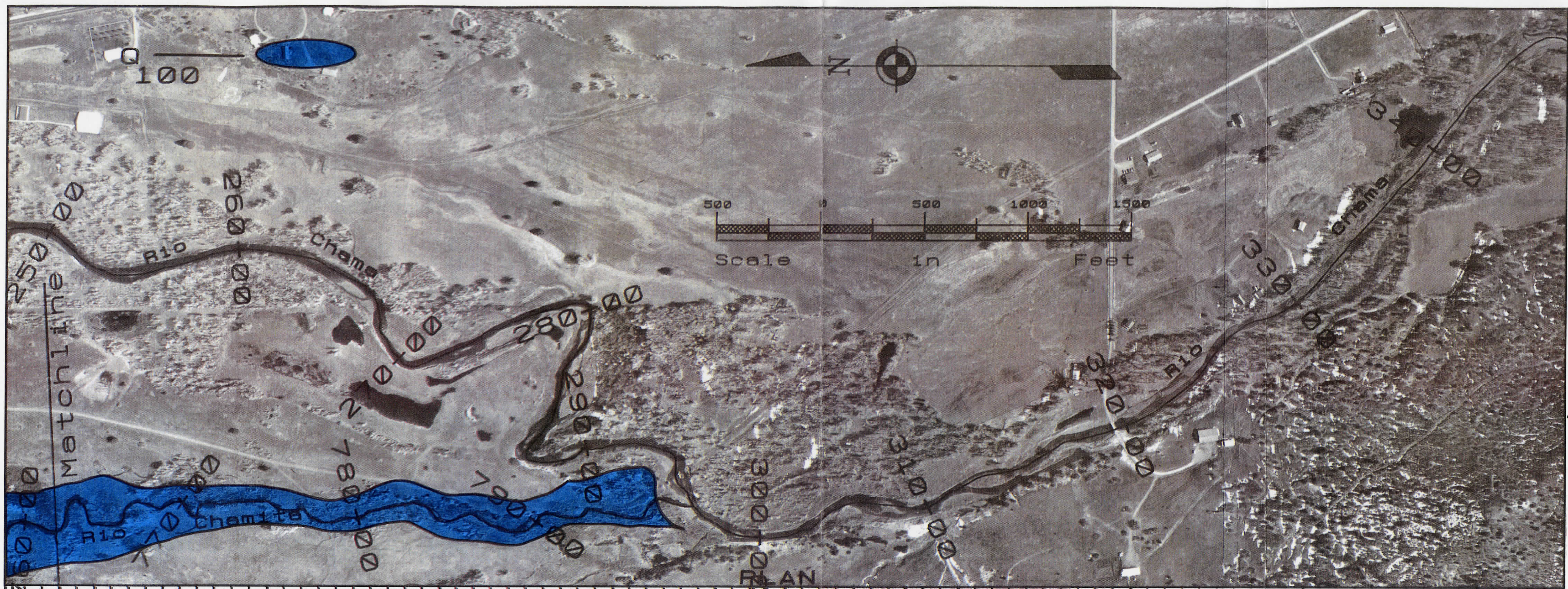

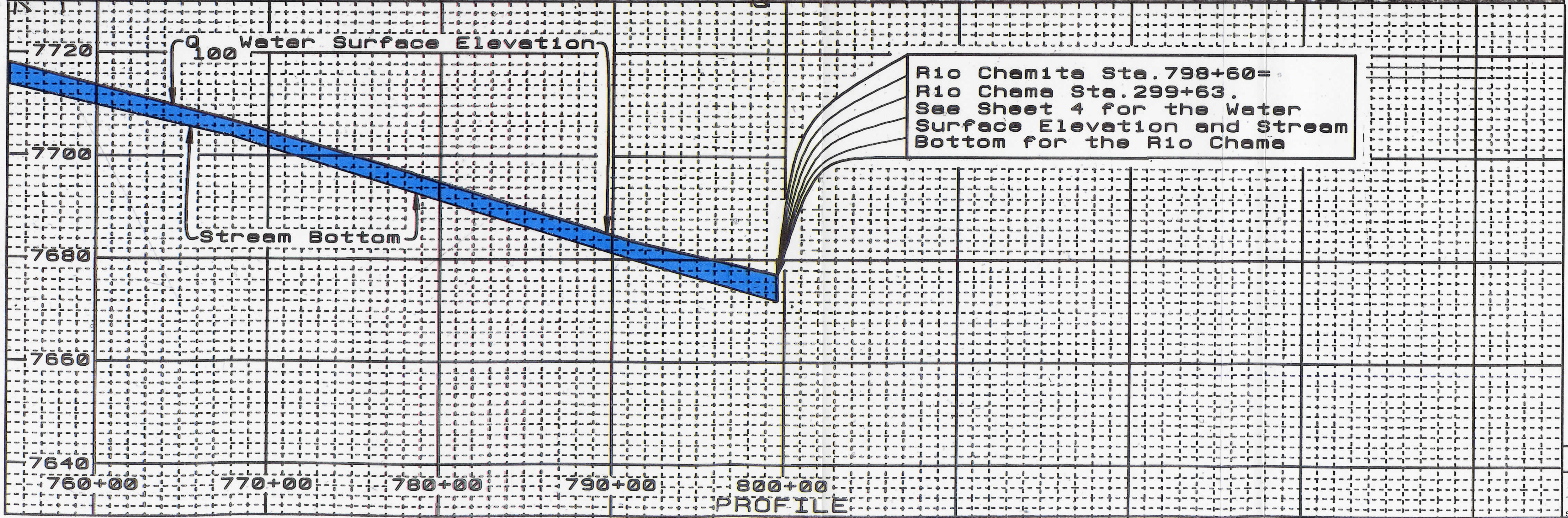

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sheet 8

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