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NORTHEAST LAS CRUCES FLOODPLAIN MANAGEMENT STUDY

Dona Ana County, New Mexico

City of Las Cruces

DONA ANA COUNTY FLOOD COMMISSION

La Union Soil and Water
Conservation District

NORTHEAST LAS CRUCES

FLOODPLAIN MANAGEMENT

STUDY

Las Cruces, New Mexico

October 1994

Prepared for and in cooperation with

City of Las Cruces
Dona Ana County Flood Commission
and
La Union Soil and Water Conservation District

Prepared by
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NORTHEAST LAS CRUCES FLOODPLAIN MANAGEMENT STUDY

INTRODUCTION

LOCAL STUDY NEEDS - The City of Las Cruces and the Dona Ana County Flood Commission requested the Soil Conservation Service to conduct a study of the northeast Las Cruces area. Residential and commercial development in the study area and the potential for continued expansion necessitate a responsible land and water 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 City of Las Cruces and the Dona Ana County Flood Commission 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 alternatives that will reduce those flood risks.

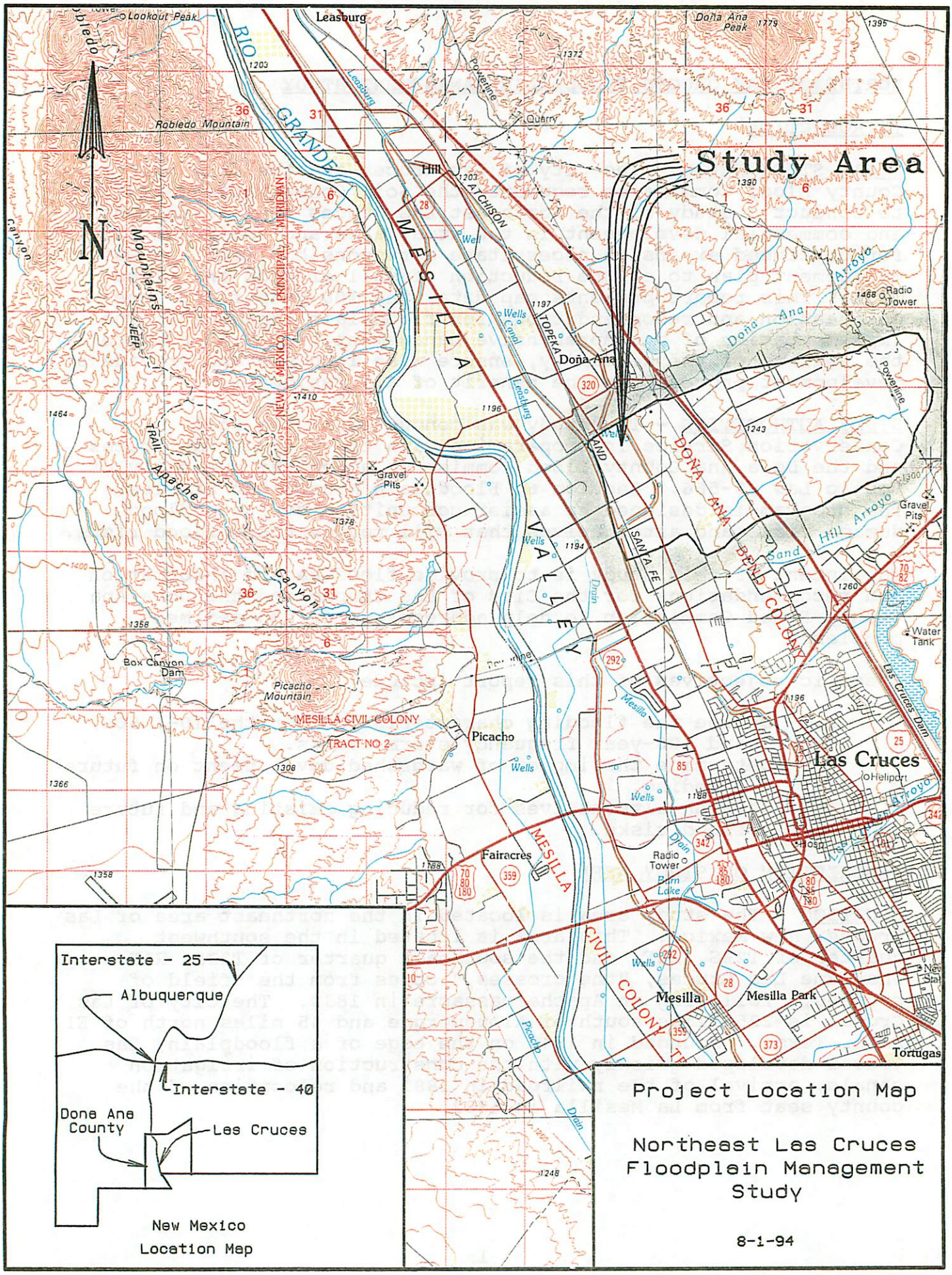
The intent of this study is to provide flood hazard information and recommendations for the City of Las Cruces and the Dona Ana County Flood Commission to help address runoff and sediment problems.

Specific objectives of this report include:

1. Define the flooding characteristics for the 10-, 50-, and 100-year frequency storm events.
2. Determine the impact of watershed development on future flooding.
4. Develop alternatives for reducing existing and future flood risks.

DESCRIPTION OF STUDY AREA

LOCATION - The study area is located in the northeast area of Las Cruces, New Mexico. This area is located in the southwest quarter of T22S, R2E, and the southeast quarter of T22S, R1E. The name Las Cruces, "the crosses," comes from the "field of crosses," following an Apache massacre in 1830. The City of Las Cruces is 225 miles south of Albuquerque and 45 miles north of El Paso, Texas. Founded in 1849 on the edge of a floodplain, Las Cruces developed quickly with the construction of irrigation canals, arrival of the railroad in 1881 and relocation of the county seat from La Mesilla in 1882.


Study Area
Leasburg
Doña Ana Peak
Lookout Peak
Robledo Mountain
RIO GRANDE
MESILLA VALLEY
Doña Ana
Radio Tower
Gravel Pits
Box Canyon Dam
Picacho Mountain
MESILLA CIVIL COLONY
TRACT NO 2
Picacho
Fairacres
Las Cruces
Heliport
Hospital
Radio Tower
Barn Lake
Mesilla
Mesilla Park
Tortugas
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Interstate - 25
Albuquerque
Interstate - 40
Dona Ana County
Las Cruces
New Mexico Location Map
Project Location Map
Northeast Las Cruces Floodplain Management Study
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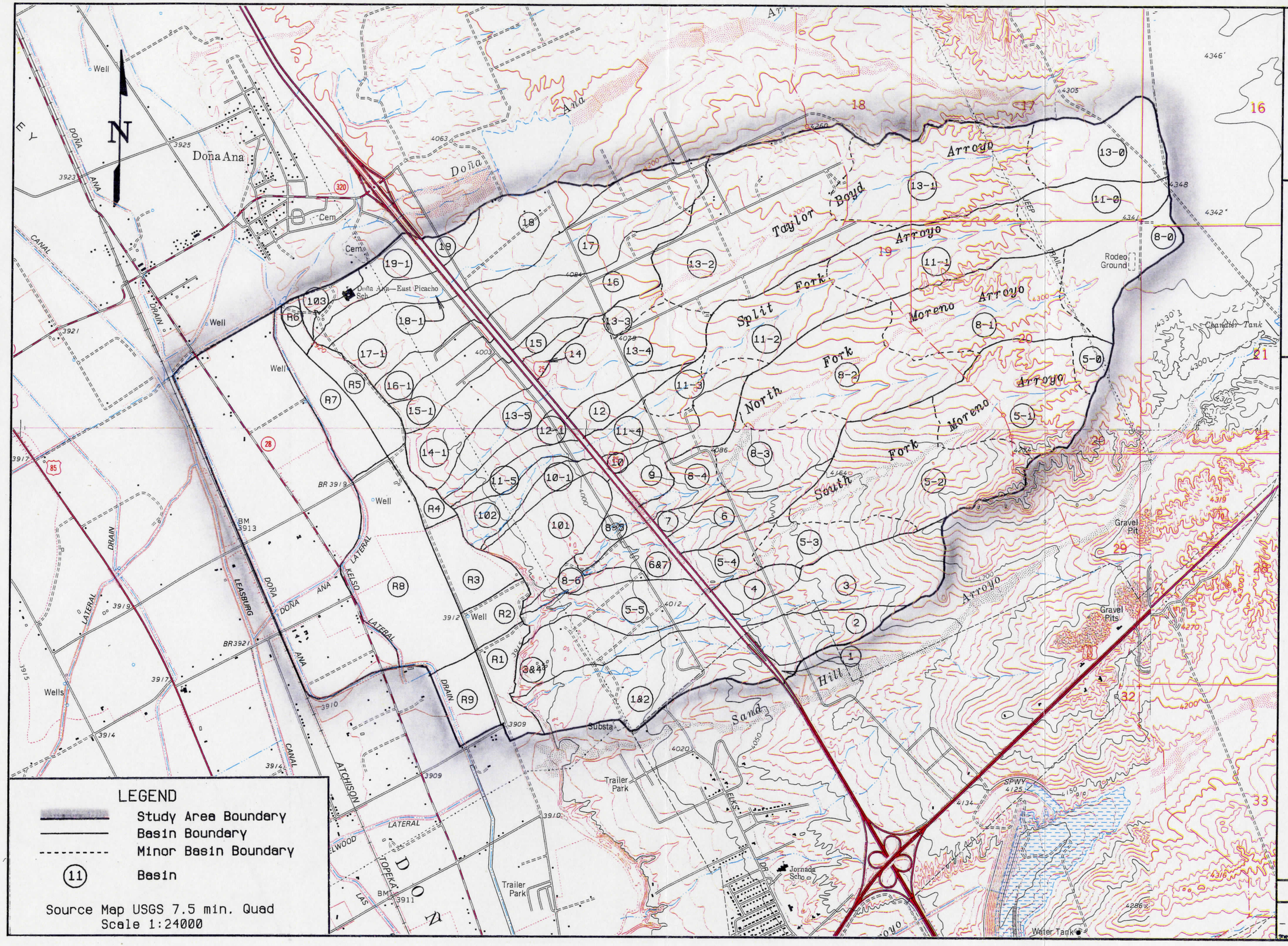


LEGEND

- Study Area Boundary
- Basin Boundary
- Minor Basin Boundary
- (11) Basin

Source Map USGS 7.5 min. Quad
Scale 1:24000

The four arroyos studied, South Fork Moreno Arroyo, North Fork Moreno Arroyo, Split Fork Arroyo and Taylor-Boyd Arroyo, are southern tributaries of the Rio Grande, which flows south into the Gulf of Mexico. The area is within Hydrologic Unit 13030102-240. The floodplain management study area extends from State Highway 70 (excluding Sand Hill Arroyo) north to the Dona Ana Exit and from the Dona Ana Drain (west of El Camino Real) east to the mesa east of I-25.

CLIMATE - The climate in the Las Cruces area is semiarid, averaging 9.4 inches of precipitation per year. Hot summers and mild winters are typical. Temperatures ranged between -10 and 107 degrees Fahrenheit during the period 1960 - 1990. Average daily temperatures are the lowest in January, 42.4 degrees, and highest in July, 80.6 degrees. The average annual temperature at New Mexico State University station is 61.1 degrees. There are 181 frost free days per year (90% probability). Las Cruces has an average of 18 days per year with precipitation of 0.10 inch or more. Over 50% of the annual precipitation falls in the three-month period from July to September. The average annual snowfall is 5.1 inches. Typically severe thunderstorm activity occurs during the summer months as a result of warm moist air from the Gulf. Weather station summaries for stations at Hatch, Jornada Experiment Range and the State University may be found in Appendix C.

GEOLOGY - The uplands portion of this watershed is situated primarily on the Quaternary age rocks of the Camp Rice formation. The extreme southwestern edge of the uplands portion consists of the debouchment deposition of the late Pleistocene age to recent arroyos which drain the alluvial fans and mountain slopes to the northeast of this location.

The lowlands portion of this location is situated upon recently deposited floodplain and channel alluvium.

The Camp Rice formation in this area consists mainly of the fluvial deposits of the ancestral Rio Grande. These materials consist mainly of interbedded clays, silts, sands and gravels and beds of mixtures of these materials in every possible combination. Scattered among these deposits are minor lenses of volcanic ash, and occasionally, very minor deposits of organic debris. Some of these beds are very slightly to moderately well cemented. This deposit is estimated to be about 700 feet thick. This main portion of the Camp Rice formation inter-tonques with, and is overlain by, slightly younger portions of the Camp Rice formation along the northeast edge of this area. These materials consist of intricately interbedded clays, silts, sands and gravels which are of fluvial, playa and eolian origin. These deposits are frequently very recently reworked, especially by the prevailing winds. Cementation of these beds also occurs occasionally. These deposits are estimated to be about 80 feet thick.

EROSION - Essentially, this area is composed of a relatively steeply sloping surface (Camp Rice formation), which is interrupted by a relatively flat surface (Rio Grande floodplain).

A Pacific Southwest Interagency Committee (PSIAC) evaluation of this watershed indicates that the average annual sediment yield would be about 0.91 acre feet/square mile/year. This figure could, of course, be altered by the potential trap efficiency of any existing or future flood control devices. This figure correlates very well with measured sediment fields in structures with similar soils, rocks and climate.

SOILS - A soil survey was completed in 1975 and published in 1980 for Dona Ana County. The intensity of the mapping was carried out at the Order 3 level on soils above the Rio Grande floodplain that are not used for farming and at the Order 2 level of intensity within the Rio Grande floodplain. Order 2 mapping is generally at a scale of 1:12,000 to 1:24,000 suitable for mapping cropland and urban land. Order 3 mapping is suitable for range and forest land and generally at a scale of 1:24,000 to 1:63,360 scale. An order 1 soil survey intensity would be used for site development and research plots.

Approximately 65 to 70 percent of the study area is covered by two map units of the Bluepoint series. The difference in the map units is the slope range that each covers. The Bluepoint soil is a coarse textured soil, consisting dominantly of sands and loamy sands. It is in hydrologic group A, which means that it has a rapid infiltration rate even when thoroughly wetted (6 to 20 in/hr). It has a very high wind erosion hazard and slight water erosion hazard. However, this soil is subject to piping by water erosion on steeper slopes especially if it is disturbed.

The uppermost part of the study area has small areas of Cave, Harrisburg, Tencee and Upton soils. The Cave, Tencee and Upton soils are shallow (10 to 20 inches) over a petrocalcic horizon (indurated caliche). The Harrisburg soil is moderately deep (20 to 40 inches) over a petrocalcic horizon. The shallow soils are in hydrologic group D which means that they have high runoff potential and slow infiltration rates because of the impervious nature of the petrocalcic horizon. The Harrisburg soil is in hydrologic group B, making it a soil with moderately low runoff potential and moderately rapid infiltration rates (2.0 to 6.0 in/hr).

Additional soils found above the Rio Grande floodplain in the study area include small areas of the Yturbide, Caliza and Pajarito soils. The Yturbide soil is similar to the Bluepoint soil and is also in hydrologic group A. The Caliza soil has 35 to 70 percent gravel in the soil profile which serves to protect it from erosion. It is in hydrologic group B. The Pajarito soil has moderately coarse textures and is also in hydrologic group B.

Surface textures of soils above the Rio Grande floodplain are typically loamy sand with small areas of gravelly and very gravelly sandy loam and fine sandy loam. Slopes are typically 1 to 5 percent but range to 15 percent.

The lower part of the study area is in the old Rio Grande floodplain and is irrigated farmland with some urbanization. This part of the study area is where a large part of flood waters from the watershed currently collect. Because the soils were deposited primarily by the river, they occur in a complex pattern of 14 consociation map units of nine different soil series. They include the Adelino, Agua, Anapra, Anthony, Armijo, Belen, Glendale, Harkey and Vinton soils. The Armijo and Belen soils are in hydrologic group D because they have relatively impervious layers of clays and heavy clay loams that have very slow (<0.06 in/hr) infiltration rates. All of the other soils are in hydrologic group B. Surface textures for these soils are typically clay loams with small areas of clay, loam and fine sandy loam. Slopes are typically less than 1 percent.

SOCIAL and ECONOMIC - The City of Las Cruces is located in Dona Ana County, which has the second largest population in New Mexico and is the sixteenth largest county in land area. Situated in the south-central portion of the State, Dona Ana County has a common border with both Texas and Mexico. The El Paso-Juarez metropolitan area lies just across the border. Agriculture and population centers are located along the Rio Grande, which traverses the county from the northwest to the southeast corner. Crop production is an important aspect of the county's and Las Cruces's economies, particularly cotton, pecans and vegetables (lettuce, onions, and chile). Outside the Rio Grande Valley, most of the county is sparsely populated, semiarid, flat low mountain land suitable primarily for ranching. In addition to agriculture, Dona Ana derives substantial economic benefit from Federal expenditures associated with the White Sands Missile Range and New Mexico State University, the state's second largest university located in Las Cruces. The county is served by two major interstate highways, Interstate 10 and Interstate 25, which intersect in Las Cruces.

Based on the 1990 General Census, the population for the City of Las Cruces was estimated at 62,126. This figure compares to a 1980 population of 45,086, which represents a 38 percent increase from 1980 to 1990. Of this 1990 population, it is estimated that 47 percent is of Hispanic origin, and the median age of a Las Cruces resident is 30 years of age.

TABLE 1

AGE DISTRIBUTION OF THE 1990 LAS CRUCES POPULATION

AGE	POPULATION	PERCENT
Under 6 years	14,730	10.3
6 - 17 years	25,570	17.9
18 - 24 years	20,820	14.6
25 - 34 years	23,820	16.7
35 - 49 years	27,950	19.6
50 - 64 years	21,380	14.9
65 and over	8,550	6.0

The 1990 Census of Population and Housing estimates 25,676 total housing units in Las Cruces. It is estimated that about 56 percent of these housing units are owner occupied. The median value of these owner occupied homes is $68,300. The per capita income for Las Cruces was estimated at $11,175 for 1989.

The 1990 Census estimates nonagricultural employment for the City of Las Cruces at 44,050. The unemployment rate for Las Cruces was approximately 8.9 percent for 1990. The following table shows the nonagricultural employment for 1990 by each major sector.

TABLE 2

NONAGRICULTURAL EMPLOYMENT

INDUSTRY	EMPLOYMENT NUMBERS
Construction and Mining	2,200
Manufacturing	3,600
Transportation and Utilities	1,600
Wholesale Trade	950
Retail Trade	8,300
Finance, Insurance and Real Estate	1,600
Services	7,800
Federal Government	4,700
State Government	7,300
Local Government	6,000
Total Nonagricultural Employment	44,050

Per capita income in Dona Ana County for 1989 was $10,389, which ranks 23rd among the 33 New Mexico counties. This figure compares to the state per capita income of $11,246 in 1990. The 1992 unemployment rate for Dona Ana County was 7.4 percent, which compares to 6.8% for the State.

The land status in Dona Ana County includes the following land ownerships:

TABLE 3

LAND OWNERSHIP

	Acres	Percent
Private	326,135	13
Federal	1,821,515	75
State	286,910	12
Total	2,434,560 acres	

Most of the land in the watershed is undeveloped as shown in Table 3A.

TABLE 3A
LAND USE WITHIN STUDY AREA

Potential Development	3,390 Acres
Irrigated Cropland	600 Acres
Residential	585 Acres
Commercial/Industrial	78 Acres

Dona Ana County includes 96,030 acres of irrigated land. Cash receipts from all farm commodities amounted to $196,273,000 in 1991. Dona Ana County ranked first in agricultural production in the State for 1991. Listed below are gross receipts from selected agricultural enterprises and their rankings in the State for 1991:

TABLE 4

GROSS RECEIPTS FROM SELECTED AGRICULTURAL ENTERPRISES

Cattle and calves, milk	$53,607,000	2nd
Cotton and Chile	$16,350,000	2nd
Vegetables and Fruits	$30,678,000	1st
Pecans	$34,220,240	1st

FLOOD DAMAGES - Flood damages from the arroyos addressed in this report are primarily to irrigated cropland, farmsteads and low density residential areas. The crops which are grown on these acres include alfalfa, chile and pecans. The flooding damages usually occur to the alfalfa and chile crops and very seldomly cause significant damages to pecan orchards.

The primary damage caused by these arroyos is flood water and sediment being deposited on growing crops (primarily alfalfa and chile). The arroyos have no outlet to carry the flood water around or through the cropland. Temporary dikes have been constructed on the upper end of the fields that attempt to divert the water around the fields; however, these dikes are only effective for small storms and cannot contain the larger runoff events. The fields are level, and when large amounts of flood water are deposited on them, it sometimes takes several days to get the water off the fields. Alfalfa and chile are sensitive to damage from standing water. These crops are also high value crops that require a large investment to plant and have the potential for high returns. Chile has the potential for a gross return of $2,350 per acre, and alfalfa has a potential gross return of $840 per acre. The timing of the flood has a great effect on the extent of damages that might occur. If the ground is saturated when the flood water inundates the field, the time that the water can be on the field is much shorter before extensive damages will occur.

To calculate an average annual damage value, the crop rotation must be considered. A discussion with a landowner identified a 5-year alfalfa, and 1-year chile rotation. By using the gross values for alfalfa and chile mentioned above, the average gross value is $1,090 per acre. If the full 600 acres of cropland are flooded during a 100-year event, there is a potential of damages from crop failure of $654,000. This scenario would be the worst case example; however, during any average year, there is potential of damages to crops due to flood water and sediment.

Damages from flooding above the cropland area may occur on a few residential and commercial lots along the east side of I-25. Arroyos have been constricted and nearly eliminated in the residential areas west of Elks Road. Flood water has also caused damages to culverts and streets. Sediment and sand are deposited in culverts and on streets, causing expenses in maintaining these facilities. As more of the watershed area is developed, there is a potential for increased damages in the downstream area.

NATURAL RESOURCE INVENTORY

VEGETATION - The study area is within the Southern Desertic Basins, Plains and Mountains Major Land Resources Area. The drainage area east of Interstate 25 is native rangeland that is gradually urbanizing. The area west of the interstate is already primarily urban or urban-influenced. Some irrigated cropland

exists in and around the area of Camino Real and the Dona Ana Drain. Natural vegetation is relatively stable except where disturbances connected with urbanization are taking place. Partly because the soils found in the study area are naturally somewhat droughty, thin stands of grasses and forbs are characteristic, even in undisturbed area. Desert shrubs and half shrubs often dominate and occur in thicker stands in the lower portion of the watershed. Typical shrubs and half shrubs are creosote bush, mesquite, four-wing saltbush, broom snakeweed and mariola. An occasional cholla or prickly pear cactus may be found. Tarbush, Datil yucca and broom dalea are found more often farther downstream. Grasses include mesa dropseed, sand dropseed, bush muhly, fluffgrass, perennial threeawns and annual gramas. Annual forbs vary greatly in both kind and amount from year to year. Perennial forbs are sparse. Range condition, where existing vegetation is compared to the potential vegetation for the soils found in the study area, is estimated to vary from poor to high-fair over most of the area.

WILDLIFE - Wildlife habitat ranges from steep shallow and deep sand southern desert short grass shrub sites to the farmland and urban sites. Due to the diversity of wildlife habitat in the study area, a variety of wildlife species adapted to southern desert short grass, shrub, farmland urban habitats occur in the study area. Wildlife species occurring on these sites include black tailed jackrabbit, thirteen lined ground squirrel, fox, coyote, muskrat, Gambel's quail, scaled quail, mourning dove, pheasant, house finch, house sparrow, western kingbird, raven, robin, boat-tailed grackle, rattlesnake, garter snake, and skunk. Any alternatives developed for the study area should include a detailed inventory of wildlife species and habitat to account for other wildlife species and habitat occurring in the study area. As the southern desert short grass shrub sites are developed and urbanized, wildlife species occurring in these sites will be replaced by those species that can adapt to the urban setting.

THREATENED AND ENDANGERED SPECIES - No endangered and threatened animals were observed during the extensive inventory conducted for this study. As alternatives are developed, the U.S. Fish and Wildlife Service (USFWS) must be consulted to assure that no listed species would be affected by the proposed alternatives. Those species that may occur in the study area which are listed in the federal and state endangered and threatened list include Aplomado falcon, whooping crane, American peregrin falcon, bald eagle, and Gila monster. There are also several species that are listed on the state list as group II endangered and threatened. State group II species include those species whose prospects of survival or recruitment within the State may become jeopardized in the foreseeable future. These species include Bell's vireo, Baird's sparrow, and the Trans-pecos rat snake. As alternatives are developed and implemented, care must be taken to assure that no threatened and endangered species are adversely affected.

Rare and endangered plants that may be found within the Las Cruces Floodplain Management Study, Dona Ana County, New Mexico include Visnagita cactus, sand prickly pear, smooth cucumber, Plank's catchfly, long-stemmed flame flower and grama grass cactus.

Visnagita cactus, sand prickly pear and grama grass cactus are New Mexico List 1 species. Taxa listed as NM List 1 are included for any one of the following criteria:

A. The taxon is listed as threatened or endangered under the provisions of the Federal Endangered Species Act.

B. The taxon is so rare across its entire range and of such limited distribution and population size that unregulated collection could jeopardize its survival in New Mexico; or

C. The taxon may be widespread in adjacent states or Mexico, but its numbers are being significantly reduced to such a degree that within the foreseeable future the survival of the taxon within New Mexico is jeopardized.

Smooth cucumber, Plank's catchfly, and long-stemmed flame flower are New Mexico List 2 species. New Mexico List 2 taxa are considered to be rare because of restricted distribution or low numerical density. They need not be endemic to New Mexico, but must be regionally endemic or rare throughout their range. Since they are rare, these species are sensitive to long-term or cumulative land use impact and are vulnerable to biological or climatic events that could eventually threaten them with extinction or extirpation. Therefore, List 2 species are monitored by the State of New Mexico to determine if they should ever be elevated to List 1 endangered species status. <u>They are not protected by state statute or policy.</u>

NATURAL RESOURCE OPPORTUNITIES

One of the major effects from current and future development in the drainage system will be an increased demand for recreational facilities. As the study area becomes urbanized and human populations increase in the area, recreational services should be developed to address this increased demand. As alternatives are developed, opportunities for recreational development should be addressed. Any recreational alternatives included in the plan should be coordinated with existing recreational facilities to assure planning flexibility and optimize recreational services provided to the public.

If holding ponds are constructed, recreational opportunities may be possible. For example, the development of parks, picnic areas, playgrounds and walking and jogging paths may be developed in conjunction with the holding ponds.

Green belt areas along channels with various recreational options could be developed. Recreational opportunities along designated green belt areas could include walking and jogging paths, nature trails, outdoor classrooms, picnic areas and playgrounds.

HISTORICAL, ARCHAEOLOGICAL AND CULTURAL RESOURCES

A cultural resources file check of the Northeast Las Cruces Flood Plain Management Study has been done. The purpose of the file check was to ascertain what cultural resources, if any, have been recorded in and around the study area north of the City of Las Cruces, Dona Ana County, New Mexico.

This information is to be used for planning purposes and should be considered preliminary in nature. As specific actions and locations are chosen, more intensive checks for cultural resources should be done.

The study area lies in Township 22 South, Ranges 1 and 2 East, Dona Ana County, New Mexico. Encompassing a portion of the Dona Ana Bend Colony land grant, the study area consists of both flood plain and lower bajada physiographic zones.

Sources of information checked include the Archaeological Records Management System (ARMS) computerized files, current listings of the National Register of Historic Places and the State Register of Cultural Properties and New Mexico State University site files.

The file check revealed the presence of 37 previously recorded prehistoric and historic sites in the vicinity of the study area. These sites range from very small (less than 100 square meters) prehistoric artifact scatters to very large prehistoric sites in excess of 10,000 square meters in size. Also noted in the recorded site assemblage are several historic properties dating from roughly 1850 to pre-WWII.

Given the relatively high density of previously recorded cultural resources in the area, it can be assumed that ground-disturbing activities undertaken in the study area have some potential for impacting cultural resources. Numerous archaeological surveys done in the Las Cruces area have revealed a pattern of site occurrence along the plain of the Rio Grande. It appears to have been an optimum location for prehistoric and historic settlers. Pit-house villages, open camp sites, and small pueblos have all been recorded in this physiographic setting in the Las Cruces area. The eastern portion of the recent study area encompasses some of the lower bajada zone, indicating a strong possibility of finding prehistoric resources along the valley margin. No part of the study area should be considered to be devoid of cultural resources.

There is no intensive archaeological survey coverage of the area. Should any federal funding, permit or assistance be used or required, the mandates of the National Historic Preservation Act, as amended (16 USC 470, 36CFR800, and SCS General Manual 420-401), require that cultural resources must be accounted for prior to any ground-disturbing activity. These mandates address the need for intensive inventories of areas to be disturbed and the required consultation process involving various state and Federal agencies. The data in this report are intended to provide a preliminary assessment of the cultural resources currently known in the planning area and are by no means exhaustive. Intensive record and field inventories and consultation with the New Mexico State Historic Preservation Officer should be undertaken prior to any ground disturbing activities.

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). "Computer Program for Project Formulation Hydrology" Technical Release 20 (TR20), February 1992, USDA-Soil Conservation Service was selected because of proven reliability, familiarity with the program, multiple sub-watershed and routing capabilities and ability to model reservoir routing and channel modifications.

The study area was subdivided into 63 basins. Thirty-six basins are east of I-25 and 27 are to the west. TR20 input parameters include basin size, time of concentration, rainfall and runoff curve number. Basin sizes ranged from 0.009 to 0.4 square miles. The total watershed area is 7.04 square miles.

Time of concentration (Tc) is the time in hours that it takes runoff to travel from the most distant point to the basin outlet. Time of concentration values were computed with the Modified Kirpich equation. No adjustment was made to the Tc values for the future condition hydrology. Due to the generally high length to width ratios of the basins, decreasing the Tc values was not considered appropriate for future conditions. If extensive concrete channel improvements are installed in the middle and upper portions of the watershed, the future condition Tc values may need to be reconsidered. Decreasing Tc values would tend to increase the peak flows. However, runoff volumes would not be affected by a change in Tc.

SCS NM-II-75 rainfall distribution was used to represent the high intensity storms of the Las Cruces area. The type NM II-75 places 75% of the 24-hour precipitation in the most intense one-hour period. 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. The 24-hour rainfalls used are shown in Table 5.

TABLE 5

24-Hour Duration Precipitation Values

Return Period Yrs.	24-Hour Precipitation Inches
2	1.2
5	1.7
10	2.1
25	2.6
50	3.0
100	3.6

Soils information was derived from the SCS Dona Ana County Soil Survey. Curve numbers are used in the computer model to define the infiltration/runoff phenomena for various soils, cover types and conditions. Runoff curve numbers were assigned for existing conditions based on field investigations, aerial photography, soil textures, land use, cover and cover condition. Runoff volumes are determined from curve number and rainfall values. A curve number of 98 indicates very little infiltration, resulting in almost all the precipitation becoming runoff (road surfaces). Whereas a 65 curve number indicates high infiltration (sandy soil) and low runoff. Curve numbers ranged from 68 to 90. Three scenarios for basin runoff conditions were developed: existing condition, future developed condition low density and future condition high density. The flood hazard zone maps and profiles are based on existing conditions. The alternatives for reducing flood risks are based on the future low density developed condition in 50 years. Low density means the residential areas consist of mostly half-acre and one-acre lots with 20 and 25% impervious areas respectively. The high density scenario assumes the future developed areas will have 1/10 to 1/8-acre lots with 50% impervious area.

Basin hydrologic parameters and delineations were developed using ortho-topographic maps (1 inch = 200 feet) provided by the City of Las Cruces and the Dona Ana Flood Commission (dated 1989-1992). Contour intervals consisted of 1 foot in the valley floor areas and 2 feet in the bluff and mesa areas to the east. Basin delineations are shown on page 3. Tables 12 and 13 show the basin characteristics and hydrologic properties for the existing condition and the two developed condition scenarios.

The four main arroyos studied, South Fork Moreno Arroyo, North Fork Moreno Arroyo, Split Fork Arroyo, and Taylor-Boyd Arroyo, were subdivided into five or more basins each. The analysis points of main interest are at Del Rey Blvd., I-25, the valley

floor, and the irrigated fields which act as floodways and reservoirs.

In addition to the four main arroyos mentioned previously, there are an additional 15 arroyos on the east side of I-25. Each of these arroyos cross I-25 through separate culverts. On the west side of I-25 three more basins are added to the system before reaching the valley floor. The valley floor, consisting of irrigated farmland and residential areas, was divided into nine basins (R1-R9).

Ten-year and 100-year basin discharges and runoff volumes for the existing condition are displayed in Table 14. The low density and high density 50-year future conditions for the 100-year flood event only are displayed in Table 15. The accumulative values for basins 5-4, 8-4, 11-4 and 13-4 represent the I-25 analysis point. Basins 5-5, 8-6, 11-5 and 13-5 accumulative values are at the valley floor.

The future condition assumes a 3% per year growth rate. The west side of I-25 is considered 100% developed in the 50-year future condition. The minor basins on the east side of I-25 are also 100% developed. The lower three basins (5-2 to 5-4, 8-2 to 8-4, 11-2 to 11-4 and 13-2 to 13-4) of the four main arroyos are 80% or more developed, and the upper two basins (5-0 to 5-1, 8-0 to 8-1, 11-0 to 11-1 and 13-0 to 13-1) of the main arroyos are 10 to 75% developed.

<u>HYDRAULICS</u> - The northeast Las Cruces arroyos were analyzed by detailed methods using numerous cross sections and "HEC-2 Water Surface Profiles" September 1990 (Revised 9/91), US Army Corps of Engineers. Sheets 1 through 12, Appendix D show the 100-year floodplain and water surface profiles for the North and South Fork Moreno Arroyos, Split Fork Arroyo and Taylor-Boyd Arroyo. The valley floor between Dona Ana School Road to the north and San Ysidro Road to the south and between the arroyo mouths on the east and the Dona Ana Lateral, Kelso Lateral and the Dona Ana Drain to the west were mapped for flood hazard areas without profiles using peak flows and weir flow computations at field boundaries and roads. Flood elevations are provided for the valley floor flood hazard areas on the plan maps. Only the present condition 100-year flood was analyzed for the flood hazard zones and water surface profiles.

Cross section data for the four main arroyos were obtained from the ortho-topographic maps (1 inch = 200 feet) provided by the City of Las Cruces and the Dona Ana Flood Commission (dated 1989-1992). Contour intervals consisted of 1 foot in the valley floor areas and 2 feet in the bluff and mesa areas to the east.

An evaluation of the I-25 culvert capacities indicates that all 19 culverts will carry the expected 100-year existing condition peak flows. No routings were performed through the I-25 culverts. Routings may reduce the peak discharges downstream

slightly, but they were not considered to be significant and therefore were not justified. Culvert crossings along Del Rey Blvd. and Elks Road have capacities less than the 10-year storm flow requirements.

Split flows may occur at several locations along the South Fork Moreno Arroyo (5). The full 100-year flows were used in the main downstream natural channel in order to account for the more severe flow possibility.

On the Split Fork Arroyo, small islands above the flood elevation within the flood hazard zones were included in the flood hazard zone. In considering the stability of the channel, size of the islands, and accuracy of the two-foot contour map, it would not be prudent to show these areas outside the 100-year floodway and in a "safe" zone for development purposes.

East of Del Rey, the arroyo splits into two downstream channels. The south channel appears to be the low flow route to I-25. A 10 foot by 4 foot reinforced concrete box is located at I-25. However, the north channel is well defined and has obviously carried significant flows. Flow in the north channel would utilize the same culverts as the Taylor-Boyd Arroyo (13) in crossing I-25. The I-25 culverts (4-52" cmps) are rated at 650 cfs capacity. The south channel culvert, Split Fork Arroyo (11) has a rated capacity of 400 cfs. The 100-year frequency flows are 645 and 395 cfs respectively for the existing condition. Therefore any flows diverted from the south channel to the I-25 culvert on Taylor-Boyd would overload the I-25 culvert during the 100-year frequency flow. Because of the uncertainty of the divided flow at this location the full flow from basin 11 was used to establish the water surface profile in the south channel. It is assumed that in the future, measures will be taken to assure that the full flow will follow this path, for which the I-25 culverts were designed. The crossing at Del Rey Blvd was analyzed for overtopping using the HY8 Culvert Design program. The maximum culvert capacity is 100 cfs compared to the 100-year frequency flow of 520 cfs. Weir flow was also analyzed at Elks Road.

The Split Fork (11) and South Fork Moreno Arroyos becomes very obscure in places between Elks Road and the irrigated cropland. Several flow paths may develop in this area. A more detailed evaluation with the aid of field surveys is needed to more accurately map the present condition flood hazard zone. Any future development in this area should be carefully evaluated for drainage needs before approval and construction.

Water surface profiles for the four main arroyos extend to the arroyo mouths at the valley floor. At the valley floor, flood flows from the minor arroyos are added to the main arroyo flows and collect in the irrigated fields east of El Camino Real. The irrigated fields act as flood detention structures and floodways during the major storm events. Storm runoff moves from the north

end (B6) along the east side of El Camino Real to the south end (B1). The flood flows from the 100-year storm event will overtop El Camino Real in several places before reaching basin R1 and R2. Once flood flows reach R1 and R2 a major overtopping of El Camino Real will occur in the area of San Ysidro Road. On the west side of El Camino Real flood water is confined by the Dona Ana and Kelso Laterals. Floodwaters that reach the west side of El Camino Real, beginning in the Taylor Road area will move south to San Ysidro Road where it will join the Sand Hill Arroyo floodplain. San Ysidro Road is the southern limit of this detailed study, at which point the flood hazard zone from the Sand Hill Arroyo is joined. Flood elevations in the valley floor area were computed using weir flow calculations utilizing the HY8 computer program from the Federal Highway Administration.

EXISTING DRAINAGE STRUCTURES

Culvert crossings were inventoried along Del Rey Blvd., I-25, and Elks Road. As-built drawings for I-25 and field measurements were used to analyze flow capacities. No field surveys were made to determine invert elevations. Flow capacities were based on inlet control, clean culverts and no freeboard i.e. headwater at road elevations. Some culverts have one foot or more of sediment deposited at the inlets which will reduce the actual flow capacities significantly. Table 11 Appendix B, displays the culvert inventory along with the required capacities for the existing condition and the low density future condition.

The four main arroyo culverts along I-25 have capacity for the 100-year existing condition storm, assuming no sediment deposition in the culverts. The remaining 15 culverts for the minor arroyos will also handle the peak flows for the 100-year existing condition storm. For the low density future condition, culverts on arroyos 1, 4, 5, 7, 8, 9, 10, 12, 14, 15 and 19 will carry the expected peak flows. The remaining culvert capacities will be exceeded by 12 to 215 cubic feet per second (cfs). Culverts on North and South Fork Moreno, Split Fork and Taylor-Boyd Arroyos (5, 8, 11 & 13) at Del Rey Blvd. are at 20 to 43% of the required capacities required for the existing condition 100-year storm peaks. Only arroyos 8 and 13 have culverts on Elks Road. Neither will handle the 10-year storm peaks.

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 sponsors are in a relatively good position to develop and adopt a much needed comprehensive watershed management plan. Fortunately, not much development has taken place in the floodplain along El Camino Real or in the arroyo floodways east of I-25. 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 and floodway is the

preferred and least costly 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

TABLE 6
STRATEGIES AND MEASURES FOR FLOOD LOSS REDUCTION

Modifying Flooding
dams and reservoirs
levees and walls
channel alterations
diversions
land treatment
onsite detention
Modify Susceptibility to Flooding
floodplain regulations
development and redevelopment
warning and preparedness
floodproofing
Modify Impact of Flooding
flood insurance
relief and recovery

Modifying Flooding - 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.

Dam and Reservoirs:

Reservoirs capture and temporarily hold floodwaters upstream of flood-prone areas. Excess water is gradually released after the flood threat has passed. Use of dams requires sites capable of storing sufficient amounts of water which are upstream but fairly close to the area to be protected. Because of their cost, large dams and reservoirs are usually feasible only where they protect urban areas or high value agricultural lands. For some heavily developed urban areas, dams and reservoirs may provide the only practical means for significantly reducing flood damage.

The protection afforded by a dam is greatest in the area immediately downstream. Protection further downstream. Protection further downstream is reduced by flows from tributaries and by runoff from controlled land below the dam.

Protection can also decrease over time if the reservoir gradually fills with sediment.

Levees and Walls:

The principal purpose of levees and floodwalls is to confine floodwaters to the stream and a selected portion of the floodplain. Each of these measures protects only the area immediately behind it and only against the selected flood height for which it was designed.

Levees are normally constructed of earth. The width of a levee's base must be several times greater than the levee's height for stability. As a result, levees more than a few feet in height require that significant space be available between the stream and the property to be protected. Significant space may also be required for setting levees back far enough from the channel to provide adequate flow carrying capacity. Levees are best suited for use along large rivers where their construction is less likely to be a severe encroachment on the floodplain. Floodwalls are usually constructed of concrete or steel and take up far less room. They are more suitable for use in congested areas.

Channel Alterations:

Channel alterations reduce flooding by increasing the flow carrying capacity of an arroyo. The various types of alterations include: deepening or widening the channel; removing debris; paving the channel; and raising or enlarging bridges and culverts that restrict flow. Underground conduits can also be installed to carry part or all of a small stream's flow.

All of these channel alterations contribute toward reducing the height of a flood. It is sometimes possible, by extensively reconstructing an arroyo channel, to contain major floods within its banks. Unfortunately, such alterations sometime increase flooding downstream by accelerating the flow of flood waters.

Diversions:

Diversions intercept flood flows upstream of a damage-prone area and route them around the area through an artificial channel. Diversions may either completely reroute an arroyo or only collect and transport flows that exceed the normal capacity of the channel or that would cause damage.

Diversions are particularly well suited for protecting developed areas because they don't require land acquisition or construction within the protected area. However, opportunities for diversions are often limited by the nature of local land formations and soil conditions. There must also be a channel available into which the diversion can empty. The receiving channel must have enough capacity to carry the flow disposed of through the diversion without causing flooding.

Land Treatment:

Land treatment measures are used to reduce runoff of water to arroyos or other areas. Techniques of land treatment include maintenance of trees, shrubbery and vegetative cover, terracing, slope stabilization and waterways. These measures reduce water flow by improving infiltration of rainfall into the soil, slowing and reducing runoff, and reducing the sedimentation that can clog culverts or storage reservoirs. While the effect of any individual measure is small, extensive land treatment programs can effectively reduce flooding.

Onsite Detention:

Flooding can be increased significantly by the runoff from lands which have been stripped of vegetation or covered with buildings, pavements and other impervious materials. The main objective of onsite detention is to prevent excessive runoff from such areas. A secondary benefit is that onsite detention traps pollutants and so sometimes improves water quality.

The principal onsite detention measures are those restricting land clearing and providing for temporarily storing some or all runoff from a property. Use of the measures may be voluntary or required by regulatory or permit programs. Regulations requiring onsite detention are often part of zoning or other broad programs controlling land use and development in upland areas.

The cost of individual onsite detention measures is usually not high. However, the cost often falls on the owner of the land where flood waters arise, while most other flood control measures are paid for by the people in the protected area or by the general public.

Onsite detention ponds or reservoirs can lose their effectiveness over time if they're not regularly cleaned and maintained. This can involve a significant cost. Another potential is the lack of unified control over patterns of flow drainage. However, this problem can be handled through broad scale planning of the overall system.

<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. 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.

Measures Modifying the Impact of Flooding - 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. The 100-year floodplain map provided by the Soil Conservation Service in this study could also be adopted by the city and county to regulate development.

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 re-establishes 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.

ALTERNATIVES

The study area is split into two areas by Interstate 25. East of the interstate, the land use is primarily potential development land with urban land increasing. Land use west of the interstate is a mixture of potential development land, cropland and urban land. The cropland produces high value crops through irrigation, and the area of urban land is increasing.

Capital improvements to the fields and irrigation canals, laterals and drains, have increased the value of the cropland susceptible to flood water and sediment damage. The urban and cropland areas cannot tolerate significant changes in arroyo alignment and size.

Expanding urban areas change runoff and erosion characteristics. In general, urban areas yield increased water and sediment compared to a natural landscape. Therefore as development occurs east of the interstate, storm water runoff and sediment will increase causing more frequent flood damage in the area west of the interstate. In order to mitigate this increased risk of flood damage, structural alternatives were developed and evaluated.

Flood damage reduction using structures can be accomplished by retarding flood water and sediment in a reservoir or by conveying flood water and sediment through a channel. These two structural methods were investigated, and Table 7 and 7a summarizes four flood water retarding structures and one channel. Retarding structures on arroyos 5, 8, and 13 were more effective in reducing downstream peak discharges than a similar structure on arroyo 11.

The structural components can be used individually and in combination. The combination of two retarding structures with a downstream channel reduced the peak discharge at arroyo 19 by 25 percent (from 4,000 to 3,000 cfs). The combination of four retarding structures reduced the peak 100-year 24 hrs discharge at arroyo 19 by 34 percent (from 4,000 to 2,650 cfs). Two configurations were analyzed for the channel from the Dona Ana lateral to the Rio Grande. One configuration utilized a rectangular, reinforced-concrete channel. The second configuration used a low flow earthen channel to convey 300 cfs (approximately the 3.3 year discharge) with a floodway conveying the less frequent storms. The second configuration would reduce operation expenses by increasing sediment transport for the frequent events. Typical flows in the Rio Grande have capacity to transport this added flood water and sediment.

The information displayed in Table 7 was developed using "DAMS2, Structure Site Analysis Computer Program," Technical Release 48, October 1982, USDA-Soil Conservation Service. The channel information in Table 7A was developed using a spreadsheet to calculate water surface profiles based on uniform, normal flow conditions. Channel depth includes freeboard which was calculated using criteria from "Design of Open Channels," Technical Release 25, October 1977 (Revised June 1980), USDA-Soil Conservation Service.

Table 7. SUMMARY OF STRUCTURAL COMPONENTS, FLOODWATER RETARDING STRUCTURES

	Units	Arroyo 5 Struct 53	Arroyo 8 Struct 83	Arroyo 11 Struct 11	Arroyo 13 Struct 13
Hazard Class		c	c	c	c
Drainage Area	(Sq.Mi.)	0.68	0.83	0.55	0.90
(Acres)	435	531	352	576	
Reservoir Capacity					
Sediment Storage	(Ac-Ft)	63.9	78.0	51.7	84.6
Floodwater Storage	(Ac-Ft)	28.8	76.5	29.2	39.8
Sediment Storage	(Inches)	1.76	1.76	1.76	1.76
Floodwater Storage	(Inches)	0.79	1.73	1.00	0.83
Principal Spillway					
Rainfall, (1-day)	(Inches)	3.40	3.40	3.40	3.40
Rainfall, (10-day)	(Inches)	4.56	4.56	4.56	4.56
Runoff, (1-day)	(Inches)	1.28	1.30	1.31	1.17
Maximum Discharge	(cfs)	90.3	89.1	84.7	77.3
Conduit Diameter	(Inches)	30	30	30	30
Type of conduit	(R/C Pipe)	Yes	Yes	Yes	Yes
Emergency Spillway					
Frequency of Use	(Percent)	< 1.0	< 1.0	< 1.0	< 1.0
Rainfall, (6-hour)	(Inches)	16.6	16.6	16.6	16.6
Runoff, (6-hour)	(Inches)	13.1	13.1	12.8	12.8
Maximum Discharge	(cfs)	4,270	3,900	3,040	4,790

Table 7a. SUMMARY OF STRUCTURAL COMPONENTS, CHANNEL

Units	Arroyos Reach	1-5 1	5-9 2	9-10 3	10-13 4	13-16 5
Drainage Area (Sq.Mi.)		1.07	2.21	2.23	4.01	4.22
Channel Slope (%)		0.85	0.85	0.15	0.15	0.15
Manning's n		0.014	0.014	0.014	0.014	0.014
Channel Shape		Rect.	Rect.	Rect.	Rect.	Rect.
Bottom Width (Ft)		10	16	16	25	30
Design Discharge(cfs)		1,210	2,160	2,160	3,230	4,000
Average Velocity(fps)		19.3	22.3	11.6	12.9	13.5
Froude Number		1.36	1.60	0.60	0.72	0.76
Channel Depth (Ft)		7.8	7.6	14.0	12.0	11.8

Units	Arroyos Reach	16-20 6	20 7	Dona Ana Lateral-Rio Grande 8	Low Flow	Floodway
Drainage Area (Sq.Mi.)		4.61	4.61	4.61	4.61	4.61
Channel Slope (%)		0.35	1.84	0.14	0.07	0.14
Manning's n		0.014	0.014	0.014	0.025	0.035
Channel Shape		Rect.	Rect.	Rect.	Trap.	Trap.
Bottom Width (Ft)		30	20	35	44	600
Design Discharge(cfs)		4,000	4,000	4,000	300	4,000
Average Velocity(fps)		18.2	34.3	12.9	2.7	2.6
Froude Number		1.18	2.51	0.77	0.30	0.32
Channel Depth (Ft)		9.2	7.3	10.6	2.5	2.1

Five alternatives are presented in this report and each alternative includes one to three structural components. The purpose of each alternative is to provide a safe and adequate outlet for flood water and sediment from the area east of the interstate. Once the future developed runoff conditions are outlet to the Rio Grande, non-structural and individual on-site detention techniques can be used within the watershed to augment and supplement the structural works.

The first alternative is a channel parallel to and east of the interstate. The second alternative is a channel parallel to and west of the interstate. The third alternative considered flood water retarding structures on arroyos 5 and 8 with a channel parallel to the interstate. The fourth alternative considered floodwater retarding structures on Arroyos 8 and 13 with a channel parallel to the interstate. Alternative five is a series of two or three detention structures along the east side of El Camino Real.

A comparison of alternatives one through four follows. The peak discharge rates and runoff volumes for the future condition without improvements and for the alternatives one through four are compared in Table 8. These discharge rates and runoff volumes were computed using "Computer Program for Project

Formulation Hydrology," Technical Release 20, Second Edition, May 1983, USDA-Soil Conservation Service.

Table 8
PEAK DISCHARGE RATE and RUNOFF VOLUME FOR THE ONE-PERCENT-CHANCE STORM BY ALTERNATIVE

Arroyo Number	Drainage Area sq. mi.	Future Condition W/O Improvements		Alt.1 & 2		Alt.3		Alt.4	
		cfs	ac-ft	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
1 thru 4	0.4	624	29	624	29	624	29	624	29
5	0.7	738	49	738	49	119	49	738	49
1 thru 5	1.1	1,206	77	1,206	78	738	77	1,206	78
8	0.9	697	61	697	61	133	61	133	61
1 thru 9	2.2	2,146	155	2,146	155	1,244	155	1,656	155
Struct 09	2.2	2,146	154	2,048	154	1,135	154	1,557	154
1 thru 11	2.9	2,497	199	2,448	199	1,472	199	1,934	199
1 thru 13	4.0	3,225	268	3,214	268	2,183	268	2,186	268
1 thru 19	4.6	3,997	312	3,721	312	3,017	312	2,993	312

The future condition without improvements will increase flooding and sediment deposition on the downstream urban and croplands which are west of the interstate. The existing discharge, aggregated for the entire area east of the interstate is estimated to be 2,600 cfs. The aggregated discharge for the future developed condition is estimated to be 4,000 cfs. All of the alternatives presented will construct an outlet channel across the floodplain to the river. Two of the four alternatives use retarding structures to reduce the size of the outlet channel.

Alternative 1 is a floodwater conveyance channel east of the interstate. It will convey about 3,800 cfs from east of the interstate to the river. Inlet structures and sediment traps would be employed at arroyos 5, 8, 11, and 13. At the other arroyos inlet structures with no sediment trapping capability would be used. This alternative would require the construction of an interstate bridge near arroyo 20.

Alternative 2 is a flood water conveyance channel west of the interstate. It will convey about 3,800 cfs from the interstate to the river. The existing culverts under the interstate would be utilized as inlet structures for the channel. The ponding areas upstream of the culverts would be utilized as sediment traps. Depending on sediment yield from each arroyo and transport capacity of the channel, the existing ponding areas may be enlarged to increase the sediment trap efficiency. With this alternative, the construction of an interstate bridge would not be necessary; however, additional culverts would be needed.

Alternative 3 consists of two flood water retarding structures and a flood water conveyance channel. The structures would be constructed on arroyos 5 and 8, and they would be located just upstream of Del Rey Road.

Water released from the structures will be sediment free and will flow for several days, and this new flow regime will destabilize the existing arroyos. Therefore, lined, outlet channels from the structures to the main conveyance channel will be installed. The main conveyance channel will convey about 3,000 cfs from the interstate to the river and could be constructed on either the east or west side of the interstate.

Alternative 4 also consists of two flood water retarding structures and a flood water conveyance channel. The structures would be constructed on arroyos 8 and 13, and they would be located just upstream of Del Rey Road. As discussed in the preceding paragraph, outlet channels will be constructed from the two structures to the main conveyance channel. The main conveyance channel will convey about 3,000 cfs from the interstate to the river and could be constructed on either the east or west side of the interstate.

Alternative 5 incorporates detention areas into the irrigated cropland east of El Camino Real and would provide flood protection for the developing areas west of El Camino Real. Currently the area along the east side of El Camino Real serves as a floodway and minor detention area. El Camino Real overtops at several locations during major runoff events. Arroyo discharges collect in the fields which then flow south along the east side of El Camino Real to the mouth of Sand Hill Arroyo. At this point El Camino Real is overtopped and flooding occurs on the east side of the road in the area of San Ysidro Road. The El Camino Real detention alternative would zone the irrigated fields as a permanent detention/floodway area. Low embankment detention structures would be constructed along the field borders. Irrigation turnouts through the low embankments would enable the fields to be farmed. Pipe outlets would connect adjacent structures to the south. The proposed Sand Hill and Camino Real detention structure would receive the outflow from Reservoir C. The two detention structures would share a common pipe outlet to the Don Ana Drain.

This alternative would consist of constructing three detention areas, A, B and C. Alternative 5A would combine A and B into a single detention area located in the same area as B only with higher embankments. Detention area A would receive flows from Basins 14 - 19 and 103. Detention area B would receive flows from Basins 10 - 13, 101 and 102. And detention area C would receive flows from Basins 1 - 9. The basin shown as reservoir area R3 on the Watershed and Basin Map on page 3, includes a small development of about eighteen homes. This area has been excluded from detention area B in order to avoid relocation costs.

The detention structures will store the expected runoff volume from the low density future developed condition 100-year storm plus ten years of sediment accumulation. The low embankments would be constructed along the east side of El Camino Real and the concrete irrigation ditch and then tie into the toe of the bluff to the east. Maximum fill heights for detention areas A, B and C would be 6.7, 8 and 7.5 feet respectively. Detention area A/B would have a maximum fill height of 8.7 feet. The fill heights were computed with allowance for two feet of freeboard. Information developed for Table 9 was based on criteria found in "Earth Dams and Reservoirs", Technical Release 60, Revised October 1985, USDA-Soil Conservation Service.

TABLE 9
SUMMARY OF STRUCTURAL COMPONENTS - ALTERNATIVE 5

Structure		A	B	C	A/B
Hazard Class		c	c	c	c
Drainage Area	(Sq.Mi.)	1.11	2.24	2.90	3.35
	(Acres)	710	1435	1856	2144
Reservoir Capacity					
Sediment Storage (Ac-Ft)		10.4	21.1	27.3	31.5
Floodwater Storage (Ac-Ft)		95	160	225	255
Sediment Storage (Inches)		0.18	0.18	0.18	0.18
Floodwater Storage (Inches)		1.61	1.34	1.46	1.43
Principal Spillway					
Rainfall, (1-day) (Inches)		3.40	3.40	3.40	3.40
Rainfall, (10-day) (Inches)		4.56	4.56	4.56	4.56
Runoff, (1-day) (Inches)		1.28	1.30	1.31	1.17
Maximum Discharge (cfs)		0.3	9.1	4.7	7.3
Conduit Diameter (Inches)		30	30	30	30
Type of conduit (R/C Pipe)		Yes	Yes	Yes	Yes
Emergency Spillway					
Frequency of Use (Percent)		< 1.0	< 1.0	< 1.0	< 1.0
Rainfall, (6-hour) (Inches)		16.6	16.6	16.6	16.6
Runoff, (6-hour) (Inches)		13.1	13.1	13.1	13.1

The best alternative will have the least adverse effects when compared to the beneficial effects. The adverse and beneficial effects will consider environmental and social concerns of the city and the local residents. The City of Las Cruces will decide which alternative to install. Table 10 displays preliminary cost estimates for the five alternatives.

Table 10
PRELIMINARY COST ESTIMATES for EACH ALTERNATIVE

Item	Alt.1	Alt.2	Alt.3	Alt.4
	(Dollars in Thousands)			
Configuration using a rectangular concrete channel from the Dona Ana Lateral to the Rio Grande				
Land Rights, Acres	36.8	36.8	68.5	72.8
Potential Relocations	4	4	4	4
Construction Cost	$20,900	$18,300	$20,500	$20,600
Total Installation	$24,500	$21,500	$23,700	$23,800
Annual O&M	$31.3	$27.4	$34.3	$35.0
Configuration using an earthen low flow channel with a floodway from the Dona Ana Lateral to the Rio Grande				
Land Rights, Acres	157.3	157.3	190.9	195.2
Potential Relocations	4	4	4	4
Construction Cost	$12,900	$10,300	$13,700	$13,800
Total Installation	$16,700	$13,700	$17,900	$18,100
Annual O&M	$19.3	$15.5	$24.1	$241.7

Item Description	Alt.5	Alt.5
Land Rights Required, Acres	324	312
Cost per acre	$7,500 - $15,000	$7,500 - $15,000
Potential Relocations	$0	$0
Construction Cost	$175,000	$150,000
Annual O&M	$20,000	$15,000

Table 10 indicates the area needed to install each alternative. Alternatives 3 and 4 include detention structures and require more land area than Alternatives 1 and 2. The configurations, using a low flow channel and a floodway across the floodplain, are less expensive than using a rectangular concrete channel across the floodplain. However, the floodway requires a large land area. This floodway would provide a bosque habitat which would lend itself to recreational use. The low flow channel meandering through the floodway would provide slow water for fish fry and would improve the fishery resource through Las Cruces. The low flow channel and floodway would provide habitat for wildlife near this urban environment.

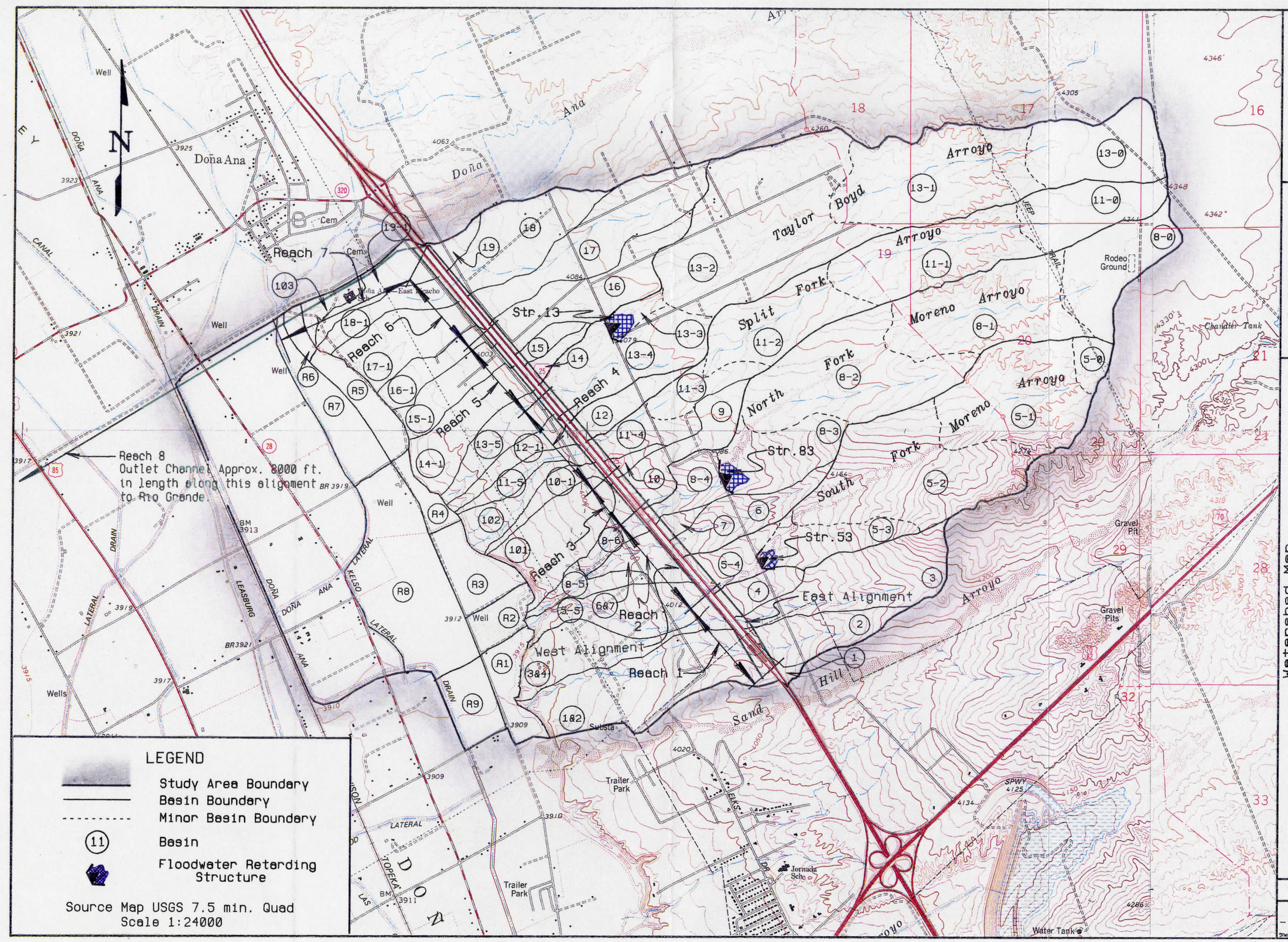
The construction costs shown in Table 10 indicate the bid price of a formal construction contract. The total installation costs include estimated costs for: construction, engineering design, quality assurance during construction, and land rights costs. The cost of annual O&M (operation and maintenance) are also shown in Table 8. The estimated O&M does not include cleaning sediment from the channels, or sediment basins.

Table 10 also displays estimated costs for alternative 5. Additional costs associated with providing stable channels will

be incurred by the local units of government or developers as development continues in the watershed. The increased capacity requirements and stability of the natural channels will need to be addressed as the needs arise. The culvert crossings at Del Rey Blvd. and Elks Road require immediate attention. The I-25 culverts are adequate for the existing conditions. However, future developments east of I-25 should comply with a strict policy of increased runoff detention and maintaining or reducing the current peak discharges at the interstate highway.

CONCLUSIONS

In comparing the benefits of the alternatives, Alternatives 1 through 4 provide flood protection for the area west of I-25 and reduce the flood risk along El Camino Real. Alternatives 5 and 5A, would benefit the area to the west of El Camino Real. Arroyo and channel improvements to safely convey flood water to the detention sites would be required to provide protection upstream of the cropland area.



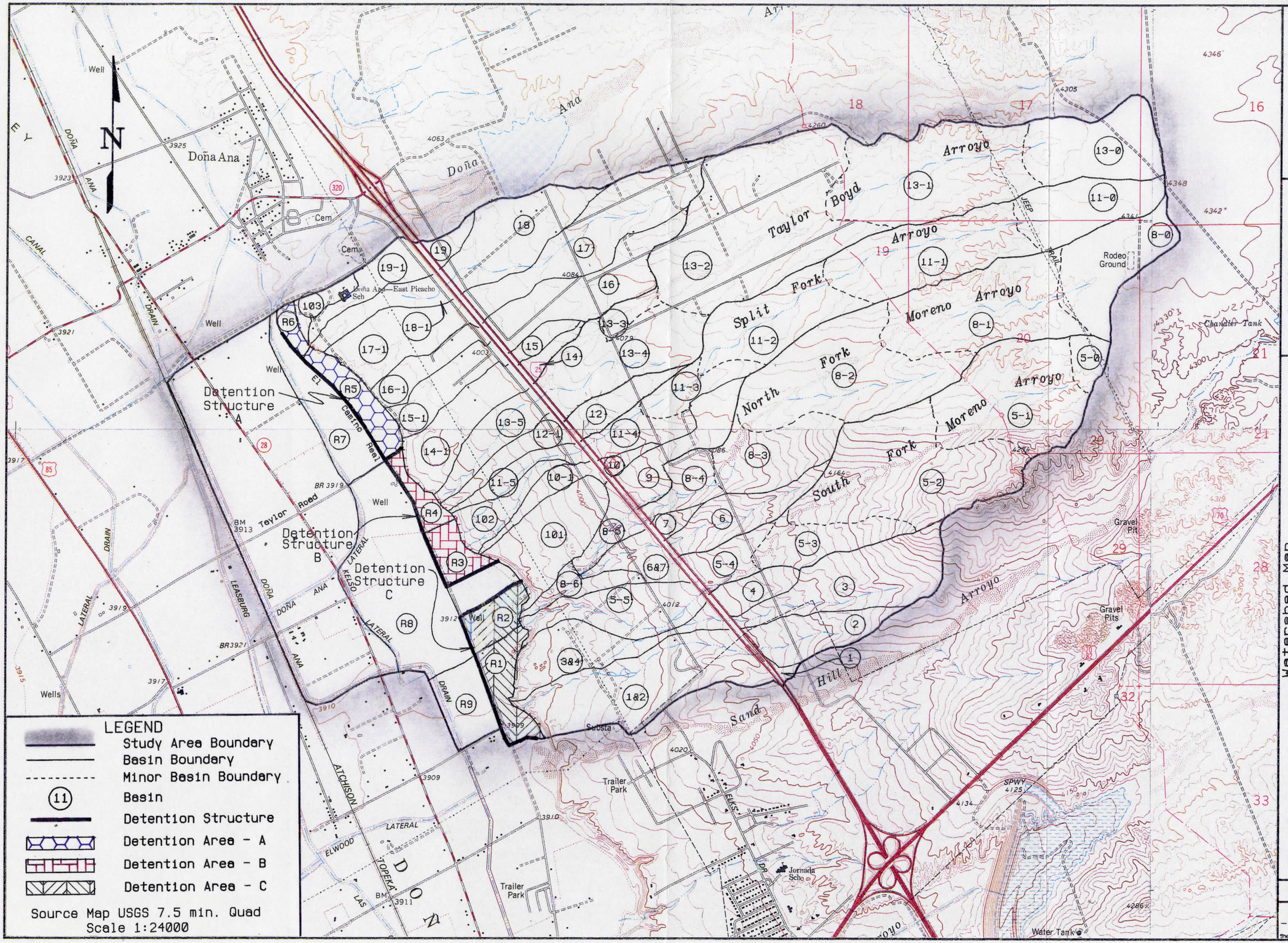
Watershed Map
Alternatives 1 thru 4
Northeast Las Cruces
Floodplain Management Study

Dona Ana County New Mexico

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Designed D. MURRAY Date 1-94
Drawn R. ARMIJO Date 4-94
Traced Date
Checked Date
Approved by Title
Title

Drawing No. 31
Sheet No. of



Designed D. MURRAY Date 1-94
Drawn R. ARMIJO Date 4-94
Traced Date
Checked Date
Approved by
Title
Title

Watershed Map
Alternative 5
Northeast Las Cruces
Floodplain Management Study

Dona Ana County New Mexico

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Drawing No. 32

Sheet No. of

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APPENDICES

APPENDIX A

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 human caused 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 below 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 that if the terrain management plan does not contain sufficient information about particular features, the needed information should be obtained from the developer.

1. SOILS

The Dona Ana County Soil Survey will provide the needed information to determine the principal detrimental or unfavorable features of the soils. 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. <u>GRADING</u>

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. To 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 should be 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 floodplain.

2. Materials placed in any position which would make it susceptible to erosion and deposition into a watercourse, waterbody, 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 measures to prevent damaging runoff waters originating on the slope itself?

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

C. When native ground cover is planned to be removed or disturbed or when fill material is planned to be 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 disposal 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 in the soil survey or in 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. FLOODPLAIN MANAGEMENT

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

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

B. Structures, fill 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. Confined animal shelters and other structures with a potential for high flood damage are not located in the floodplain.

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

4. STORM DRAINAGE - DRAINAGE PLAN

Subdivisions and developments should 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. 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. Based on the soils involved, are designed road grades flat enough to prevent erosion?

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 should be an important part of any subdivision plan. A definite time schedule for installing plant cover would be necessary to prevent erosion, particularly in areas with sandy soils.

APPENDIX B

HYDROLOGY - HYDRAULICS

Watershed Schematic
South Fork Moreno Arroyo
(Basin No.5)
Existing Condition
100 Year Storm Peaks

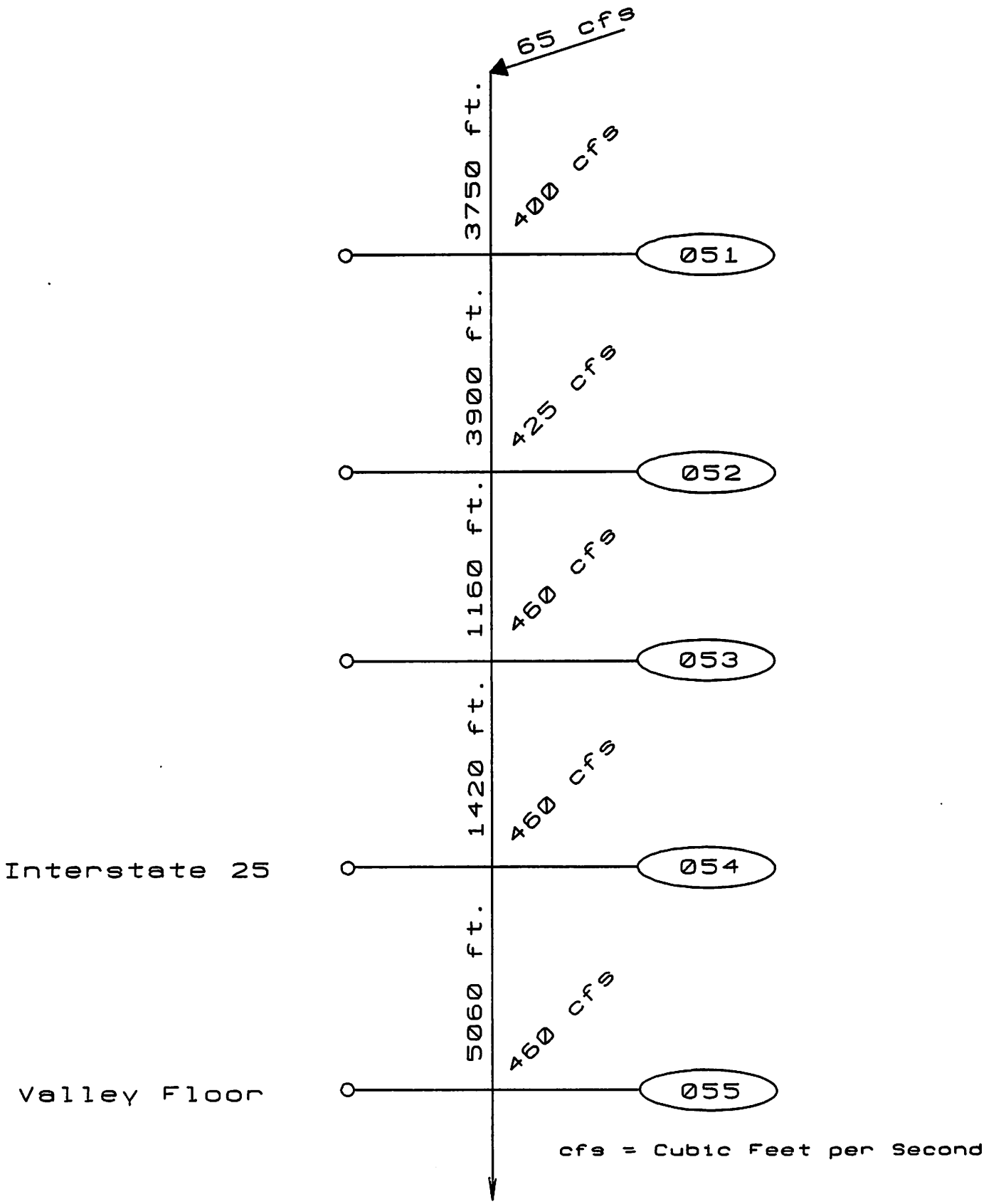


Figure B1

Watershed Schematic
North Fork Moreno Arroyo
(Basin No.8)
Existing Condition
100 Year Storm Peaks

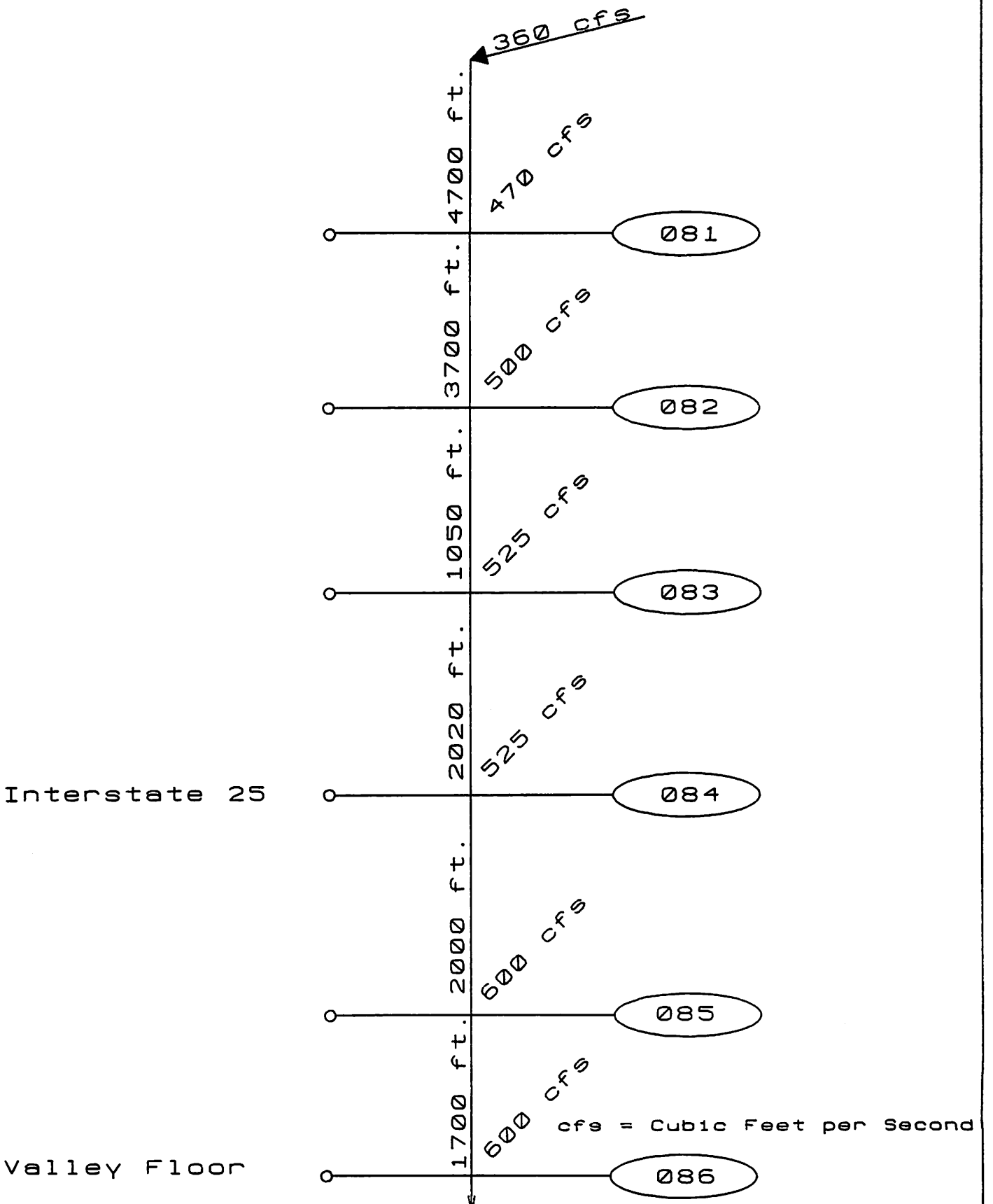


Figure B2

Watershed Schematic
Split Fork Arroyo

(Basin No. 11)

Existing Condition
100 Year Storm Peaks

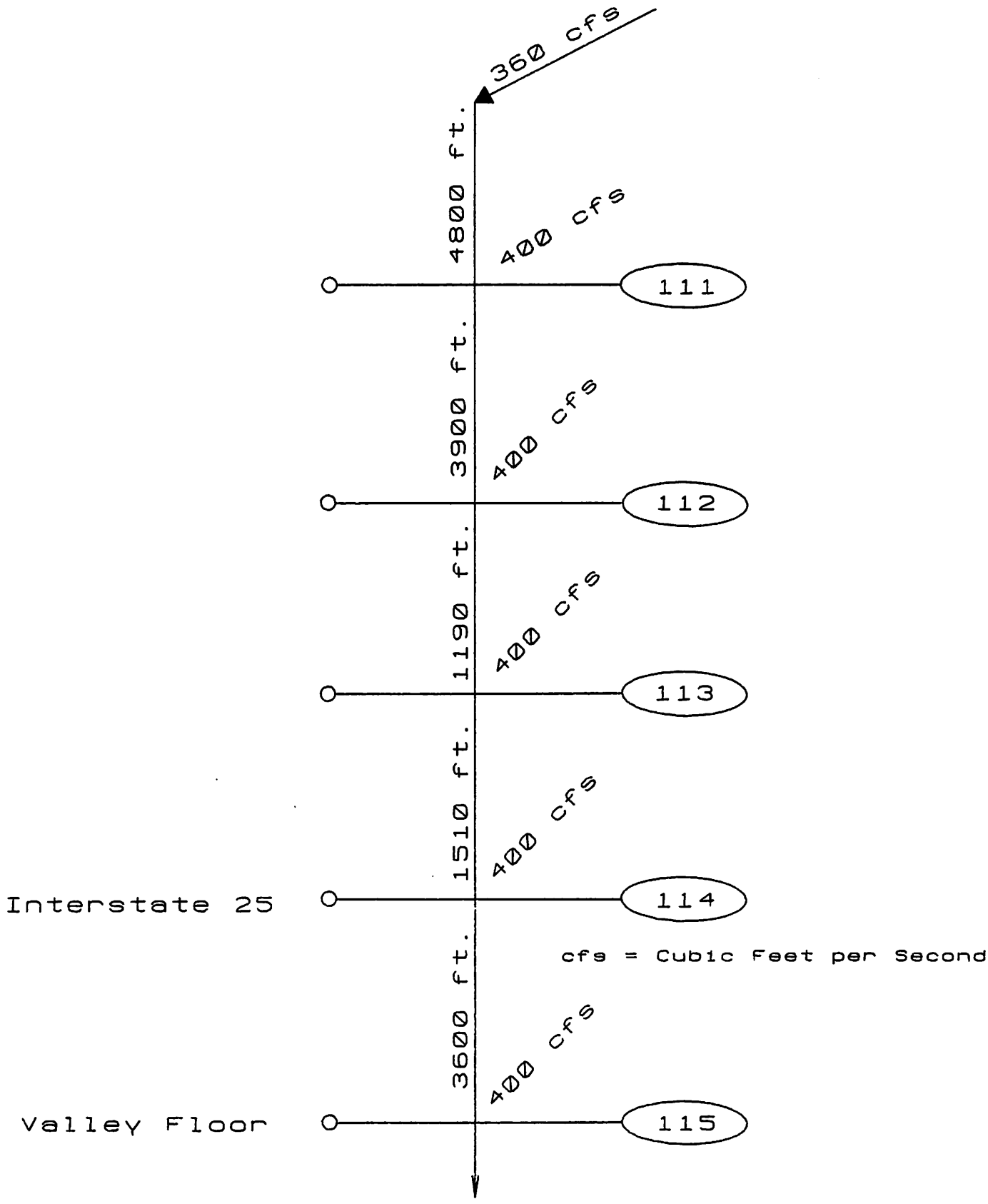


Figure B3

Watershed Schematic
Taylor Boyd Arroyo

(Basin No. 13)

Existing Condition

100 Year Storm Peaks

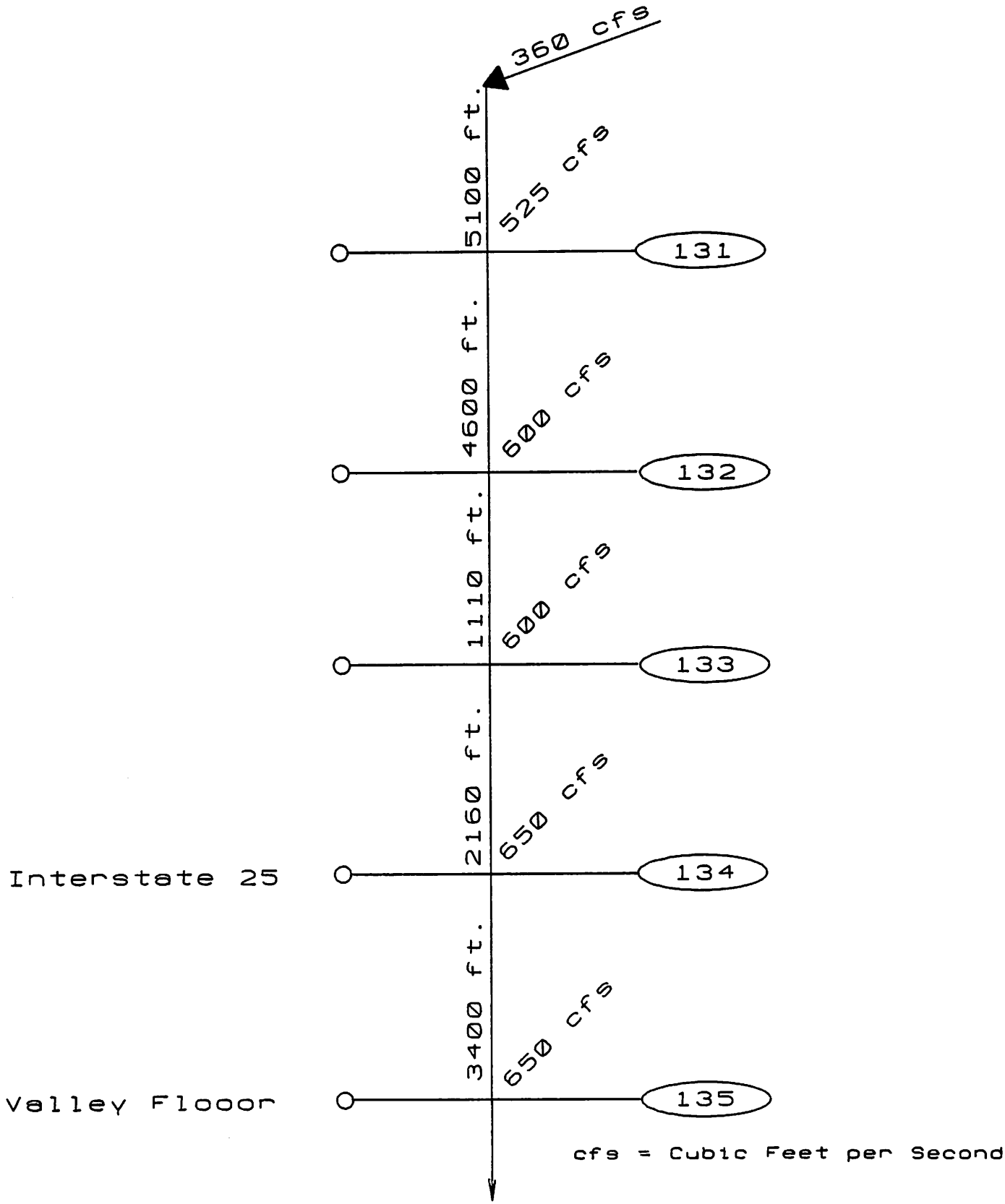


Figure B4

TR-20 Schematic
South Fork Moreno Arroyo
(Basin No.5)
Existing Condition

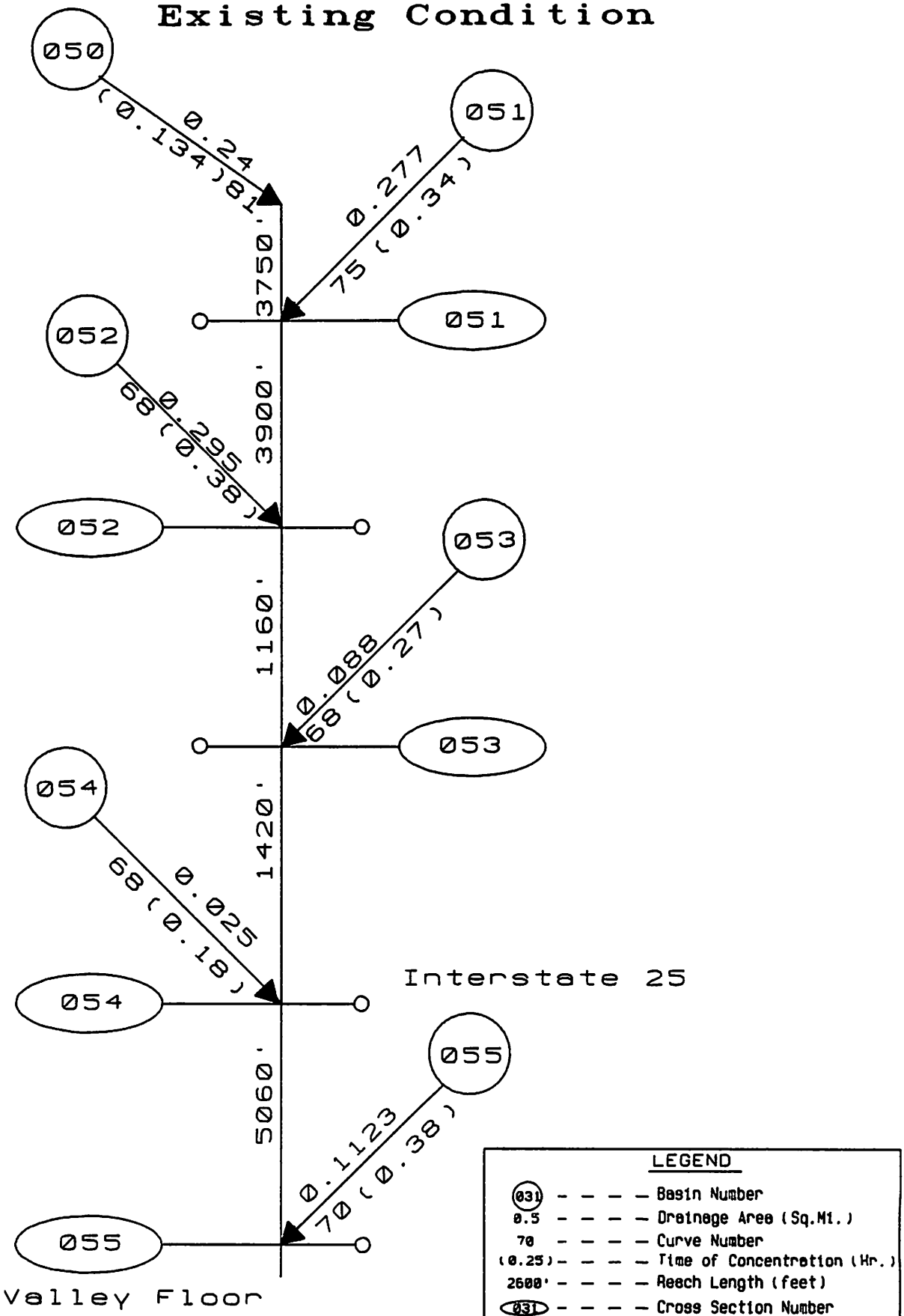


Figure B5

TR-20 Schematic
North Fork Moreno Arroyo
(Basin No. 8)
Existing Condition

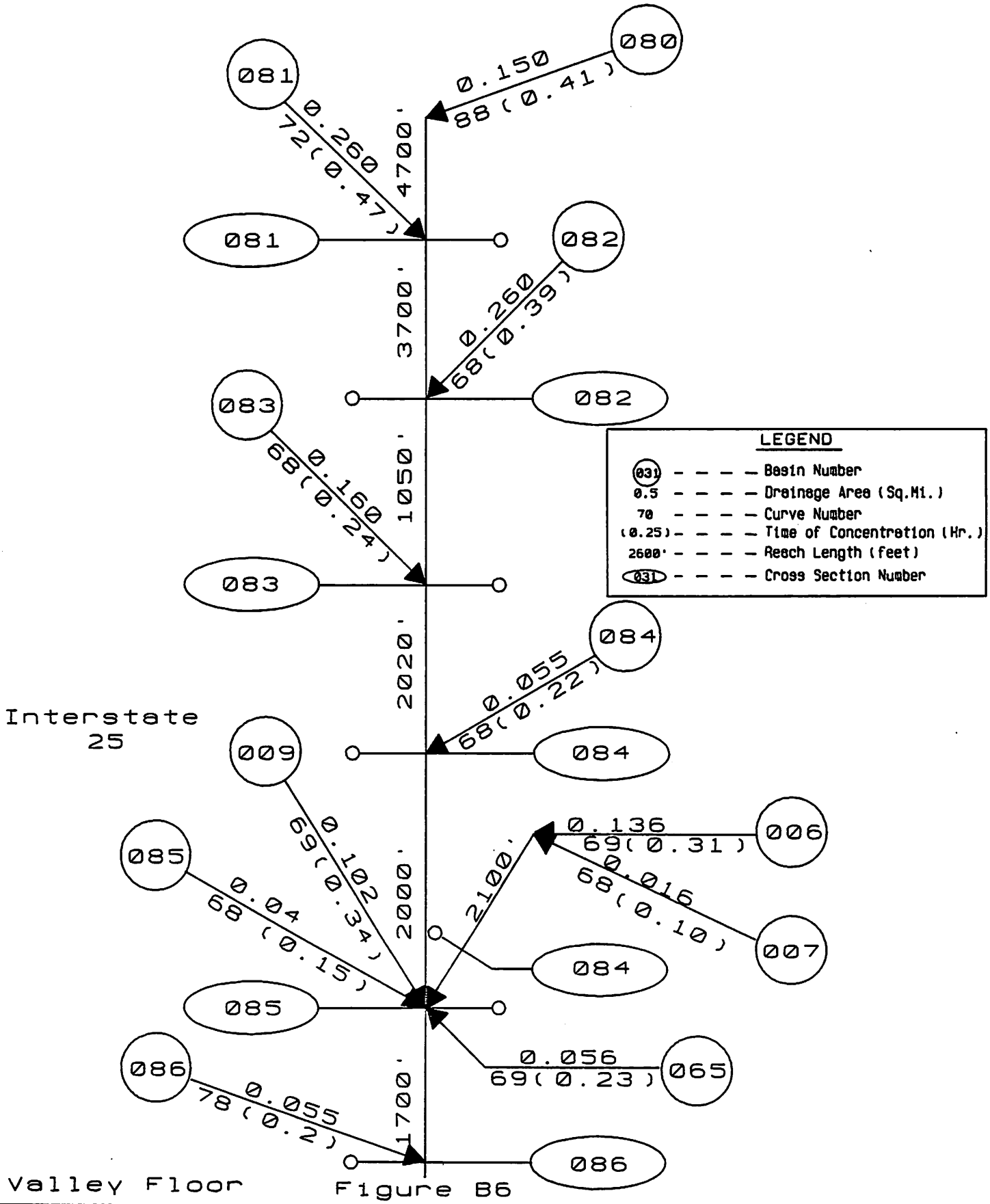


Figure B6

TR-20 Schematic
Split Fork Arroyo
(Basin No. 11)
Existing Condition

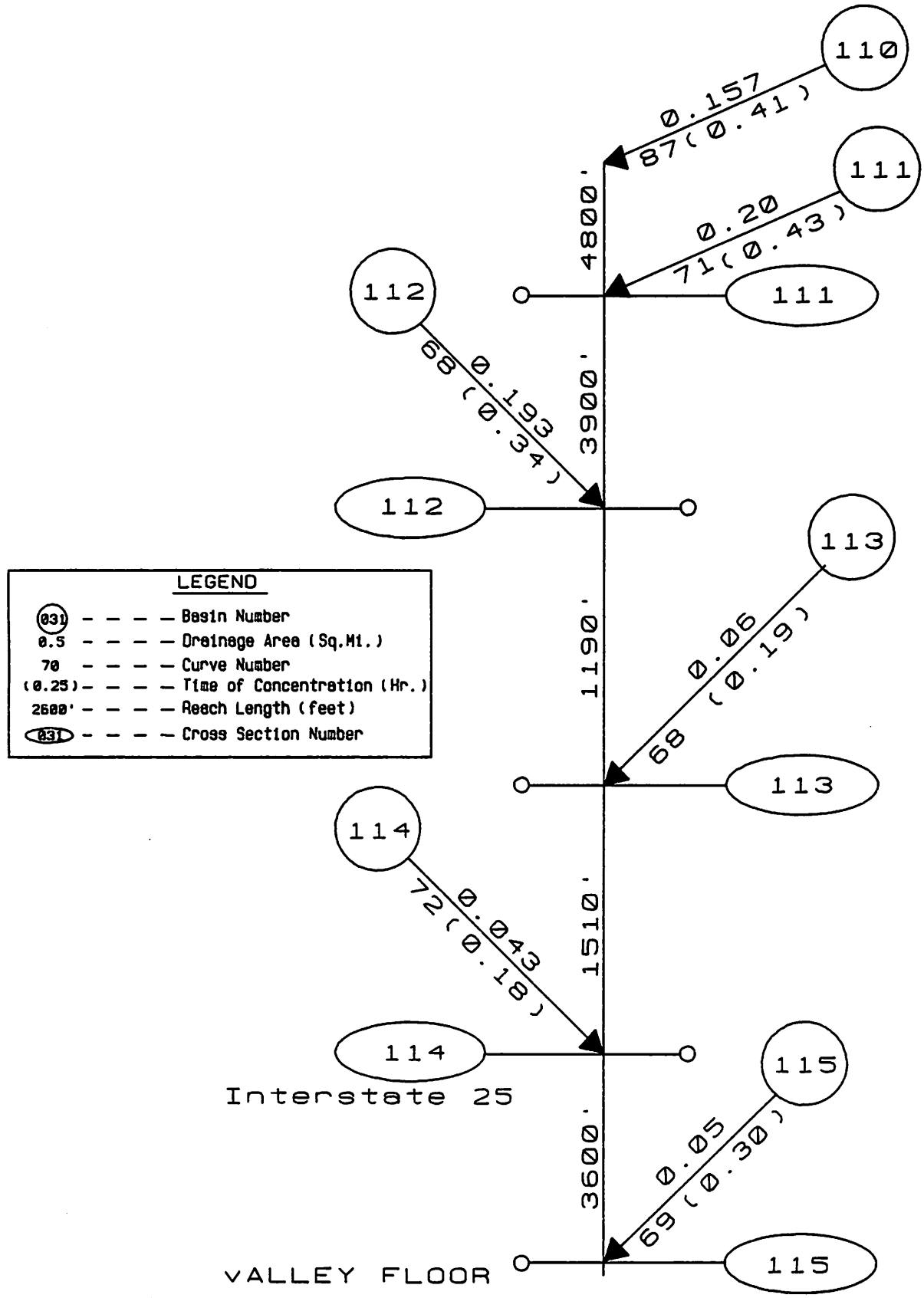


Figure B7

TR-20 Schematic
Taylor Boyd Arroyo
(Basin No. 13)
Existing Condition

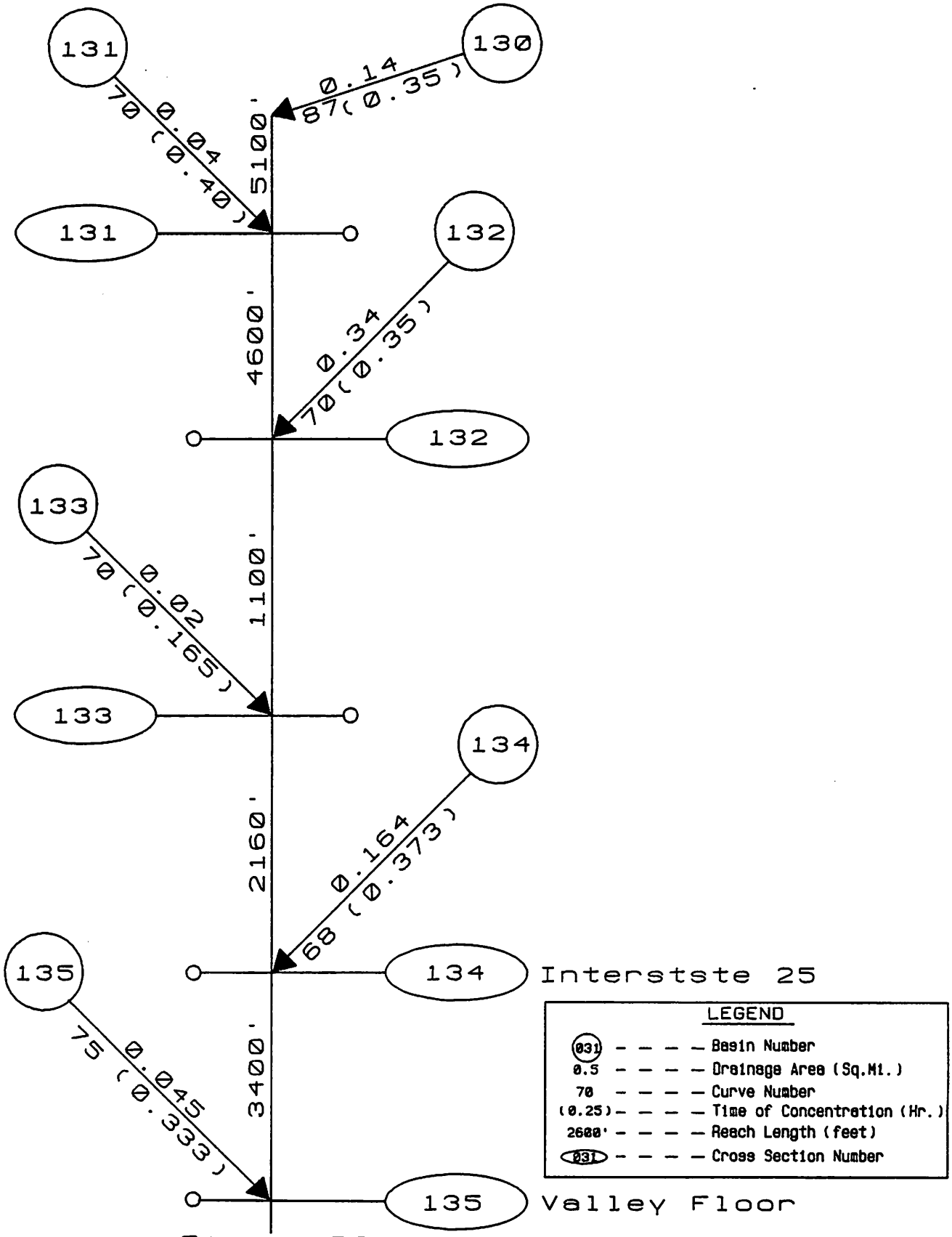


Figure B8

TABLE 11
EXISTING DRAINAGE STRUCTURE INVENTORY
At INTERSTATE 25

BASIN	LOCATION	DESCRIPTION	EXISTING CAPCITY * 100 Year (CFS)	REQUIRED CAPACITY EXISTING CONDITIONS 100 Year (CFS)	REQUIRED CAPACITY DEVELOPED CONDITIONS LOW DENSITY 100 Year (CFS)	BASIN
5	South Fork Moreno Arroyo	4 - 54" x 84' RCP 3 plugged, north culvert 10" sediment	750	455	743	5
8	North Fork Moreno Arroyo	4 - 54" x 82' RCP	750	520	671	8
11	Split Fork Arroyo	1 - 10' x 4' x 63' RCB 12" sediment	400	395	441	11
13	Taylor - Boyd Arroyo	4 - 54" x 78' RCP	650	645	787	13
1	Unnamed	1 - 48" x 116' RCP	160	17	20	1
2	Unnamed	1 - 36" x 104' RCP	100	110	252	2
3	Unnamed	2 - 48" x 98' RCP	235	175	312	3
4	Unnamed	1 - 36" x 92' RCP	90	41	93	4
6	Unnamed	1 - 60' x 94' RCP 6" sediment	220	130	232	6
7	Unnamed	1 - 30' x 108' RCP	90	20	30	7
9	Unnamed	1 - 48" x 96' RCP	180	92	122	9
10	Unnamed	1 - 42 x 82' RCP	100	20	28	10
12	Unnamed	1 - 54" x 104' RCP	240	92	105	12
14	Unnamed	1 - 30" x 90' RCP	70	36	50	14
15	Unnamed	1 - 30" x 102' RCP	60	35	50	15
16	Unnamed	1 - 48" x 96' RCP	160	131	182	16
17	Unnamed	2 - 60" x 86' RCP	450	337	490	17
18	Unnamed	1 - 48" x 102' RCP	180	185	395	18
19	(SOUTH OF DONA ANA EXIT)	1 - 30" x 78' RCP	60	23	30	19

*Based on inlet control with clean culverts, headwater elevation at roadway surface.

TABLE 11 Continued

EXISTING DRAINAGE STRUCTURE INVENTORY

At Del Rey Blvd.

BASIN	LOCATION	DESCRIPTION	EXISTING CAPCITY * 100 Year (CFS)	REQUIRED CAPACITY EXISTING CONDITIONS 100 Year (CFS)	REQUIRED CAPACITY DEVELOPED CONDITIONS LOW DENSITY 100 Year (CFS)	BASIN
5	South Fork Moreno Arroyo	3 - 30" CMP	100	455	750	5
8	North Fork Moreno Arroyo	2 - 36" CMP	100	520	670	8
11	Split Fork Arroyo	2 - 36" CMP	100	520	675	11
13	Taylor - Boyd Arroyo	3 - 48" CMP	280	650	790	13

At Elks Road

BASIN	LOCATION	DESCRIPTION	EXISTING CAPCITY * 100 Year (CFS)	REQUIRED CAPACITY EXISTING CONDITIONS 100 Year (CFS)	REQUIRED CAPACITY DEVELOPED CONDITIONS LOW DENSITY 100 Year (CFS)	BASIN
8	North Fork Moreno Arroyo	2 - 36" CMP	100	520	671	8
13	Taylor - Boyd Arroyo	2 - 36" CMP	100	650	787	13

*Based on inlet control with clean culverts, headwater elevation at roadway surface.

TABLE 12
NORTHEAST LAS CRUCES FLOODPLAIN STUDY
(EAST of INTERSTATE 25)

BASIN	CULVERT @ INTERSTATE-25	AREA IN (Sq.Mi.)	LONGEST WATER COURSE (miles)	DIFFERENCE IN ELEVATION (feet)	TIME OF CONCENTRATION	LAG TIME	SLOPE (Ft./Ft.)	CURVE NUMBERS FUTURE CONDITIONS		
								EXISTING CONDITIONS	LOW DENSITY	HIGH DENSITY
1	48 inch dia. CMP	0.0092	0.26	35.0	0.1393	0.08	0.025495	75	78	78
2	36 inch dia. CMP	0.1015	0.7384	121.8	0.2877	0.17	0.031241	70	84	87
3	2-48inch dia. CMP	0.2163	1.2538	214.7	0.4264	0.26	0.032432	69	78	83
4	36 inch dia. CMP	0.0367	0.428	74.5	0.1852	0.11	0.032967	68	81	84
5-0	SOUTH FORK MORENO ARROYO 4-54 inch dia. CMP	0.024	0.253	36.0	0.1335		0.026949	82	83	84
5-1		0.277	0.88	134.0	0.3396	0.20	0.002884	75	79	84
5-2		0.295	1.14	214.0	0.3825	0.23	0.035553	68	75	81
5-3		0.088	0.79	175.0	0.2706	0.16	0.041954	68	75	82
5-4		0.025	0.402	64.3	0.1823	0.11	0.030294	68	81	84
6	60 inch dia. CMP	0.1357	0.8485	155.7	0.3074	0.18	0.034754	69	78	84
7	30 inch dia. CMP	0.0158	0.2367	56.8	0.1037	0.06	0.045448	68	74	82
8-0	NORTH FORK MORENO ARROYO 4-54 inch dia. CMP	0.15	0.71	44.0	0.4070		0.011737	88	89	89
8-1		0.26	1.169	136.0	0.4688		0.022034	73	75	78
8-2		0.26	1.16	218.0	0.3875		0.035593	68	75	80
8-3		0.16	0.71	172.0	0.2408	0.14	0.045881	68	75	83
8-4		0.055	0.47	66.0	0.2162			68	75	81
9	48 inch dia. CMP	0.1016	0.9223	152.6	0.3411	0.20	0.031336	69	73	80
10	42 inch dia. CMP	0.0154	0.2803	44.6	0.1384	0.08	0.030135	69	74	81
11-0	SPLIT FORK ARROYO 4ft.X10ft. box RC	0.157	0.73	46.0	0.4131		0.011934	87	87	88
11-1		0.200	1.09	136.0	0.4324		0.023631	71	73	76
11-2		0.193	0.96	171.3	0.3417		0.033795	68	73	80
11-3		0.06	0.38	48.0	0.1912	0.11	0.023923	68	73	82
11-4		0.043	0.37	54.0	0.1772		0.027641	72	73	75
12	54 inch dia. CMP	0.0673	0.5909	132.9	0.2151	0.13	0.042597	72	74	80
13-0	TAYLOR-BOYD ARROYO 4-54 inch dia. CMP	0.14	0.64	48.0	0.3491		0.014205	87	87	88
13-1		0.40	0.99	126.0	0.3985		0.024105	71	73	76
13-2		0.34	1.01	190.0	0.3481		0.035629	70	73	78
13-3		0.02	0.31	38.0	0.1653	0.10	0.023216	70	73	77
13-4		0.164	1.04	176.0	0.3709		0.032051	69	73	81
14	30 inch dia. CMP	0.0301	0.411	72.4	0.1787	0.11	0.033363	69	74	81
15	30 inch dia. CMP	0.0266	0.3939	69.2	0.1731	0.10	0.033273	70	75	82
16	48 inch dia. CMP	0.1478	1.2973	215.1	0.4432	0.27	0.031403	70	75	81
17	2-60 inch dia. CMP	0.2362	1.2424	258.4	0.3928	0.24	0.039391	72	78	82
18	48 inch dia. CMP	0.1453	0.7027	126.4	0.2679	0.16	0.034068	72	85	88
19	30 inch dia. CMP	0.0091	0.2595	46.2	0.1249	0.07	0.033719	80	84	89

TABLE 12 CONTINUED
NORTHEAST LAS CRUCES FLOODPLAIN MANAGEMENT STUDY
(West of Interstate 25 to the Dona Ana Drain)

BASIN	AREA IN (Sq.Mi.)	LONGEST WATER COURSE (miles)	DIFFERENCE IN ELEVATION (feet)	TIME OF CONCENTRATION (Hr.)	SLOPE (Ft./Ft.)	CURVE NUMBERS FUTURE CONDITIONS		
						EXISTING DEVELOPMENT	LOW DENSITY	HIGH DENSITY
1 & 2	0.2734	1.307	165.0	0.4951	0.023910	73	77	84
3 & 4	0.1568	1.0644	134.0	0.4231	0.023843	73	76	81
5-5	0.0143	0.9583	130.0	0.3792	0.025693	70	75	83
6 & 7	0.0553	0.498	68.0	0.2285	0.025861	69	74	82
8 & 9	0.0950	0.729	117.0	0.2879	0.030397	78	80	85
101	0.1412	0.741	111.0	0.2994	0.028371	73	76	81
10-1	0.0567	0.742	112.0	0.2988	0.028588	69	74	82
102	0.0492	0.587	89.0	0.2491	0.028716	79	83	89
11-5	0.0491	0.735	105.0	0.3030	0.027056	69	74	82
12-1	0.0992	0.705	102.0	0.2920	0.027402	72	76	81
13-5	0.0449	0.795	104.0	0.3330	0.024776	75	79	81
14-1	0.0858	0.706	100.0	0.2948	0.026826	73	77	81
15-1	0.0774	0.710	100.0	0.2967	0.026675	75	78	82
16-1	0.0537	0.691	98.0	0.2898	0.026861	80	82	85
17-1	0.1205	0.657	94.0	0.2778	0.027097	82	83	86
18-1	0.0668	0.663	92.0	0.2831	0.026281	83	85	87
19-1	0.0612	0.674	88.0	0.2935	0.024728	82	87	87
103	0.0450	0.462	62.0	0.2171	0.025417	88	90	90

TABLE 13
NORTHEAST LAS CRUCES FLOODPLAIN MANAGEMENT STUDY
(East and West sides of El Camino Real)
VALLEY FLOOR

Basin	Area In (Sq Mi.)	Highest Elevation (feet)	Lowest Elevation (feet)	Time of Concentration (hr.)	Existing Curve Number
R1	0.055	3910	3908	0.2	75
R2	0.050	3912	3910	0.2	70
R3	0.086	3914	3912	0.1	70
R4	0.280	3915	3912	0.1	70
R5	0.055	3918	3916	0.1	70
R6	0.018	3922	3920	0.1	70
R7	0.119	3918	3914	0.2	79
R8	0.291	3911	3908	0.2	76
R9	0.063	3909	3905	0.2	75

TABLE 14
Summary of Discharges
SCS Curve Number Method
Existing Conditions

	10 YEAR EVENT				100 YEAR EVENT				
BASIN	BASIN PEAK cfs	BASIN VOLUME ac-ft	ACCUMULATIVE PEAK cfs	ACCUMULATIV VOLUME ac-ft	BASIN PEAK cfs	BASIN VOLUME ac-ft	ACCUMULATIVE PEAK cfs	ACCUMULATIV VOLUME ac-ft	BASIN
5-0	24.0	0.9			65.0	2.1			5-0
5-1	113.0	6.4	116.0	7.2	374.0	18.2	395.0	20.2	5-1
5-2	48.0	3.6	113.0	10.8	233.0	13.3	426.0	33.5	5-2
5-3	17.0	1.1	117.0	11.9	84.0	4.0	455.0	37.5	5-3
5-4	6.0	0.3	115.0	12.2	28.0	1.1	455.0	38.6	5-4
5-5		1.7	102.0	13.9	103.0	5.7	435.0	44.3	5-5
8-0	164.0	8.4			360.0	17.4			8-0
8-1	63.0	4.6	164.0	13.0	238.0	14.6	468.0	32.1	8-1
8-2	41.0	3.2	157.0	16.2	201.0	11.7	497.0	43.7	8-2
8-3	32.0	2.0	159.0	18.1	161.0	7.2	522.0	50.9	8-3
8-4	12.0	0.7	153.0	18.8	57.0	2.5	520.0	53.4	8-4
9	20.2	1.4			59.0	4.9			9
6 & 7	13.4	0.8	33.0	2.8	62.0	2.7	154.0	9.9	6 & 7
8-5	9.0	0.5	155.0	23.4	46.0	1.8	587.0	69.9	8-5
8-6	38.0	1.6	156.0	25.0	114.0	4.2	593.0	74.1	8-6
11-0	159.0	8.2			356.0	17.5			11-0
11-1	45.0	3.3	140.0	11.5	181.0	10.6	395.0	281.0	11-1
11-2	33.0	2.4	129.0	13.8	162.0	8.7	395.0	36.8	11-2
11-3	13.0	0.7	128.0	14.6	66.0	2.7	396.0	39.5	11-3
11-4	16.0	0.8	127.0	15.3	63.0	2.4	394.0	41.9	11-4
11-5	11.0	0.7	117.0	16.0	49.0	2.4	370.0	44.3	11-5
13-0	157.0	7.3			356.0	15.6			13-0
13-1	82.0	5.9	152.0	13.3	350.0	20.1	525.0	35.8	13-1
13-2	76.0	5.1	130.0	18.3	324.0	17.1	602.0	52.9	13-2
13-3	6.0	0.3	127.0	18.6	26.0	1.0	603.0	53.9	13-3
13-4	27.0	2.0	130.0	20.6	132.0	7.4	643.0	61.3	13-4
13-5	19.0	1.0	127.0	21.6	62.0	3.0	624.0	64.2	13-5

TABLE 14 Continued
Summary of Discharges
SCS Curve Number Method
Existing Conditions

Basin	10 YEAR EVENT				100 YEAR EVENT				
	Basin Peak cfs	Basin Volume ac-ft	Accumulative Peak cfs	Accumulative Volume ac-ft	Basin Peak cfs	Basin Volume ac-ft	Accumulative Peak cfs	Accumulative Volume cfs	Basin
1	5	0.2			17	0.6			1
2	26	1.4			110	4.8			2
1 & 2	73	4.9	94	6.5	264	15.3	354	20.7	1 & 2
3	39	2.7			175	9.6			3
4	8	0.4			41	1.6			4
3 & 4	47	2.8	90	5.9	170	8.8	368	20	3 & 4
6	28	1.8			130	6.5			6
7	4	0.2			20	0.7			7
6 & 7	13	0.8	32	2.8	62	2.7	154	9.9	6 & 7
9	20	1.4			92	4.9			9
101	51	2.5			185	7.9			101
10	4	0.2			20	0.7			10
10-1	11	0.6	14	0.8	53	2.4	69	3.1	10-1
102	35	1.4			100	3.7			102
12	24	1.1			92	3.6			12
12-1	36	2.9	60	4.3	132	5.6	223	9.1	12-1
14	8	0.4			36	1.3			14
14-1	31	1.6	38	1.9	114	4.8	147	6.2	14-1
15	8	0.4			35	1.3			15
15-1	34	1.6	42	2	115	4.8	146	6.1	15-1
16	31	2			131	7			16
16-1	39	1.7	67	3.7	108	4.3	230	11.3	16-1
17	87	3.9			337	12.5			17
17-1	106	4.4	191	8.3	276	10.5	605	23	17-1
18	48	2.4			185	7.7			18
18-1	64	2.6	112	5	160	6	345	13.7	18-1
19	8	0.3			23	0.7			19
19-1	52	2.2	59	2.5	136	5.3	154	6	19-1
103	69	2.4			151	5			103

TABLE 15
Summary of Discharges
SCS Curve Number Method
Developed Conditions

	100 YEAR EVENT - LOW DENSITY DEVELOPMENT				100 YEAR EVENT - HIGH DENSITY DEVELOPMENT				
BASIN	BASIN PEAK cfs	BASIN VOLUME ac-ft	ACCUMULATIVE PEAK cfs	ACCUMULATIVE VOLUME ac-ft	BASIN PEAK cfs	BASIN VOLUME ac-ft	ACCUMULATIVE PEAK cfs	ACCUMULATIVE VOLUME ac-ft	BASIN
5-0	72.0	2.3			76.0	2.4			5-0
5-1	473.0	22.0	496.0	24.2	620.0	27.3	655.0	29.7	5-1
5-2	373.0	19.4	677.0	43.6	530.0	25.6	960.0	55.3	5-2
5-3	135.0	5.8	741.0	49.3	202.0	8.0	1061.0	63.3	5-3
5-4	63.0	2.2	743.0	51.5	74.0	2.5	1064.0	65.7	5-4
5-5	283.0	13.2	759.0	64.7	283.0	13.2	1053.0	78.9	5-5
8-0	373.0	18.1			373.0	18.1			8-0
8-1	288.0	17.1	525.0	35.1	343.0	19.7	574.0	37.8	8-1
8-2	322.0	17.0	611.0	52.2	430.0	21.6	730.0	59.3	8-2
8-3	259.0	10.5	664.0	62.6	407.0	15.1	848.0	74.4	8-3
8-4	92.0	3.6	671.0	66.2	130.0	4.8	870.0	79.2	8-4
9	121.0	6.0	699.0	72.3	184.0	8.5	948.0	87.6	9
6,7	87.0	3.5	269.0	14.8	138.0	5.1	407.0	19.9	6,7
8-5	100.0	3.3	728.0	90.4	156.0	4.8	1304.0	112.4	8-5
8-6	128.0	4.6	910.0	94.9	201.0	6.6	1332.0	119.8	8-6
11-0	356.0	17.5			376.0	18.3			11-0
11-1	207.0	11.8	416.0	29.3	249.0	18.2	465.0	32.0	11-1
11-2	230.0	11.4	437.0	40.7	348.0	16.0	541.0	48.0	11-2
11-3	93.0	3.6	441.0	44.3	157.0	5.4	558.0	53.4	11-3
11-4	67.0	2.5	441.0	46.8	76.0	2.8	557.0	56.2	11-4
11-5	68.0	3.1	419.0	50.0	108.0	4.5	527.0	60.8	11-5
13-0	356.0	15.6			370.0	16.2			13-0
13-1	428.0	23.7	596.0	39.3	515.0	27.5	687.0	43.7	13-1
13-2	397.0	20.1	721.0	59.4	538.0	25.7	905.0	69.4	13-2
13-3	32.0	1.2	722.0	60.6	41.0	1.4	906.0	70.9	13-3
13-4	187.0	9.7	787.0	70.3	300.0	14.2	1029.0	85.1	13-4
13-5	78.0	3.6	761.0	73.9	87.0	3.9	990.0	89.0	13-5

TABLE 15 Continued

Summary of Discharges

SCS Curve Number Method

Developed Conditions

	100 YEAR EVENT - LOW DENSITY				100 YEAR EVENT - HIGH DESITY				
Basin	Basin Peak cfs	Basin Volume ac-ft	Accumulative Peak cfs	Accumulative Volume ac-ft	Basin Peak cfs	Basin Volume ac-ft	Accumulative Peak cfs	Accumulative Volume ac-ft	Basin
1	20.0	0.6			20.0	0.6			1
2	252.0	9.6			291.0	10.9			2
1 & 2	337.0	18.7	549.0	28.9	491.0	25.7	727.0	37.1	1 & 2
3	312.0	15.5			408.0	19.5			3
4	93.0	3.1			108.0	3.5			4
3 & 4	205.0	10.2	587.0	28.8	271.0	13.0	738.0	35.9	3 & 4
6	232.0	10.3			320.0	13.4			6
7	30.0	1.0			47.0	1.5			7
6 & 7	87.0	3.5	270.0	14.8	138.0	5.1	407.0	19.9	6 & 7
9	122.0	6.0			184.0	8.5			9
101	223.0	9.2			296.0	11.7			101
10	28.0	0.9			43.0	1.3			10
10-1	80.0	3.4	103.0	4.3	126.0	4.9	162.0	6.3	10-1
102	123.0	4.4			165.0	5.6			102
12	105.0	4.0			150.0	5.3			12
12-1	160.0	6.5	262.0	10.5	212.0	8.3	358.0	13.6	12-1
14	50.0	1.8			76.0	2.5			14
14-1	146.0	5.9	192.0	7.7	182.0	7.1	253.0	9.6	14-1
15	49.0	1.7			73.0	2.3			15
15-1	137.0	5.5	181.0	7.2	171.0	6.7	237.0	9.0	15-1
16	182.0	9.2			256.0	12.2			16
16-1	121.0	4.7	291.0	13.8	140.0	5.3	383.0	17.5	16-1
17	489.0	17.0			610.0	20.4			17
17-1	289.0	10.9	768.0	27.9	335.0	12.4	933.0	32.8	17-1
18	393.0	14.3			453.0	16.1			18
18-1	177.0	6.6	570.0	20.8	194.0	7.1	647.0	23.2	18-1
19	29.0	0.8			36.0	1.0			19
19-1	174.0	6.5	174.0	7.3	174.0	6.5	201.0	7.5	19-1
103	165.0	5.4			165.0	5.4			103

APPENDIX C

CLIMATIC DATA

TAPS Station : HATCH 2 W, 3855
Start yr. - 1961 End yr. - 1990

Month	Temperature						Precipitation				
	avg daily max	avg daily min	avg	2 yrs in 10 will have max temp. >than	2 yrs in 10 will have min temp. <than	avg no of grow deg days*	avg (in.)	2 yrs in 10 will have less than (in.)	2 yrs in 10 will have more than (in.)	avg no of days w/ 0.10 inch or more	avg snow-fall
January	58.6	23.1	40.9	75	5	93	0.54	0.19	0.99	1	1.3
February	63.7	26.9	45.3	80	12	174	0.36	0.13	0.72	1	0.5
March	70.0	33.2	51.6	85	16	361	0.23	0.09	0.44	0	0.3
April	78.3	40.2	59.3	91	25	579	0.18	0.07	0.48	0	0.2
May	86.4	47.8	67.1	98	33	831	0.29	0.08	0.73	0	0.0
June	94.9	56.3	75.6	106	40	1068	0.64	0.27	1.47	1	0.0
July	95.0	63.0	79.0	105	55	1202	1.90	0.95	2.73	4	0.0
August	92.5	60.8	76.6	103	51	1117	2.20	1.18	3.10	4	0.0
September	87.3	54.0	70.7	98	40	919	1.66	0.62	2.53	3	0.0
October	78.9	40.9	59.9	91	26	614	1.01	0.26	1.81	2	0.0
November	68.0	30.5	49.2	82	15	286	0.58	0.14	1.13	1	0.6
December	59.3	24.1	41.7	74	9	100	0.78	0.36	1.42	2	1.1
Yearly :											
Average	77.7	41.7	59.7	---	---	---	---	---	---	---	---
Extreme	111	-17	---	106	3	---	---	---	---	---	---
Total	---	---	---	---	---	7343	10.38	7.79	12.41	19	4.1

*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)

Spring: Missing data years	24 deg = 1,	28 deg = 1,	32 deg = 1
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0
Fall: Missing data years	24 deg = 1,	28 deg = 1,	32 deg = 1
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0

FROST Station : HATCH 2 W, 3855
Start yr. - 1961 End yr. - 1990

	Temperature		
Probability	24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 15	April 27	May 8
2 year in 10 later than--	April 6	April 19	May 1
5 year in 10 later than--	March 20	April 4	April 18
First freezing temperature in fall:			
1 yr in 10 earlier than--	October 30	October 22	October 9
2 yr in 10 earlier than--	November 3	October 27	October 14
5 yr in 10 earlier than--	November 12	November 4	October 23

3855 had missing years of data from 1961 to 1990 ==>

Missing data years	24 deg = 2,	28 deg = 2,	32 deg = 2
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0

GROWTH Station : HATCH 2 W, 3855
Start yr. - 1961 End yr. - 1990

	Daily Minimum Temperature		
Probability	# days > 24F	# days > 28F	# days > 32F
9 years in 10	203	180	157
8 years in 10	214	191	167
5 years in 10	236	213	185
2 years in 10	258	234	204
1 year in 10	269	245	213

TAPS Station : JORNADA EXP RANGE, 4426
Start yr. - 1961 End yr. - 1990

Month	Temperature						Precipitation				
				2 yrs in 10 will have				2 yrs in 10 will have			
	avg daily max	avg daily min	avg	max temp. >than	min temp. <than	avg no of grow deg days*	avg (in.)	less than (in.)	more than (in.)	avg no of days w/ 0.10 inch or more	avg snow-fall
January	56.8	19.9	38.4	74	-3	64	0.50	0.30	0.87	1	1.0
February	61.6	23.7	42.7	78	6	123	0.37	0.16	0.65	1	0.3
March	68.5	29.3	48.9	85	9	279	0.26	0.10	0.49	0	0.1
April	77.0	36.8	56.9	91	19	498	0.20	0.06	0.48	0	0.0
May	85.3	44.7	65.0	98	26	759	0.36	0.14	0.73	0	0.0
June	94.2	54.5	74.3	106	37	981	0.70	0.23	1.39	1	0.0
July	95.5	62.0	78.7	105	44	1139	1.93	0.93	2.79	4	0.0
August	92.2	59.9	76.0	103	49	1076	2.38	1.27	3.36	5	0.0
September	86.2	53.2	69.7	97	38	858	1.56	0.69	2.41	3	0.0
October	77.8	39.9	58.9	91	22	569	0.93	0.25	1.66	2	0.0
November	66.3	27.8	47.1	80	8	221	0.60	0.13	1.13	1	0.3
December	57.0	21.0	39.0	72	1	66	0.79	0.25	1.33	2	1.3
Yearly :											
Average	76.5	39.4	58.0	---	---	---	---	---	---	---	---
Extreme	110	-19	---	107	-4	---	---	---	---	---	---
Total	---	---	---	---	---	6633	10.59	7.79	13.04	20	3.1

*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)

Spring: Missing data years	24 deg = 2,	28 deg = 1,	32 deg = 1
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0
Fall: Missing data years	24 deg = 5,	28 deg = 4,	32 deg = 3
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0

FROST Station : JORNADA EXP RANGE, 4426
Start yr. - 1961 End yr. - 1990

	Temperature		
Probability	24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 30	May 14	May 25
2 year in 10 later than--	April 23	May 7	May 18
5 year in 10 later than--	April 9	April 22	May 5
First freezing temperature in fall:			
1 yr in 10 earlier than--	October 21	October 10	October 5
2 yr in 10 earlier than--	October 26	October 15	October 10
5 yr in 10 earlier than--	November 5	October 25	October 20

4426 had missing years of data from 1961 to 1990 ==>

Missing data years	24 deg = 6,	28 deg = 5,	32 deg = 4
Years with no occurrence	24 deg = 0,	28 deg = 0,	32 deg = 0

GROWTH Station : JORNADA EXP RANGE, 4426
Start yr. - 1961 End yr. - 1990

	Daily Minimum Temperature		
Probability	# days > 24F	# days > 28F	# days > 32F
9 years in 10	173	158	135
8 years in 10	184	167	145
5 years in 10	204	185	164
2 years in 10	224	202	183
1 year in 10	235	212	193

TAPS Station : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

Month	Temperature						Precipitation				
	avg daily max	avg daily min	avg	2 yrs in 10 will have max temp. >than	2 yrs in 10 will have min temp. <than	avg no of grow deg days*	avg (in.)	2 yrs in 10 will have less than (in.)	2 yrs in 10 will have more than (in.)	avg no of days w/ 0.10 inch or more	avg snow-fall
January	57.7	27.0	42.4	74	9	127	0.45	0.23	0.77	1	1.[illegible]
February	63.0	30.5	46.8	79	15	209	0.37	0.14	0.72	1	0.[illegible]
March	69.7	36.1	52.9	85	19	403	0.22	0.08	0.42	0	0.[illegible]
April	77.7	43.0	60.3	91	28	611	0.21	0.06	0.54	0	0.[illegible]
May	85.7	51.1	68.4	98	36	880	0.29	0.09	0.55	0	0.[illegible]
June	94.1	60.4	77.2	104	46	1117	0.72	0.15	1.36	1	0.[illegible]
July	94.6	66.7	80.6	104	59	1259	1.36	0.56	2.04	3	0.[illegible]
August	91.6	64.3	77.9	101	56	1176	2.29	1.07	3.35	4	0.[illegible]
September	86.3	57.7	72.0	96	44	960	1.36	0.61	2.00	3	0.[illegible]
October	78.1	45.0	61.5	91	29	667	0.91	0.23	1.57	2	0.[illegible]
November	66.8	34.0	50.4	81	17	320	0.53	0.11	0.96	1	1.[illegible]
December	58.0	27.8	42.9	73	12	131	0.68	0.20	1.20	2	1.[illegible]
Yearly :											
Average	76.9	45.3	61.1	---	---	---	---	---	---	---	---
Extreme	107	-10	---	105	6	---	---	---	---	---	---
Total	---	---	---	---	---	7858	9.40	6.78	11.83	18	5.[illegible]

*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 : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

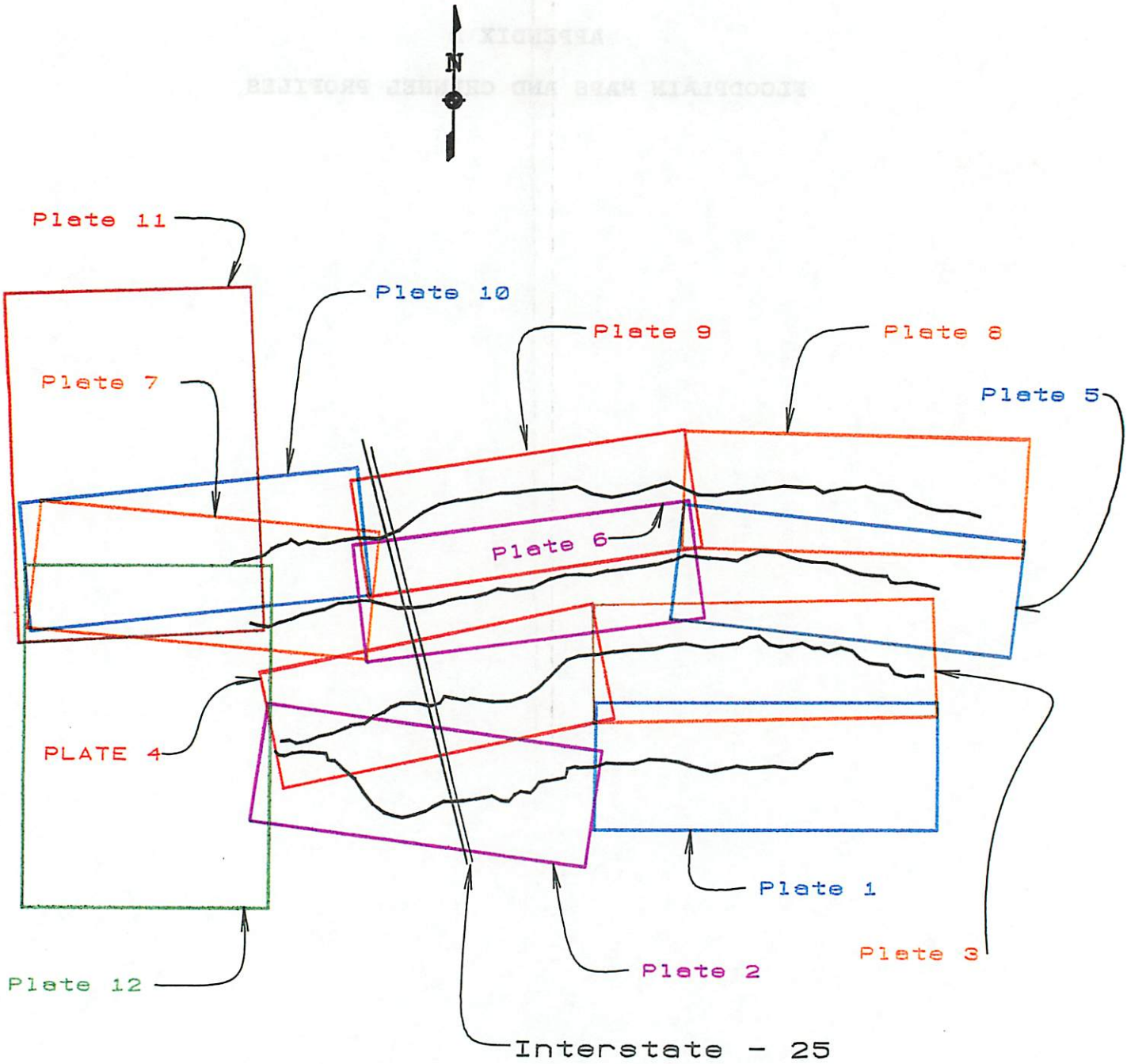
Probability	Temperature		
	24F or lower	28F or lower	32F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 23	April 14	April 25
2 year in 10 later than--	March 15	April 7	April 19
5 year in 10 later than--	March 1	March 23	April 8
First freezing temperature in fall:			
1 yr in 10 earlier than--	November 11	October 31	October 18
2 yr in 10 earlier than--	November 16	November 4	October 23
5 yr in 10 earlier than--	November 27	November 13	November 2

GROWTH Station : STATE UNIVERSITY, 8535
Start yr. - 1961 End yr. - 1990

Probability	Daily Minimum Temperature		
	# days > 24F	# days > 28F	# days > 32F
9 years in 10	244	202	181
8 years in 10	253	213	190
5 years in 10	270	234	207
2 years in 10	286	255	224
1 year in 10	295	266	233

APPENDIX D

FLOODPLAIN MAPS AND CHANNEL PROFILES


N
Plate 11
Plate 10
Plate 9
Plate 8
Plate 7
Plate 5
Plate 6
PLATE 4
Plate 1
Plate 3
Plate 2
Plate 12
Interstate - 25

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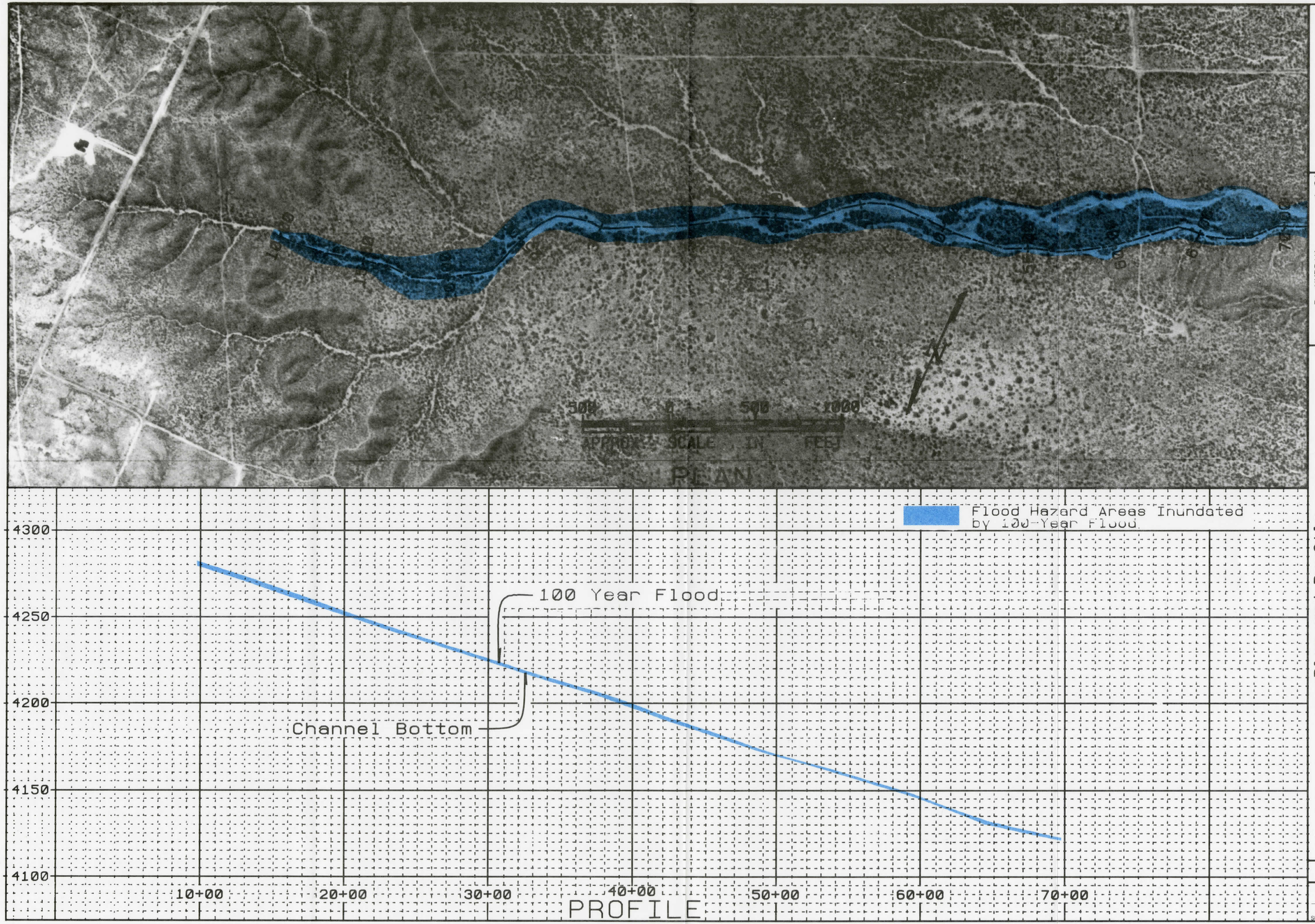

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Plan and Profile
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Northeast Las Cruces
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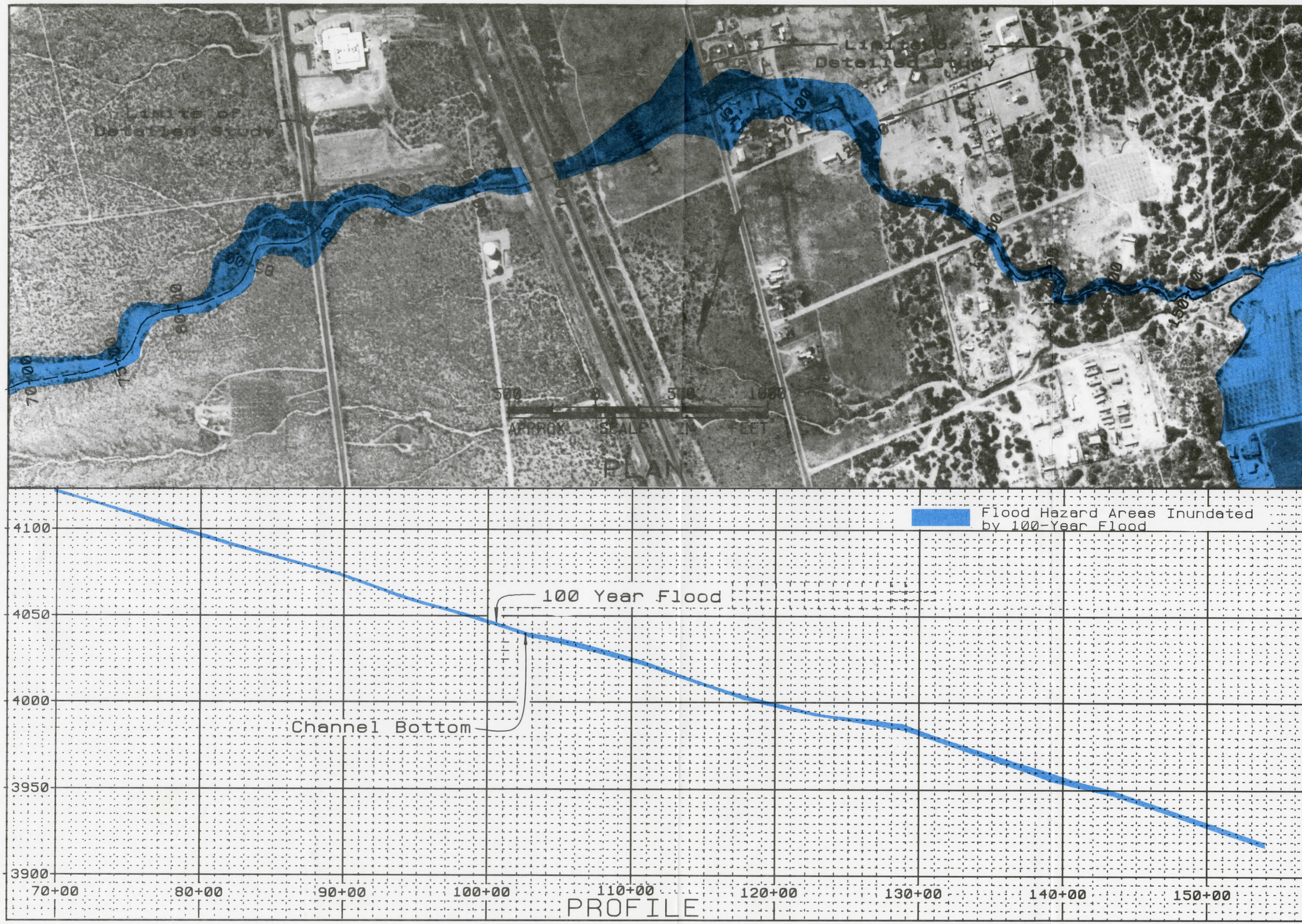

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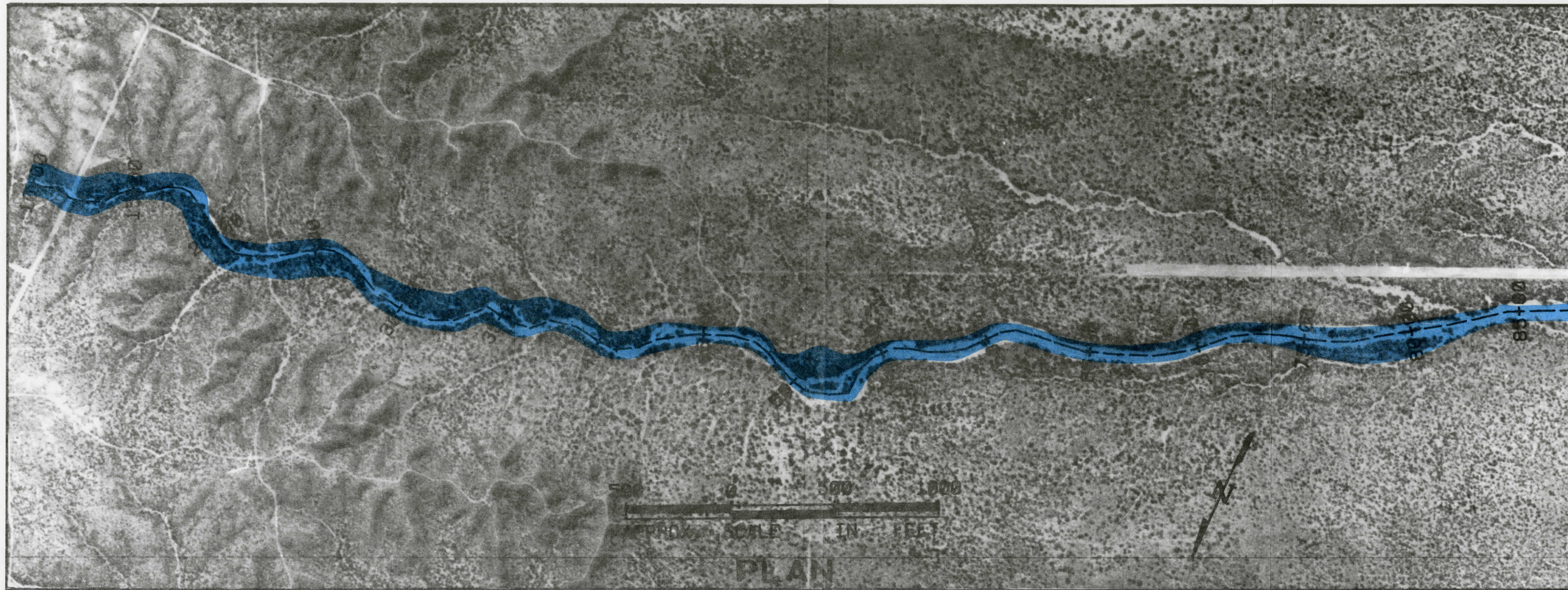

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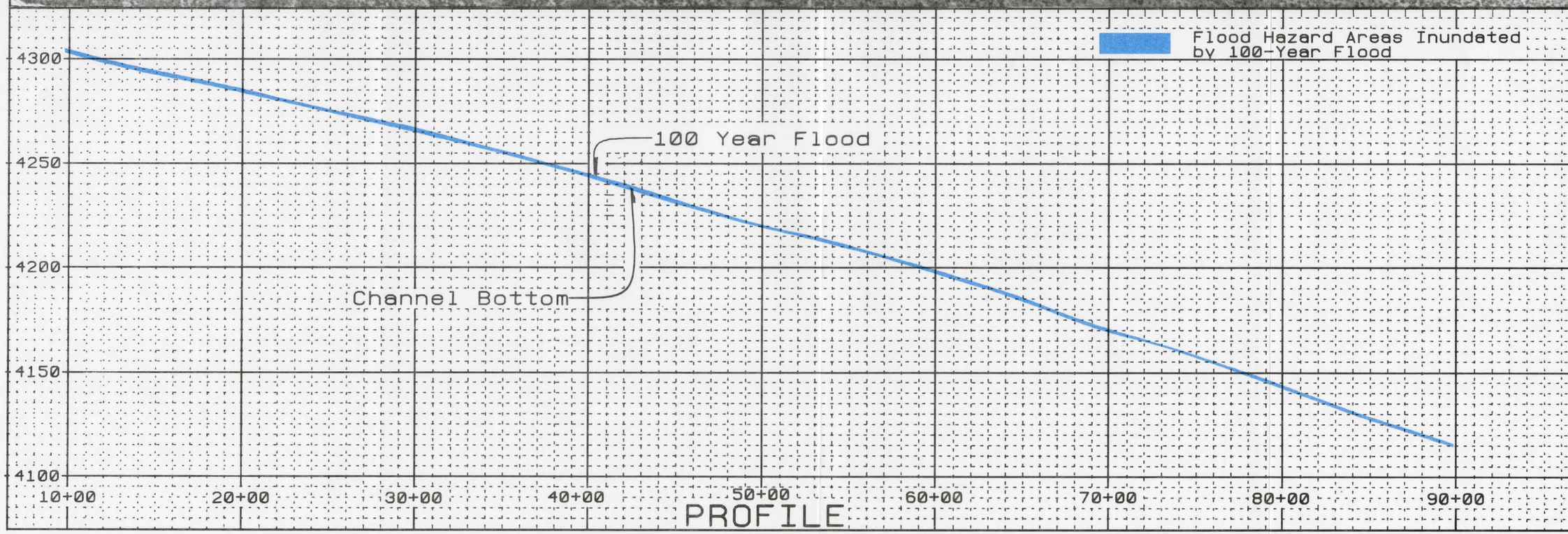

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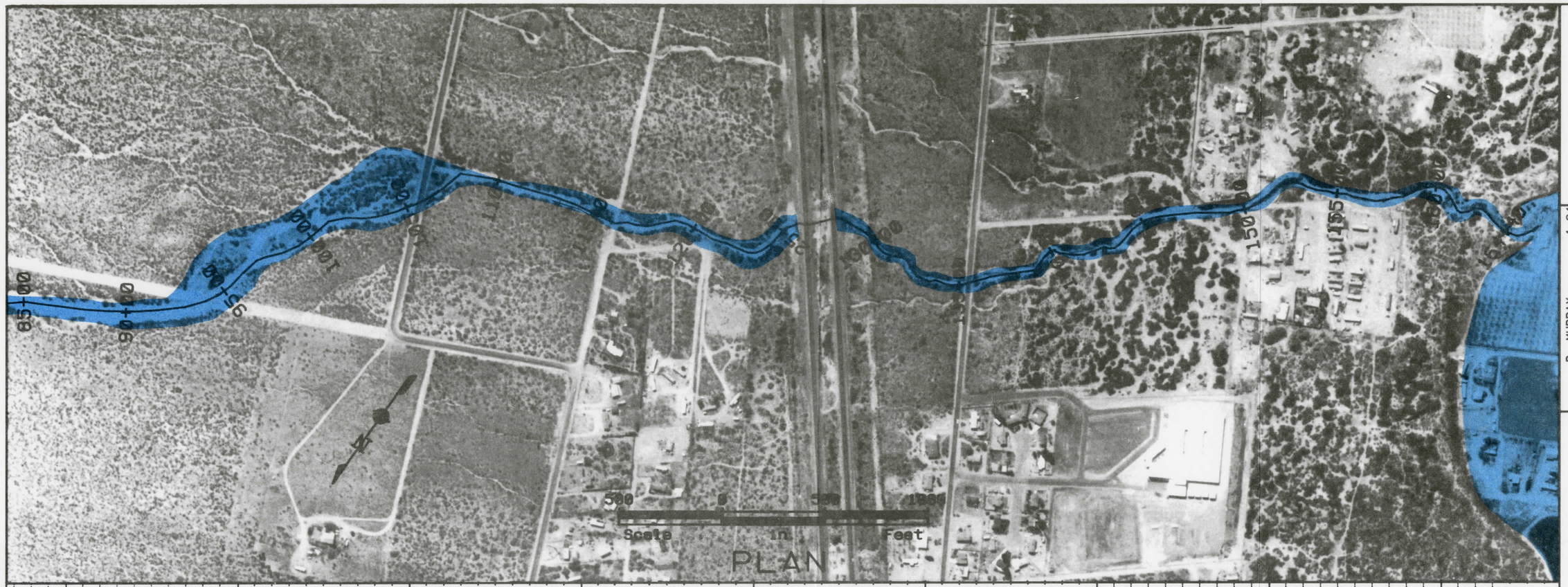

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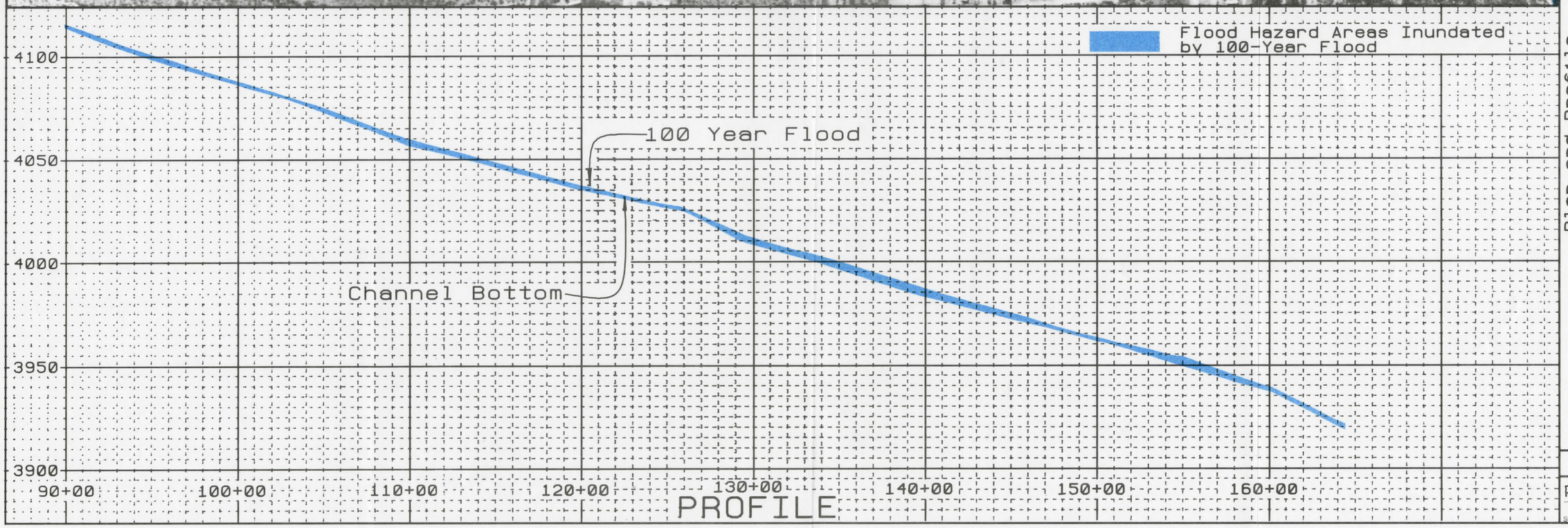

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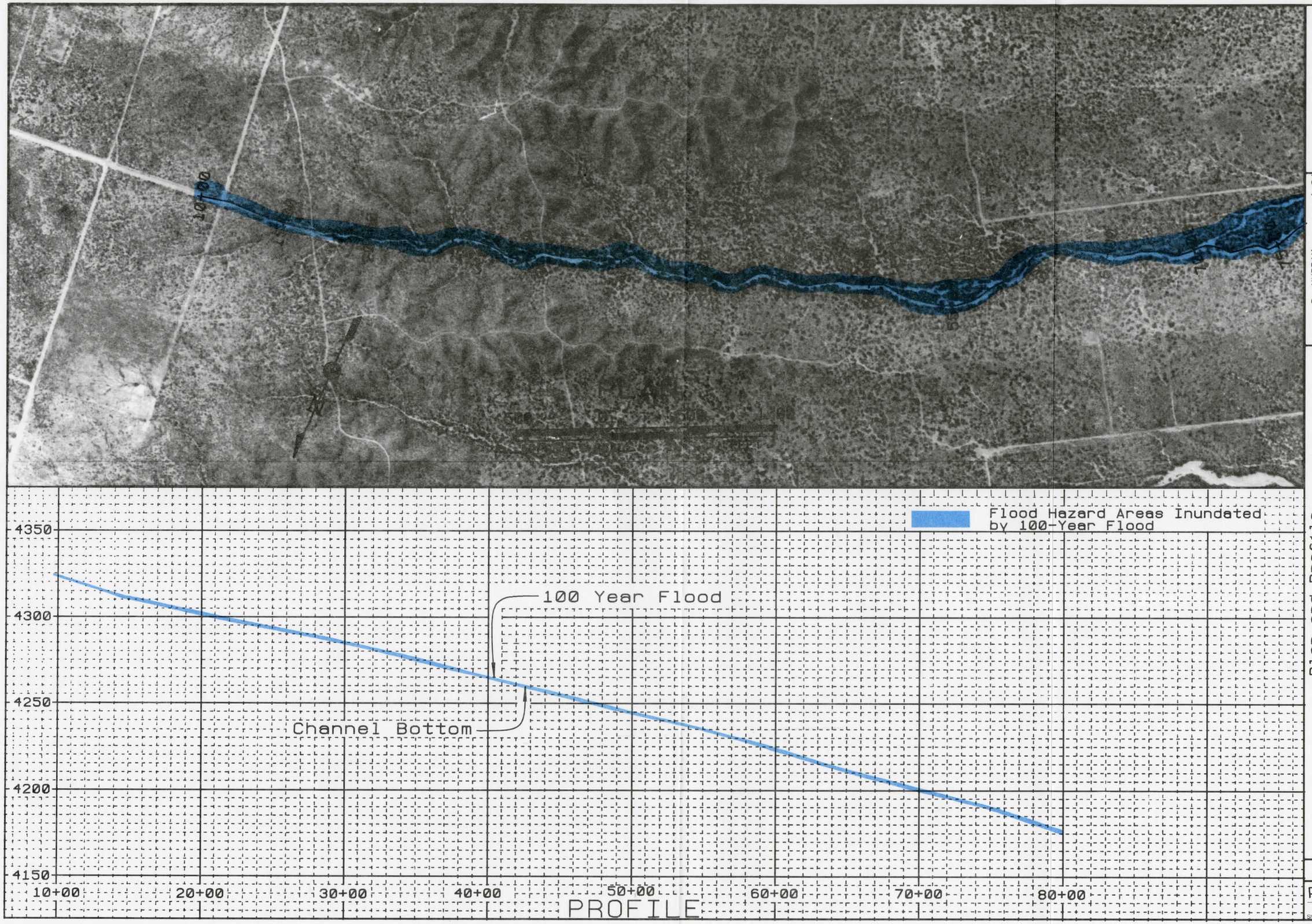

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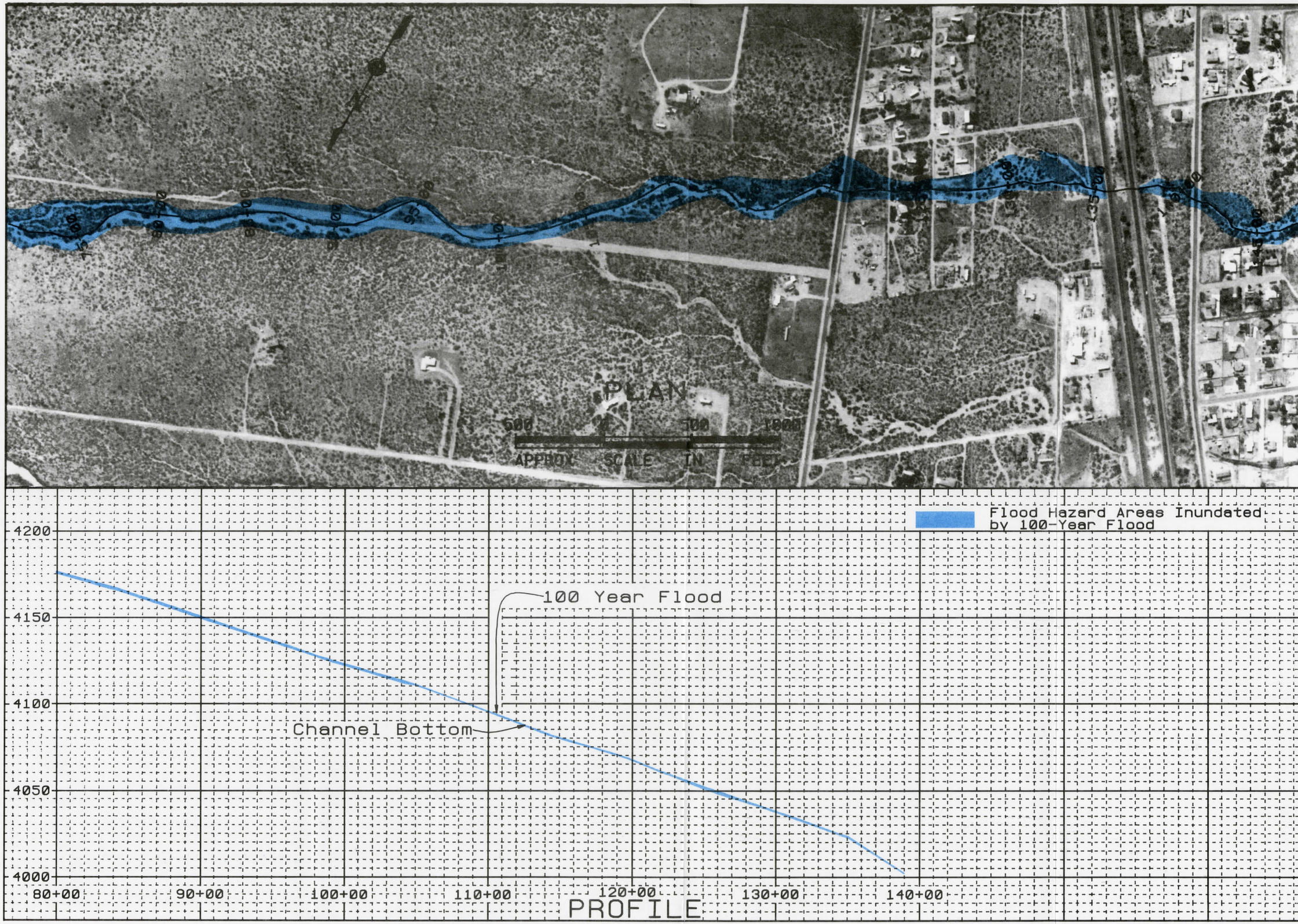

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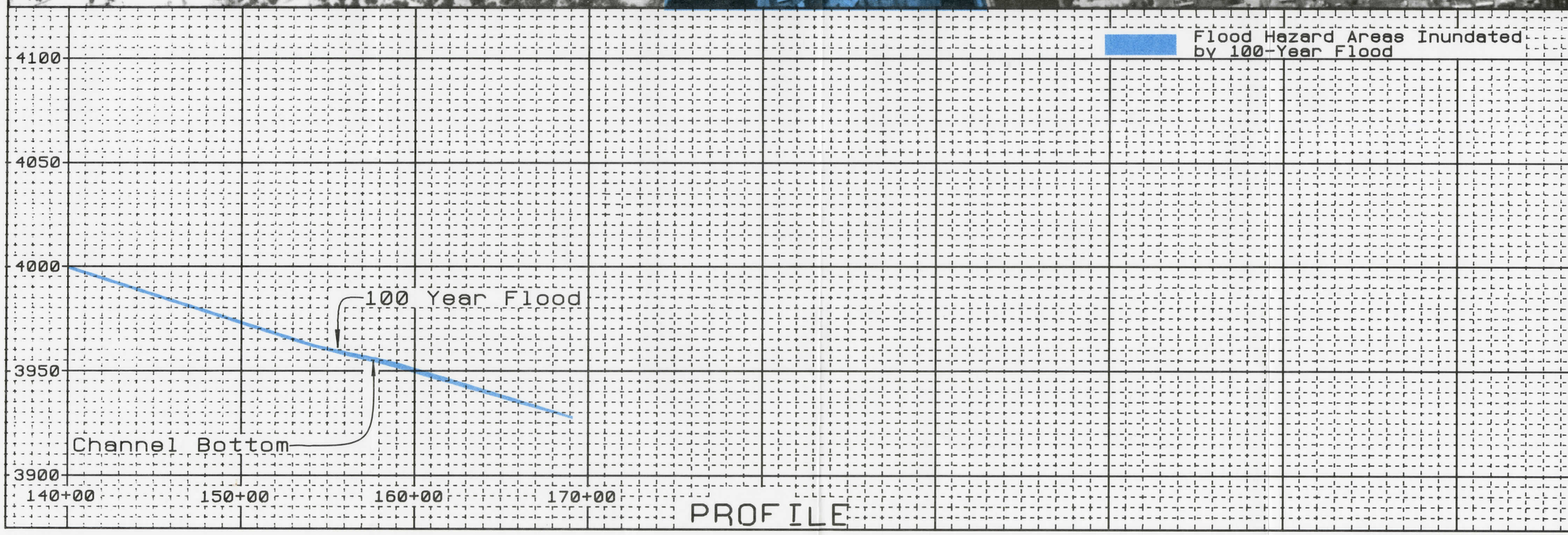

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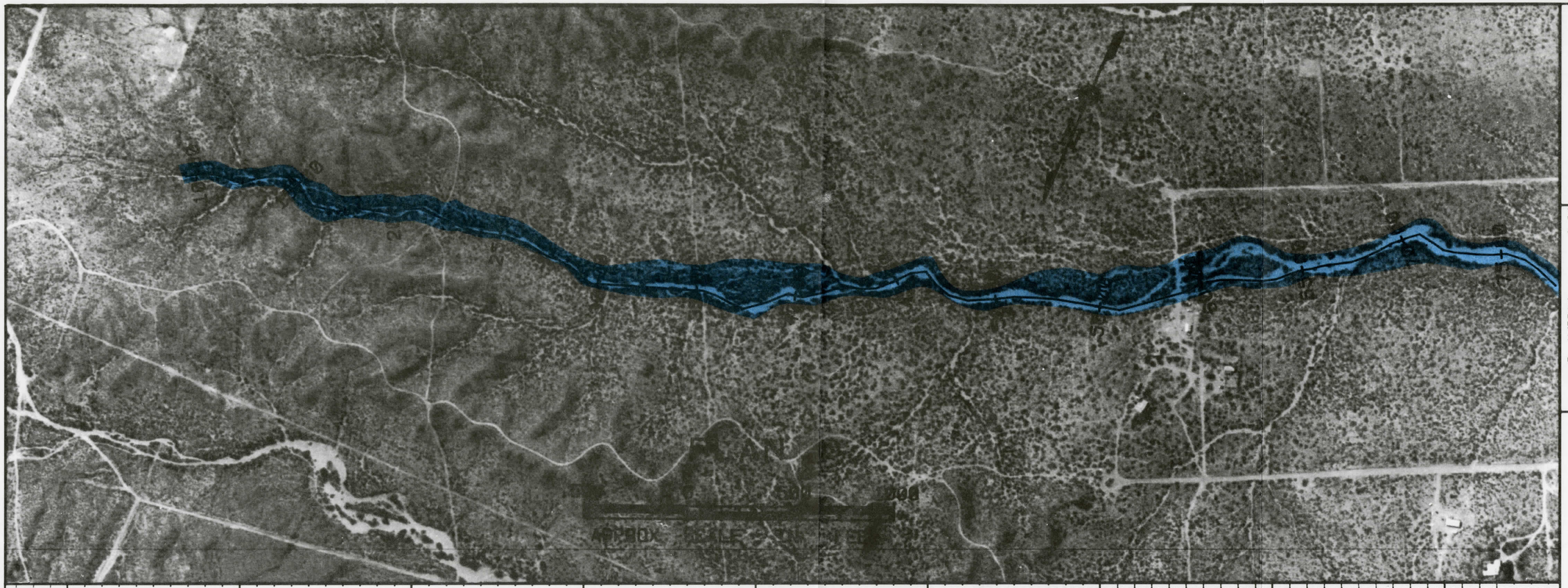

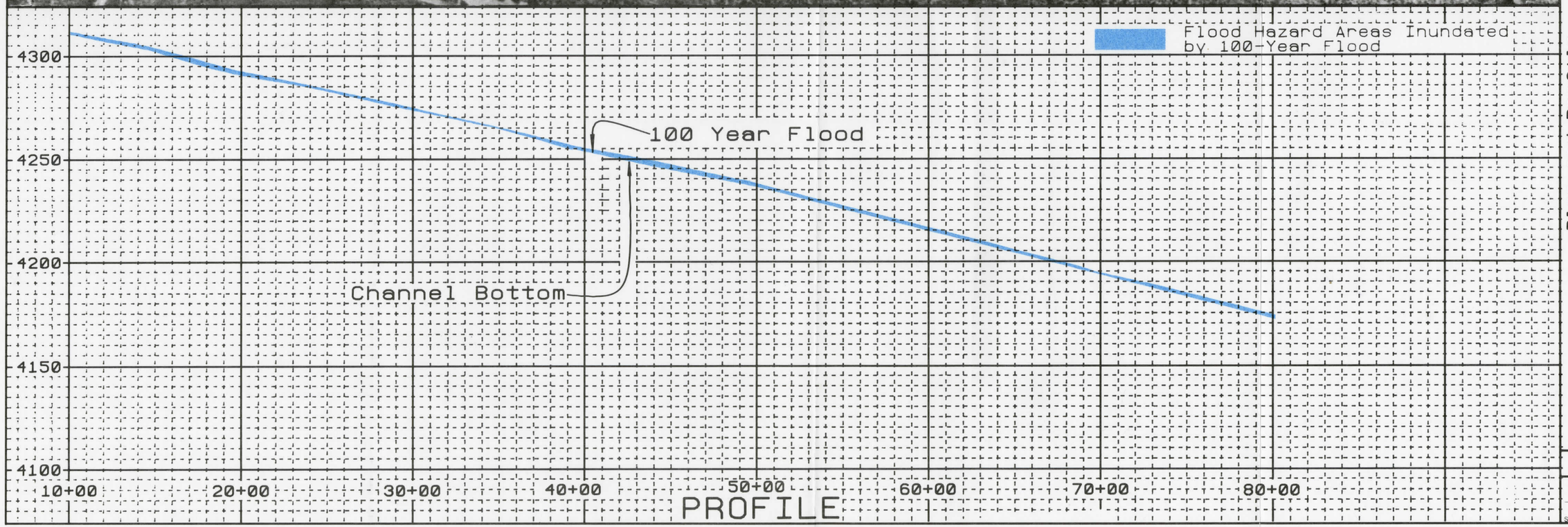

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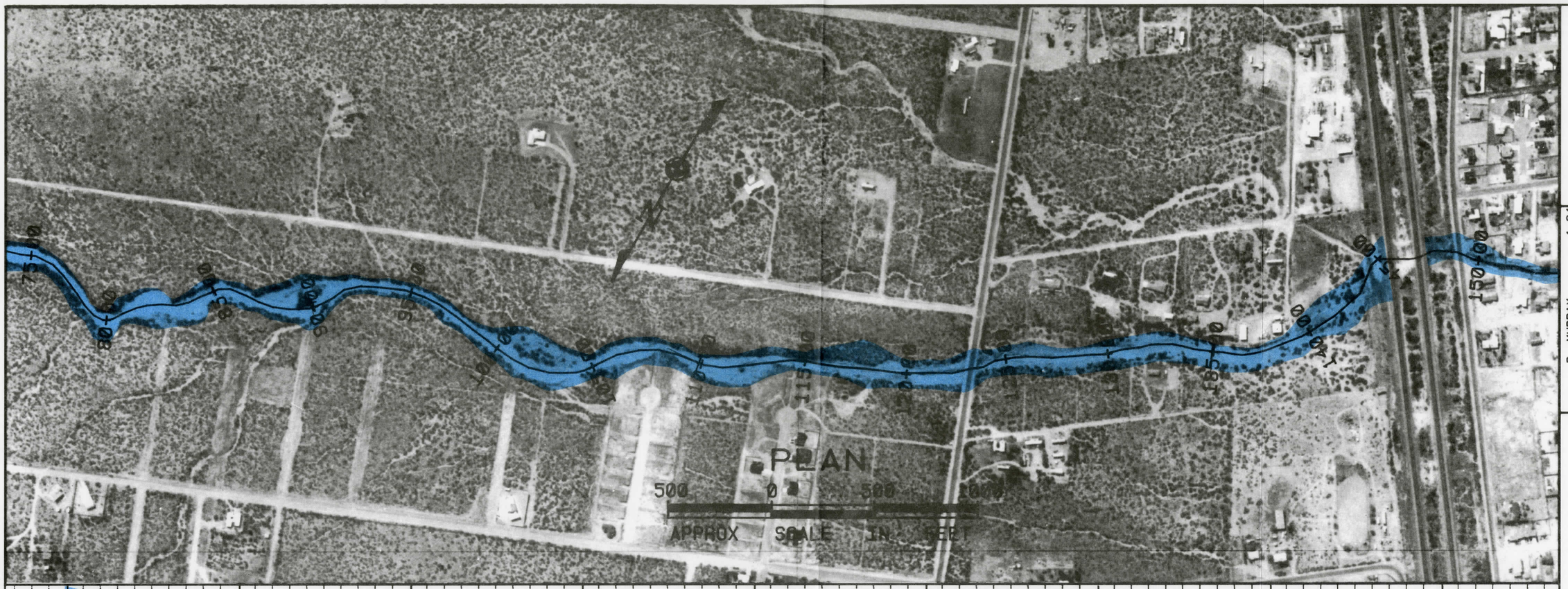

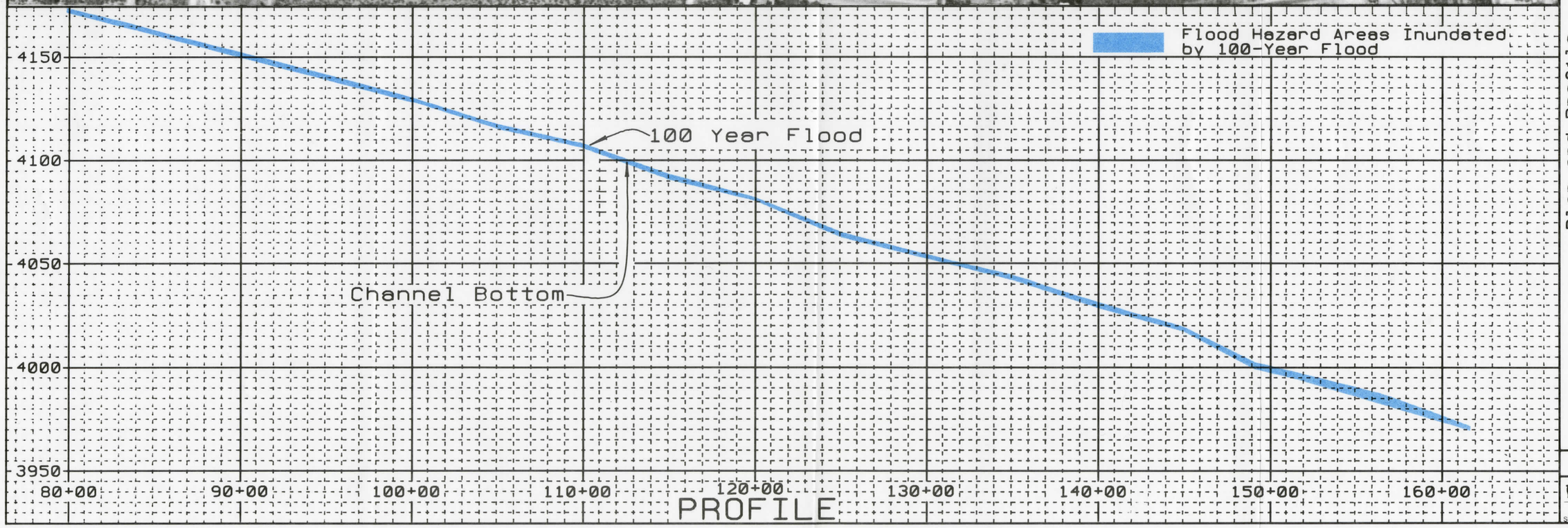

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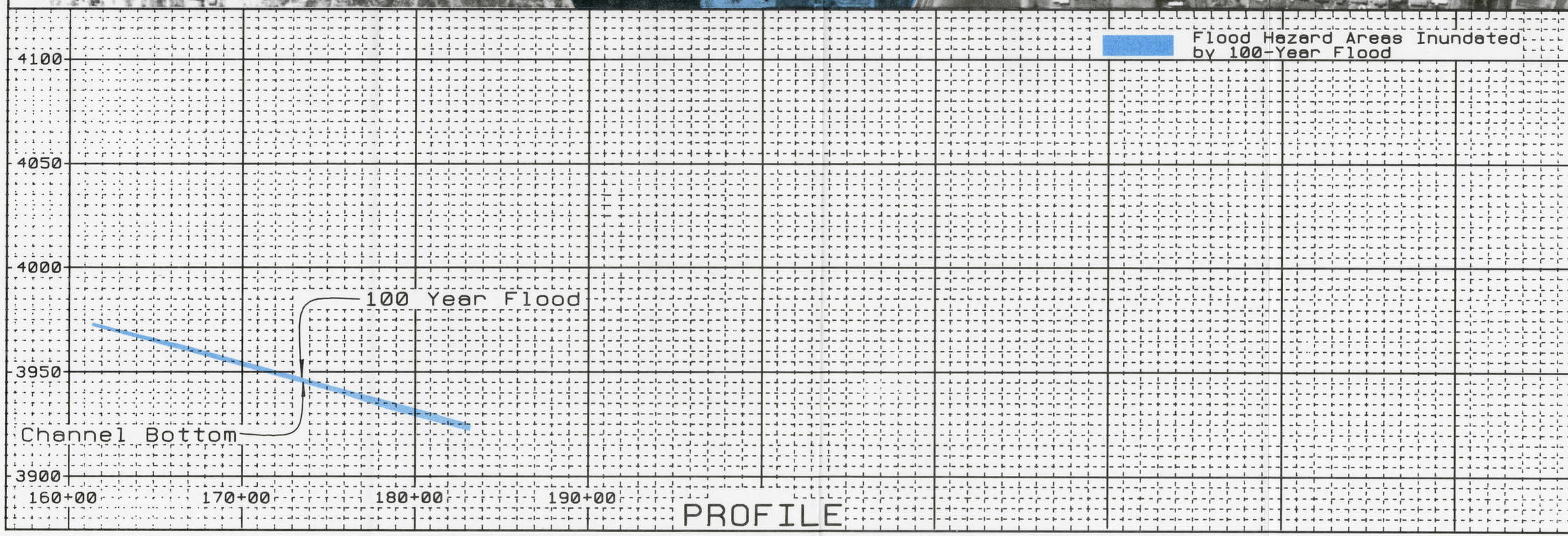

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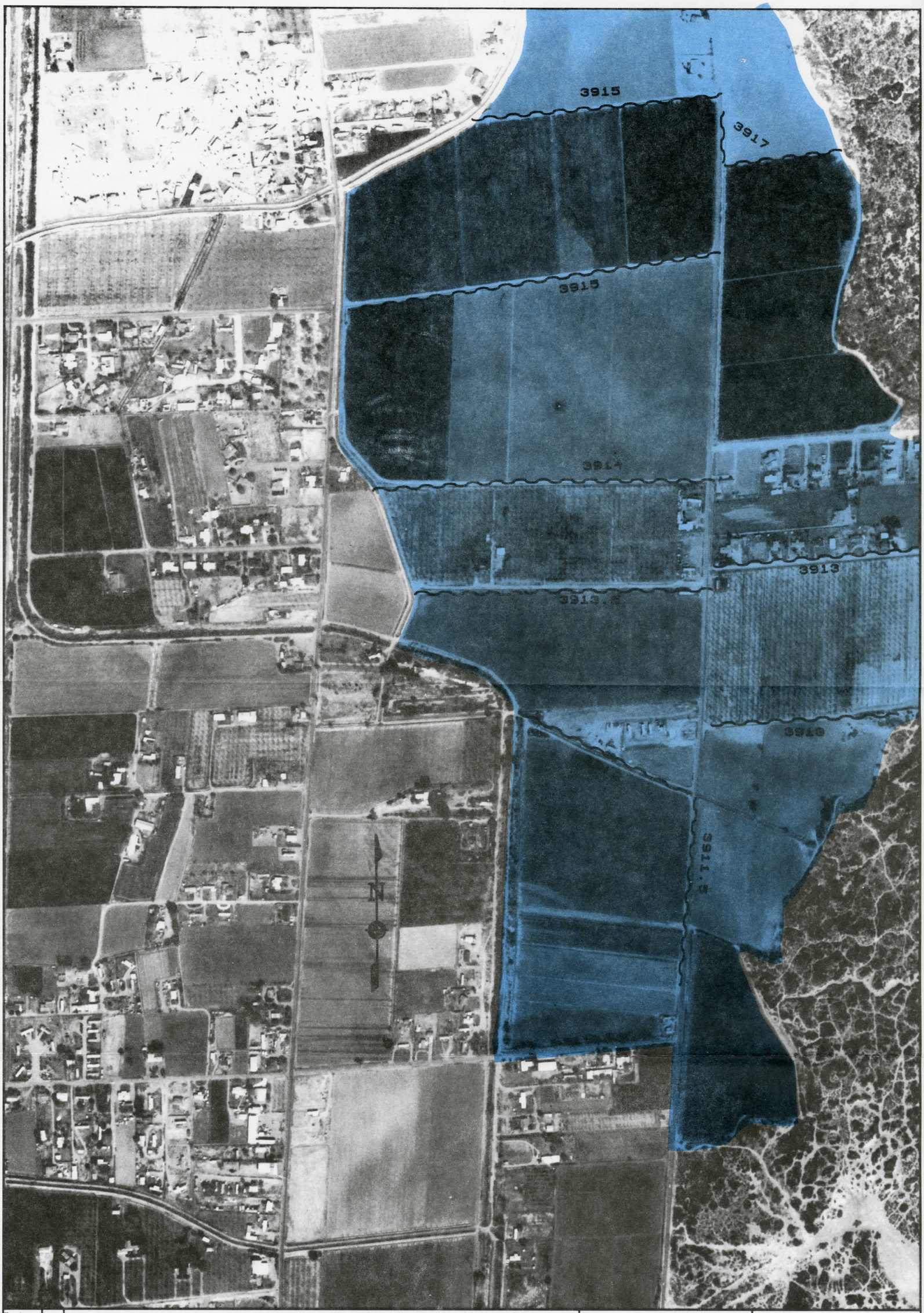

Plan View
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