Hydrology for Special Study of

Luke Air Force Base, Arizona

Contract No. DACW09-77-C-0013

Work Order No. 5

January 1979

Prepared for:

Los Angeles District, Corps of Engineers

Los Angeles, California

Prepared by:

PRC TOUPS Corporation

4131 North 24th Street

Phoenix, Arizona 85016

Draft Report

Special Flood Hazard Study

Luke Air Force Base, Glendale, Arizona

1982

Performed by:

Los Angeles District, U.S. Army Corps of Engineers

Darrel Elwood

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I. INTRODUCTION

a. Purpose and Scope

The purpose of this hydrology study for Luke Air Force Base is to generate flood peak discharges and flood hydrographs at specific locations along the base perimeter. This hydrologic data will then allow a hydraulic investigation of alternative plans. The objectives of this report are (1) to present the basic meteorologic and hydrologic characteristics of the study area, (2) to outline the methods and techniques used to model the runoff process and (3) to present discharge-frequency values for existing conditions. Throughout this report the phrase "natural conditions" refers to the study area before any development, while the term "existing conditions" refers to the year 1978. A summary of results titled Peak Discharges for Existing Conditions is presented in table 1.

b. References

1) Department of the Air Force, "Master Plan - Storm Drain System", Luke Air Force Base, Glendale, Arizona, August, 1974.

2) Los Angeles District, Corps of Engineers, "Design Memorandum No. 1, Hydrology and Hydraulic Design for Trilby Wash Detention Basin and Outlet Channel".

3) Los Angeles District, Corps of Engineers, "Design Memorandum No. 1, General Design Memorandum - Phase 1, Plan Formulation for Indian Bend Wash", dated October, 1973.

4) Los Angeles District, Corps of Engineers, "Flood Hydrology Report, Phoenix Urban Study", dated February, 1977.

5) Los Angeles District, Corps of Engineers, "Greater Arizona Standard Project Summer Thunderstorm, Instructions for Computation of Rainfall", dated August 17, 1972.

6) Los Angeles District, Corps of Engineers, Memorandum for: The Hydrologic Engineering Section Files, dated April 12, 1978, subject: The Field Reconnaissance of the Trilby Wash Detention Basin and the Luke Air Force Base following the Flood of February-March, 1978.

7) Los Angeles District, Corps of Engineers, "Improved Procedures for Determining Drainage Area Lag Values".

8) Los Angeles District, Corps of Engineers, "Indian Bend Wash, Design Memorandum No. 1, General Design Memorandum, Phase II, Project Design for Indian Bend Wash", dated May, 1975.

References (continued)

9) Los Angeles District, Corps of Engineers, Computer Program, "Los Angeles District Flood Hydrograph Package", (LADFHP) source deck and instructions.

10) Los Angeles District, Corps of Engineers, "Luke Air Force Base, Phoenix, Arizona: Flood Control - North Channel, Plan and Profile, Hydraulic Design", March, 1956.

11) Los Angeles District, Corps of Engineers, "New River and Phoenix City Streams, Arizona, Design Memorandum No. 2, Hydrology Part I", dated October, 1974.

12) Los Angeles District, Corps of Engineers, "Summary Report for Flood Control, Gila Floodway, Maricopa and Pinal Counties, Arizona", dated September, 1977.

13) Los Angeles District, Corps of Engineers, various memorandums, photographs and reports describing flood history prior to completion of McMicken Dam.

14) U.S. Soil Conservation Service, "General Soil Map, Maricopa County, Arizona", dated 1973.

II. GENERAL DESCRIPTION OF DRAINAGE AREA

a. Physiography and Topography

The drainage area affecting Luke Air Force Base (Luke AFB) is located in north central Maricopa County, Arizona (see plate 1). The watershed ultimately drains to both the Agua Fria River and the Gila River Basin. Luke AFB's watershed is 46 square miles in size and is located on an alluvial fan with gradients typically being 30 feet per mile. Topography is best represented by gently sloping desert lands, transformed into vital farmlands by irrigations, with very poorly defined flow paths and no perennial stream flows, all reflecting the conditions of the alluvial plain. The McMicken Dam is the only flood control structure affecting Luke AFB's drainage area. Beardsley Canal is an irrigation canal that parallels the southeast (downstream) side of McMicken Dam. Since the canal was not designed or intended to be a flood control structure, most of the land between the canal and the dam has been included in the drainage area. This land consists of an area of less than 2 square miles or approximately 4% of the drainage area affecting Luke AFB (see plate 1). The White Tank Mountains are located northwest of Luke AFB, an investigation was completed to determine if runoff from the mountains was capable of influencing flooding events at Luke AFB. Attention is called to this particular watershed because the width of the watershed decreases significantly as it approaches the vicinity of Olive Avenue and Beardsley Canal. It was concluded that this watershed does not influence flooding events at Luke AFB.

b. Development in the Watershed

Most of the land within the study area is presently devoted to agricultural purposes with some lands along the northwest portion of the drainage area still in their natural state. There are inhabited farmhouses found throughout the study area. Future land use projections prepared by the Maricopa County Planning and Zoning Department indicate the major land use will remain agricultural at least until the year 1990.

c. Structures Affecting Runoff

1. Flood Control Structures

i. McMicken Dam

McMicken Dam was constructed by the Army Corps of Engineers in 1957 and is presently under the jurisdiction of the Maricopa County Flood Control District. The dam is an earth, sand and gravel-fill structure designed to control the standard project storm. The drainage area regulated by McMicken Dam consists of 247 square miles. Reservoir capacity at spillway crest was approximately 19,300 acre feet when constructed. No recent surveys have been made to determine its present storage capacity. For the purposes of this report, the dam is assumed to provide protection for the standard project flood, despite the fact that two notches were excavated in the embankment in 1976. A 700 foot notch 0.7 miles north of Bell Road and 110 foot notch at the outlet structure approximately 3 miles north of Bell Road, were excavated because of structural deficiencies in the embankment. Remedial work bringing the dam up to design requirements is expected to occur within the next few years.

ii. North Channel

The North Channel provides limited flood protection to Luke AFB by intercepting flood flows and conveying them away from the base. The channel originates at the northwest edge of the base and ultimately conveys flows for a distance of approximately 4 miles, discharging it's contents into the Agua Fria River. At the northwest edge of the base the channel is unlined and trapezoidal in shape until it nears the Atchison, Topeka and Sante Fe Railroads tracks where it becomes concrete lined. Hydraulic capacities were taken from plan and profile sheets (Ref. 1) until the channel crosses Litchfield Road, then the hydraulic capacities were determined by field investigations to be approximately 1000 cfs. Northern Avenue, which parallels the North Channel along the base's northern border, has a dip section which allows flows from an earth channel to cross and enter the channel. The earth channel starts east of Reams Road and parallels Northern Avenue. The earth channel was estimated to convey 300 cfs by normal depth calculations.

ii. North Channel (continued)

There exists the possibility of high backwater from two existing road crossings that connect Northern Avenue to the farmlands. A backwater analysis was not undertaken, therefore, any possible effects of the two structures have been neglected.

iii. West Channel

The West Channel also provides limited flood protection to Luke AFB by intercepting flood flows and conveying them away from the base. The channel begins as a low swale running north-south just west of the northern limit of the base and then continues southwesterly parallel to the runways. The channel is grass lined and varies in configuration and conveying ability. Field data was collected and analyzed to determine hydraulic parameters. (plate no. 2)

2. Beardsley Canal

Beardsley Canal is an irrigation canal constructed in 1927 that is approximately 33 miles in length, originating from Lake Pleasant and terminating near Indian School Road. The canal is under the jurisdiction of the Maricopa County Water District, Number One. Since the canal was not designed or intended to be a flood control structure and is elevated generally 1 to 3 feet above natural ground, most of the land between the canal and the dam has been included in Luke AFB's drainage area. This land consists of an area of less than 2 square miles or approximately 4% of the drainage area affecting Luke AFB. The canal parallels McMicken Dam on the downstream (southeast) side of the dam. The canal has two siphons in the study area, one located 0.5 miles north of Peoria Avenue and another at Union Hills Road. These structures allow drainage upstream of the canal to cross. Land situated between the dam and canal at southwest corner of the study area (south of subarea 11) was considered to drain south along the canal passing under Olive Avenue via 2 - CMP's (one 8 foot diameter and one 7.5 diameter) thus leaving the drainage area that affects Luke AFB.

3. Farmlands - Irrigation Canals and Tailwater Ponds

Since the drainage area is predominately farm lands there exists a vast network of small irrigation canals. These canals are fed from the Beardsley Irrigation Canal system, they are trapezoidal in shape and generally have approximately 15 square feet of cross sectional area. These small canals parallel most of the roads in the study area and branch out in even smaller canals to service the farmlands. It was concluded that these irrigation canals have little impact on drainage patterns when dealing with major flood flows. Also

3. Farmlands - Irrigation Canals and Tailwater Ponds (continued)

associated with the farmlands is the use of tailwater ponds. These ponds collect and store local runoff and are usually found to be at near capacity. Therefore, in the event of a major storm, no reduction in flood flows is expected from these ponds.

4. Citrus Groves

Citrus groves are considered non-contributing to runoff because of the dikes built around the groves to facilitate irrigation by flooding. These dikes usually are 6 inches or more in height. For the study area there exists a total of 2.35 square miles of citrus groves, the citrus groves are located in small segments throughout the study area (see table 2). When modeling existing runoff conditions the area associated with citrus groves was subtracted from the subareas' drainage area.

5. Railroads

There are three branches of the Atchison, Topeka and Sante Fe Railroad that run through the study area (see plate no. 1); branch 1 runs north-south and parallels Cotton Lane, branch 2 runs east-west paralleling Olive Avenue and joins branch 1 at Olive and Cotton, branch 3 runs north-south and east-west intersecting branch 2 at 0.5 miles west of Litchfield Road. For branch 1 the railroad bed is 1 to 3 feet higher than natural ground or the bed is at natural ground. Where the railroad is above natural ground floodwaters could be diverted or ponded, but field investigations revealed evidence of the railroad bed washing out and releasing ponded waters. Branch 1 does not divert floodwater in or out of the drainage area and is abandoned north of Cactus Road. Because of the bed returning to natural ground at a number of locations and evidence of bank failures, branch 1 was considered to have little affect on the overall drainage pattern. Branch 2 was found to be at grade with the natural ground and determined not capable of influencing drainage patterns. For branch 3, the east-west portion of the railroad was found to be at grade with natural ground and have no effect on runoff patterns. For the north-south portion of the railroad the bed is mostly elevated 2-3 feet above ground and does divert flows southward, therefore forming the eastern boundary of subarea 81.

6. Streets

There are no major highways located within the watershed.

6. Streets (continued)

The street system located within the study area reflects a square mile grid pattern. There are streets within the grid but they are mostly dirt roads to the farmlands. Most streets appear to be at natural grade and due to their inherent hydraulic characteristics are capable of influencing runoff patterns. There are two north-south streets, Cotton Lane and Reams Road, that do influence runoff patterns. South of Olive Avenue, Cotton Lane is below natural grade and has a definite slope to the south, thus tending to intercept sheetflow conditions. It was estimated from normal depth calculations that 1000 cfs could be diverted out of the study area, by Cotton Lane. Cotton Lane is not an inverted-crown road. Reams Road is an inverted-crown road and is capable of intercepting and routing flows to the south.

d. Vegetation

In the study area the native vegetation has been mostly replaced by farm corps which include alfalfa, barley, cotton, sugar beets, small feed grains, lettuce and citrus and deciduous fruits. Where natural vegetation still exists it is sparse and is best represented by cacti and desert shrubs. Native trees such as Juniper, Palo Verde, Mesquite, Ironwood and Shrub Oak are found throughout the study area. The vegetation tends to be thicker along side and adjacent to irrigation canals. Annual grasses occur after winter rains.

e. Soils

Soils in the study area belong to the Antho-Valencia Association and are classified as Group B in the hydrologic soil group classification. The Antho-Valencia Association consists of deep sandy loam soils on nearly level to gently sloping alluvial fans and valley plains. Slopes are less than one percent on the valley plain, but range to as much as five (5) percent. Some areas are as close as 1/2 mile, but most are at least one mile downslope from the mountains. These soils formed in recent alluvium from a wide variety of rocks, but are dominantly granitic. The Antho-Valencia Association makes up about 6.5 percent of Maricopa County. Antho soils comprise about 55 percent and Valencia soils about 25 percent of the association. Gilman, Coolidge, Maripo, Vint, Estrella, Carrizo and Tremant soils make up the remaining 20 percent of the association. Antho soils consist of 40 inches or more of light brown and light yellowish-brown sandy loam or gravelly sandy loam. The soil profile is slightly to strongly calcareous and moderately alkaline. Valencia soils have light brown and brown sandy loam surface layer and an older light brown and brown clay loam buried soil. The soil profile is moderately alkaline and slightly to strongly calcareous. Antho soils are on the alluvial fans, while Valencia soils are on the lower lying plains. The soils of this association are used for irrigated crops, seasonal

e. Soils (continued)

grazing, homesites, recreation and wildlife habitat. The areas used for rangeland yield little forage because of low rainfall and high evaporation. Group B soils have moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of transmission.

f. Climate

The climate of the study area is warm and arid, with short-mild winters and long, hot summers. Mean maximum/minimum daily temperatures range from approximately 65/35 degrees Fahrenheit in January to about 105/75 degrees Fahrenheit in July. The heaviest rainfall of the year normally occurs during the summer months of June through September, with most of the remaining rainfall occurring from December to March. Snow can occur at times over the entire basin, although snow below 2,000 feet is very rare.

Prevailing winds are generally rather light. However, moderate winds are often observed in conjuction with general winter storms, particularly in the higher elevations, and moderate winds frequently occur in spring when low pressure develops in Nevada. Summer thunderstorms often produce strong gusty winds over local areas.

Three types of storms occur in this region:
1) general Pacific storms with low intensity rainfall over wide areas, often continuing for several days during the winter months,
2) local storms of small areal extent and brief (up to 3 hours) duration which include the sporadic showers and cloudbursts, due usually to insolational heating of tropical maritime air that frequently invades the region from the Gulf of Mexico or the Gulf of California and the south Pacific and,
3) general summer rains that result either from convergence and orographic lift when tropical hurricanes influence the region, or from convergence, orographic lift, and frontal lift when frontal systems with associated tropical maritime and polar continental or maritime air pass through the region. Thunderstorms may or may not be associated with the general summer rains. Two or more thunderstorms may occur over an area with only a few hours interval separating them. Multiple occurrences of intense, long-duration general summer rains within a critical length of time are not indicated in the regional records.

g. Runoff Characteristics

Generally runoff occurs only during and immediately following heavy precipitation because climatic and drainage characteristics are not conducive to continuous flow. There are no natural

g. Runoff Characteristics (continued)

water-courses in the study area that flow perennially. Due to the drainage area being located on an alluvial plain, flood flows do not tend to concentrate naturally but rather proceed downslope as sheetflow. The shallow depths encountered with sheetflow are capable of being influenced by obstruction, as discussed under the previous heading Structures Affecting Runoff.

h. Subarea Delineation

The watershed was subdivided into 20 areas, ranging from 1% to 10% of the overall drainage area. The subareas were dictated by the radial patterns of the contours, reflecting the alluvial plain, and the existing man-made structures. Refer to plate number I for subarea boundaries and table number 2 for subarea characteristics.

i. Subsidence

There exists indications of subsidence in the study area. During an inspection of McMicken Dam in March, 1976, cracks on the eastern and western exposed slopes and across the crest were discovered. Two notches were later cut into the structure to prevent dam breaching by flood waters. Subsidence is one of the possible causes of the cracking. Subsidence has caused settlement or sag in different locations of the North Channel in the reach east of Litchfield Road.

III. FLOOD HISTORY

Histroical accounts indicate that damaging floods have occurred in the Gila River Basin. Sizeable floods were produced by the general storms of February 1884, February 1891, January 1916 and February-March 1938, but available records and estimates of severity are insufficient for detailed analysis of the study area. Winter storms may cause flooding in the study area, but most severe floods generally occur during the summer months as a result of local thunderstorms. Severe local storms and floods occurred in the Phoenix area in 1921, 1935, 1936, 1939, 1943, 1951, 1955, 1956, 1957, 1963, 1964, 1967, 1969, 1970 and 1972. Brief descriptions of the storms and floods of January 1916, August 3, 1943, August 26-29, 1951, September 25-26, 1962, December 13-21, 1967, September 3-7, 1970, June 21-22, 1972 together with the August 19, 1954 storm (southwest of Phoenix) which was used to develop the standard project flood hydrology are given in the following subparagraphs.

a. Storms and Flood of January 1916. Two general winter storms occurred over the Gila Basin in January 1916. The first storm period extended from January 14-21, and the second from January 25-30. Both storms originated over the Pacific Ocean. The heaviest rainfall in each storm was centered in the area north of Roosevelt

Reservoir, with secondary centers in the Pinal and Santa Catalina Mountains. The second storm had another secondary heavy rainfall center in the area tributary to the Agua Fria and the Hassayampa Rivers. The first storm, which was of broader areal extent than the second produced the larger flood. Observed total precipitation at Phoenix for the two storms was only 2.07 inches. Ground conditions were conducive to runoff owing to the occurrence of the precipitaiton of January 10-12, and to the presence of snow cover over much of the mountain area. The maximum discharge of the second flood on the Agua Fria River at Lake Pleasant Dam, (drainage area 1,460 square miles) was 105,000 cubic feet per second (cfs). On the Salt River near Roosevelt, 17 miles upstream from Roosevelt Dam (drainage area 4,310 square miles), the peak discharge of the first flood was estimated at 100,000 cfs.

b. Storm and Flood of August 3, 1943. The August 3, 1943 flood was caused by heavy precipitation resulting from thunderstorms over the desert areas north and east of Phoenix. Storm conditions started on August 1. Late on August 2, at Tempe, 2.11 inches was recorded in 30 minutes. Heavy precipitation occurred early August 3. The total precipitation for August 3, was 2.12 inches at Phoenix, 2.99 inches at Phoenix airport, 3.50 inches at Tempe, and 2.63 inches at Granite Reef Dam. It is likely that more rain than this fell in the desert areas to the north, but no records are available. Runoff was heavy upstream of the Arizona Canal. A series of 22 breaks occurred in the south bank levee of the canal in the vicinity of Indian Bend Wash. A break in the south bank of the Arizona Canal in the Cave Creek area released water that caused nine breaks in the Grand Canal. The total peak inflow into the Arizona Canal was estimated at 30,000 cubic feet per second and in the Cave Creek upstream of the Arizona Canal, the flow was estimated at 9,000 cubic feet per second. The maximum peak discharge in Indian Bend Wash at the Arizona Canal was estimated at 15,000 cubic feet per second.

c. Storm and Flood of August 26-29, 1951. A tropical hurricane entered the mainland of Mexico from the east in the vicinity of Tampico on August 22. Moist air associated with this storm crossed Mexico to the eastern coast of the Gulf of California. This moist air, augmented by moisture outflow from a tropical storm on the west side of Mexico began flowing into southwestern Arizona during the 26th, mostly in the vicinity of Organ Pipe Cactus National Monument. By the morning of the 27th, precipitation had become quite general over southern and central Arizona. Heavy precipitation spread northward and northeastward to the northern border of Arizona by the 29th. Moderate to heavy precipitation continued from the 27th through the 29th. The storm was most severe east and north of Phoenix. The total storm precipitation at Phoenix was 3.85 inches. Heaviest precipitation for the period was 13.55 inches at Crown King and 12.11 inches at Sunflower. About 65 percent

8 inches of rainfall in 24 hours. The Workmen Creek rain gauge, about 60 miles east and northeast of Phoenix, measured 11.4 inches of rainfall which exceeded the previous 24 hour record for Arizona by more than 5 inches. Record floods occurred in many portions of Arizona, Southwestern Utah, and Southwestern Colorado during September 4-7. Heavy rainfall in the mountainous areas of central Arizona resulted in sudden large floodflows in Tonto, Sycamore, Oak and Beaver Creeks and the east Verde and Hassayampa Rivers. The peak flow for the New River near Rock Springs stream gauge was 21,100 cfs, the highest since records began in 1960. The Hassayampa River at Box Dam site near Wickenburg had a peak of 58,000 cfs, which is more than twice the previous known maximum of 27,000 cfs which occurred in both 1927 and 1951.

h. Storm and Flood of June 21-22, 1972. The heavy thunderstorm which hit northeastern Phoenix, Arizona on the morning of June 22, 1972, was part of a series of moderate-to-heavy early summer thunderstorms which affected the entire southwest during the period of June 20-23, 1972. The storm resulted from a deep flow of very moist unstable tropical air that invaded the far southwestern United States from the Gulf of Mexico and the Pacific Ocean west of Baja California. Most of the storm's rainfall in the Phoenix area occurred during the periods 0600 to 1000, on June 22, and many of the stations observed their greatest intensities during a 1 1/2 to 2 hour period. The maximum unofficial intensity report was 5.25 inches during as estimated 2 hours in the vicinity of 24th Street and Camelback Road in Phoenix. Bucket survey amounts of 4.87 inches at 24th Street and Indianola Avenue and 4.8 inches at 28th Street and Indian School Road were confirmed by the National Weather Service. The maximum recording gauge intensity measured in this storm was 3.85 inches in 1 hour and 20 minutes at 18th Street and Turner Avenue. The storm in the Phoenix area was highly localized. Heavy runoff from the south slopes of the Phoenix mountains occurred as a result of the intense rainfall of June 22. In Paradise Valley and on the southwest slopes of the McDowell Mountain, large areas were inundated by sheet flow. Flooding occurred along Indian Bend Wash from Paradise Valley through Scottsdale and Tempe to the Salt River. A peak discharge of 20,000 cfs was measured at Indian Bend Road in Indian Bend Wash. Flooding occurred upstream of Arizona Canal as floodwaters ponded behind the canal levees. Much of the damage downstream of Arizona Canal resulted from breaks in the canal as overtopping occurred.

i. Storm and Flood of February-March 1978. The storm which affected the Phoenix area during the period of February 28 through March 11 formed off the coast of southern California and moved slowly northeast into Arizona. Associated with the front was a relatively strong southwesterly flow of warm, moist air aloft. Precipitation occurred as the moisture laden air piled up against the Mogollon Rim. The major amount of rainfall occurred in the areas wave attenuation and channel percolation must have occurred to reduce the peak discharge so greatly in the 13 mile reach between the two measuring points.

f. Storm and Flood of December 12-21, 1967. This storm period consisted of two general storm systems, one during December 12 through 16 and the other during December 17 through 21. During December 12 and 13, very cold air invaded Arizona from the north, while a deepening upper level low pressure center off the southern California coast brought strong southerly winds aloft to Arizona and caused widespread substantial precipitation over much of the state. Snowfall was very heavy in the mountain areas with some stations reporting unprecendented snow depth and the snow level dropped to as low as 1,000 feet on December 13 and 14. Precipitation from this first storm system generally diminished from December 15 through December 17, as the storm began moving to the east. A strong flow of warm moist air from the south began invading Arizona ahead of the second storm system and rainfall over the area began to increase, with the snow level rising to around 5,000 feet. Around mid-day on December 19, precipitation became quite heavy over the Phoenix area as a cold front moved through the region from the northwest and a considerable amount of melting snow was added to the runoff. Precipitation intensities diminished and the snow level lowered once again late on December 19, after the passage of the cold front. New December precipitation records were set at several Arizona stations during December 1967, including 16.21 inches at Crown King, 7.30 inches at Flagstaff and 3.92 inches at Phoenix. All of the month's precipitation fell during the 10 day period, December 12-21, in Central Arizona. The heaviest daily precipitation occurred on December 19, with Crown King measuring 6.00 inches and Bumble Bee reporting 4.61 inches. With approximately 5 days of antecedent rainfall during the period of December 13-18, the ground conditions were ripe to produce sizeable floods in the Phoenix area during the higher intensity rainfall which occurred on December 19. The New River-Skunk Creek system produced a peak of 19,800 cfs near Glendale (323 square miles).

g. Storm and Flood of September 4-6, 1970. The conditions that led to the storm of September 4-6, 1970 began to develop on September 1, when moist tropical air flowed into southern Arizona as a result of tropical storm Norma located off the top of Baja California. The buildup of moist air continued over the entire southwest until September 5, when a cold front entered Arizona from the northwest and strong southerly winds developed over the state. The combination of the upward motion of air ahead of the cold front and the orographic lifting of this moisture-laden tropical air led to the extremely heavy rains in Central Arizona. Numerous precipitation stations recorded 5 to of the total rainfall occurred during the maximum 24-hour period. An estimate by the U.S. Soil Conservation Service, based on high area (about 25 miles northwest of Phoenix), indicated a total peak discharge of 35,000 cfs assuming all the numerous flood peaks along the Beardsley Canal had occurred at the same time. The total volume of runoff for this flood was estimated at 10,600 acre feet. The peak discharge at Luke Air Force Base was estimated at 5,000 cubic feet per second by the U.S. Geological Survey.

d. Storm and Flood of August 19, 1954. Very moist warm tropical air that originated over the Gulf of Mexico and the Gulf of California entered Arizona and New Mexico from the south during the storm period accompanied by widespread thunderstorm activity. The storm and flood of August 19, 1954, was the most severe of record within the Queen Creek drainage area approximately 50 miles east and southeast of Phoenix. Precipitation in the area occurred between 0100 and about 1000 hours on the morning of August 19, 1954, in the Superstition Mountain and Pinal Mountain areas. The precipitation intensities were very high during portions of the storm, especially between 0500 and 0900 hours. The Boyce Thompson Southwestern Arboretum, about 4 miles west of Superior, report the highest measured precipitation amount of 5.3 inches (most of it falling within 3 hours), although greater amounts are believed to have fallen in the mountains to the south. Florence Junction (about 15 miles west of Superior) reported 1 and 6 hour amounts of 1.75 and 4.25 inches, respectively, while the smelter at Ray (about 11 miles southeast of Superior) measured 4.05 inches in less than 2 hours. An estimated 140 square miles of area had over 5 inches of precipitation and approximately 850 square miles had over 1 inch of precipitation. Peak discharge at the gauging station at Queen Creek at Whitlow Ranch Dam site near Superior, Arizona (drainage area 142 square miles), was estimated at 42,900 cfs.

e. Storm and Flood of September 25-26, 1962. The unusually heavy precipitation during the storm was associated with a tropical storm originating off the coast of Baja California. The main stream of moist air, which was about 70 miles wide, passed over Sells, the Tucson Mountains-Cortaro area, Oracle, and into New Mexico. Heaviest rain fell during the night of September 25 and most of September 26. A total of 4 inches of precipitation occurred at Sells in a 10 hour period on September 25 and 26. Estimates of depths of 7 inches were made for two locations about 17 and 22 miles west of Tucson. Peak discharges were estimated by the U.S. Geological Survey for the Santa Rosa Wash near Vaiva Vo (1,782 square miles) at 53,100 cubic feet per second and for the Santa Rosa Wash at State Highway 84 between Casa Grande and Stanfield at 12,800 cubic feet per second. A significant amount of flood north and east of metropolitan Phoenix. Rain which began in the northwestern portion of the state on February 27, fell intermittently in the following days with the largest amounts during the periods of March 1-2. A secondary storm system passed through the area on March 4-5, but the amounts were much less than the earlier storm period. Another storm system was expected to pass through the Phoenix area during the period March 9-11 but when it arrived it produced only light showers. The storm period of March 1-2 was critical in the region northwest of Phoenix. During this period, heavy rains were falling in the drainage areas contributing to the Trilby Wash Basin which is formed by the McMicken Dam. The reservoir level was being monitored by the Maricopa County Flood Control District and at 0130 hours, March 2, approximately one foot of water was passing over the emergency outlet. (According to the report from MCFCD, it was not specified as to which emergency outlet, there are two). Aerial photographs taken during the daylight by personnel of Luke AFB show water flowing through both outlet notches and closeup photographs of the staff gauges at the same time show the flow still at approximately one foot deep. Flood waters passing through the northernmost outlet (110 foot notch) caused considerable damage to the levees and lining of the Beardsley Irrigation Canal. From the aerial photographs it appears that the outlet notch flows overtopped the canal, with some of the flow being carried away by the canal and the remaining flows going into the dam outlet works channel where it was successfully contained. The flows that were caught in the Beardsley Canal were conveyed through the siphon, the flow in the canal exceeded the carrying capacity of the canal and broke out to the southeast, flowing overland a short distance into the surrounding fields. Flows through the southern emergency outlet (700 foot notch) caused damage to the Beardsley Canal and to agricultural areas downslope from the outlet. In the fields below the dam, there are no natural watercourses to confine the outflow. Local farmers have cultivated nearly all available land and have made only minor provisions for the channeling of flood waters. The floodwaters spread out in sheetflow. The flow from the notch was ponded behind the Beardsley Canal levee until a sufficient volume was attained to cause the floodwater to break over into the canal, exceed its capacity and pour over into the adjoining fields becoming sheetflow. The flow was modified slightly by the roads and irrigation ditches. The flow continued southeastward only to pond behind a road embankment or irrigation lateral until sufficient volume was again obtained to overtop or breach the obstruction. Outflow from the 700 foot notch could be easily discerned for approximately three miles downslope of the dam embankment and possibly extended for six or seven miles.

IV. SYNTHESIS OF STANDARD PROJECT FLOOD

a. General

The standard project flood (SPF) represents the flood that would result from the most severe combination of meteorological and hydrologic conditions considered reasonably characteristic of the region. It normally is larger than any past recorded flood in the area and can be expected to be exceeded in magnitude only on rare occasions. It thus constitutes a standard that will provide a high degree of flood protection.

b. Standard Project Storm

The August 19, 1954 thunderstorm that was centered generally in the Queen Creek drainage area was determined to be the storm with the most severe flood producing rainfall depth-area-duration relationship and isohyetal pattern that may reasonably be expected to occur over the central portion of Arizona. While the storm lasted a total of about 9 hours, local observations during the storm indicated that nearly all of the precipitation fell during a 7 hour period and that most of the rainfall occurred at many stations within 3 hours or less. Very short durations (5 minutes to 1 hour) of extremely intense rates of precipitation, although not measured in the August 18, 1954 Queen Creek storm because of the complete lack of properly functioning recording rain gauges in the area at the time of this storm, have been measured on a number of other occasions in the vicinity of central Arizona and are therefore considered to be reasonably characteristic of the heavier thunderstorms in this part of the state. Thus, a standard project storm of 7 hour duration, having large portions of the total precipitation occurring within 1-3 hours, was developed. Spatial and temporal characteristics of the standard project storm were derived using procedures set forth in "Greater Arizona Standard Project Summer Thunderstorm, Instruction for Computation of Rainfall", dated August 17, 1972.

c. Rainfall-Runoff Relationships

The Los Angeles District Unit Hydrograph procedure was used to synthesis unit hydrographs for Luke AFB (Department of the Army, T.B. 5-550-3, "Flood Prediction Techniques", February, 1957). Table number 2 lists the individual subarea parameters that were used to model the runoff process. Basin "n" values were estimated by field investigation, an approach defined in "Improved Procedure for Determining Drainage Area Lag Values", and by comparisons to existing hydrology reports relevant to the study area. The Indian Bend Wash S-Graph, which is the time distribution of runoff as a function of basin lag time for Indian Bend Wash was applied to Luke AFB because of the similarities of the two watersheds in their natural state - before development.

d. Precipitation Loss Rates

Precipitation loss rates were taken from a past hydrology report title "New River and Phoenix City Streams, Arizona" (ref. 11 plate 30). It was determined that this was the most appropriate data, since soils in the Luke AFB area are similar to soils of the Phoenix area.

e. Flood Routing

The study area is located on an alluvial plain. Flood flows do not tend to concentrate naturally but rather proceed downslope as overland flow. Investigations have revealed that, although the study area is predominantly agricultural land and has transportation routes throughout, runoff primarily follows the natural slope of the land. The Muskingum Method was used for modeling overland flow conditions. The Muskingum K coefficient is approximated by the travel time of a flood wave through a reach. Overland flow velocity was estimated to be 1.5 fps. The Muskingum X coefficient is a dimensionless constant that represents; channel slope, cross sectional shape and discharge. Since overland flow represents a rather level water surface profile the X coefficient was estimated to be 0.0. As documented during the February-March 1978 flooding event (Ref. 6 p 4), flood flows were temporarily detained on farm lands. The roads, irrigation laterals and farm lands were responsible for the flows being temporarily detained, for existing conditions, consequently the Modified Puls routing procedure was used for storage routing of flood flows. Each subarea hydrograph was storage routed by composite storage outfall relationships that represented the storage features of the subarea. Storage outflow relationships were estimated from quad maps, aerial photos, field investigation and computations based on the weir formula.

f. Streambed Infiltration

Runoff from the study area is not concentrated in streambeds. Runoff occurs as overland flow and therefore is not subject to the high infiltration losses associated with defined streambed flows. Consequently infiltration losses were considered negligible.

g. Effects of Structures

From field investigation, it was determined that Cotton Lane is capable of diverting 1000 cfs out of the contributing drainage area to Luke AFB. It was also determined that an existing drainage ditch paralleling Northern Avenue will divert flows (maximum of 300 cfs) into the North Channel that naturally would reach the West Channel. Cotton Lane and the drainage ditch are two major structures affecting runoff patterns, a complete analysis concerning effects of structures is given under heading II c. Structures Affecting Runoff.

h. Base Flow and Snowmelt

Base flow is considered negligible for this study area because runoff occurs only as a direct response to high intensity rainfall. Allowance for snowmelt is inappropriate in this region for storms occurring in the summer season.

IV. SYNTHESIS OF STANDARD PROJECT FLOOD (continued)

i. Stream System Analysis

The stream system analysis approach to computation of flood involves division of a study area into subareas (which are homogenous with respect to hydrologic factors) and routing and combining the flood hydrographs generated from each subarea to determine the flood peak at a desired concentration point. Dividing a watershed into subareas permits more accurate modeling of the runoff process, as variations in topography and land use, as well as channel shape and slope may be incorporated into the hydrologic description of the basin. Schematic descriptions of the stream systems analyzed for this study are shown on plate 3.

j. Standard Project Flood

The standard project flood (SPF) for Luke AFB was generated employing the following conditions: Rainfall procedures set forth in Greater Arizona Standard Project Summer Thunderstorm (Ref. 5); the Indian Bend Wash S-Graph; drainage basin variables pertinent to the watershed; and the local storm loss function. SPF peak discharges are given in table 1. Natural condition SPF values are plotted on an enveloping curve of observed peak discharges on streams in the Phoenix area as shown on plate 4. Sheet-flow basins are typically less efficient in producing peak discharges than basins with concentrated flows. Because the SPF's for Luke AFB are for sheet-flow conditions and plot lower than the displayed enveloping curves, they are considered reasonable.

V. DISCHARGE - FREQUENCY DETERMINATIONS

a. Basis of Discharge - Frequency Relationships

There exists no runoff data suitable for deriving direct discharge - frequency relationships for the study watershed. This lack of data led to deriving relationships for Luke AFB based on Indian Bend Wash Discharge - Frequency curve (plate 5). The Indian Bend Wash curve is acceptable for Luke AFB because both watersheds have similar hydrologic (in their natural state) and meteorological characteristics. Modifications as discussed in the following paragraphs will be applied to account for the influence of man-made structures.

b. Transposition of Discharge-Frequency Relationships to the Study Area

The Standard Project Flood (SPF) was the parameter used to transpose the Indian Bend Wash discharge-frequency relationships to Luke AFB. SPF peak discharges were computed using the following hypothetical conditions: (1) the study watershed is in its natural state (2) the north and west channels exist and are capable of conveying all runoff to each concentratio point (3) the subarea boundaries are reasonably similar to those for existing conditions.

V. DISCHARGE - FREQUENCY DETERMINATIONS b. (continued)

Computations are based on the SPF, Local Storm Loss Rate Function, the Indian Bend Wash S-Graph and subarea characteristics representative of natural conditions. Natural condition SPF values for the study area are judged to have the same frequency as the SPF for Indian Bend Wash because similar factors are used in their derivations. Accordingly, the ratio of n-year discharge values to SPF for Indian Bend Wash are considered to be applicable for the study area (under natural conditions) because of hydrologic and meteorologic similarities. Luke's SPF values were then multiplied by the ratio based on Indian Bend Wash to derive the natural condition n-year peak discharges for Luke AFB.

c. Rainfall Calibration

The amount of rainfall needed (in a rainfall-runoff analysis) to obtain the previously established n-year peak discharge was determined by using the following conditions: (1) the dry watershed loss rate function; (2) reducing the standard project storm total rainfall by direct percentage; (3) adjusting basin "n" values - increasing by 0.005 for each lower frequency storm. This procedure calibrates total storm rainfall to the discharge-frequency relationships. For Luke AFB the drainage area was divided into two areas, one contributing to the West Channel, the other contributing to the North Channel. The following table presents Rainfall Adjustment Factors (RAF) which were used to generate n-year frequency values. RAF is the percentage applied to the standard project storm's rainfall.

West Channel		North Channel	
n-year	RAF	n-year	RAF
100	.55	100	.55
50	.43	50	.43
25	.32	25	.33
10	.24	10	.24

d. Discharge-Frequency Analysis for Existing Conditions

Peak discharges for existing conditions were calculated for the SPF, 100-year, 50-year, 25-year and the 10-year flood event (see table 1). Parameters used to calculate the n-year flood event were as follows:

(1) The Indian Bend Wash S-Graph for all frequencies.
(2) The previously determined calibrated storm for each frequency.
(3) The Local Storm Loss Rate Function for SPF and the Dry Watershed Loss Rate Function for all other frequencies.
(4) Adjusted basin "n" values for all frequencies. (see table 2).

V. DISCHARGE - FREQUENCY DETERMINATIONS d. (continued)

Frequency	Basin "n"
SPF	n (existing value)
100	n + .005
50	n + .01
25	n + .015
10	n + .02

(5) Routing and storage routing procedures as discussed previously.

Peak discharges were computed for nine different concentration points (CP) along the perimeter of the base. The CP's are located along the North and West Channels, each channel has different conveying abilities, therefore flows exceeding said capacities are capable of flooding Luke AFB (see plate 2).

CP	CHANNEL	CAPACITY (cfs)
12	North	300
1	North	1000
2	North	1100
31	North	1100
3	North	1100
4	West	900
5	West	1500
51	West	2600
6	West	3700

The computer model was set up to generate the flood hydrographs that are capable of reaching the designated concentration points. Overland flows were determined from the difference between the capacities of the channels and the incoming flood hydrographs. Given in table I are the peak discharges for the nine concentration points and the eight overland flow areas.

VI. FUTURE STUDIES

The Los Angeles District, Corps of Engineers plans to conduct detailed hydraulic studies on the North and West Channel systems and shall revise the standard project flood and discharge-frequency values, as necessary, using procedures outlined in this report.

TABLE 1

PEAK DISCHARGES FOR EXISTING CONDITIONS

CONCENTRATION POINT *	DRAINAGE AREA (SQ. MI.)	STANDARD PROJECT FLD. (CFS)	100-YEAR FLOOD (CFS)	50-YEAR FLOOD (CFS)	25-YEAR FLOOD (CFS)	10-YEAR FLOOD (CFS)
12	—	300	300	300	160	80
1	7.22	2600	1250	900	500	240
2	15.08	3100	1650	1250	700	330
31	21.96	2700	1800	1550	900	420
3	26.56	2900	1850	1600	1100	510
4	3.84	1400	600	370	210	100
5	10.34	3500	1650	1100	600	300
51	13.33	3600	1850	1150	650	320
6	19.76	5800	2550	1300	700	350
OVERLAND FLOW AREAS *						
A		1550	230	0	0	0
B		2000	550	160	0	0
C		1650	700	450	0	0
D		1800	750	500	0	0
E		1450	0	0	0	0
F		2000	150	0	0	0
G		1000	0	0	0	0
H		2100	0	0	0	0

* SEE PLATE 1 FOR LOCATIONS

TABLE 2
SUBAREA CHARACTERISTICS

SUBAREA NO.	DRAINAGE AREA (mi^2)	CITRUS AREA (mi^2)	EFFECTIVE DRAINAGE AREA (mi^2)	LENGTH (mi)	L_{CA} (mi)	SLOPE (ft/mi)	BASIN "n" NATURAL	BASIN "n" EXISTING
11	1.43	0.00	1.43	5.1	2.4	10	0.05	0.05
12	3.80	0.04	3.76	3.4	1.5	47		0.056
13	1.11	0.01	1.10	2.7	1.2	29		0.07
21	0.67	0.09	0.58	1.5	0.5	40		0.069
22	2.37	0.08	2.29	3.5	1.6	33		0.07
31	3.19	0.08	3.11	2.5	1.3	45		0.063
32	3.31	0.12	3.19	4.3	2.5	30		0.07
41	2.26	0.12	2.14	2.6	1.7	40		0.063
42	1.58	0.00	1.58	4.4	2.2	29		0.07
51	1.47	0.06	1.41	2.0	1.2	35		0.059
52	2.91	0.58	2.33	3.4	1.7	32		0.07
53	2.84	0.00	2.84	2.7	1.3	20		0.07
61	4.44	0.02	4.42	4.3	2.5	28		0.064
62	1.35	0.00	1.35	2.2	1.1	28		0.07
63	2.07	0.09	1.98	3.1	1.5	22		0.07
71	2.86	0.03	2.83	4.6	2.3	28		0.07
72	1.35	0.00	1.35	2.3	1.0	28		0.07
73	2.67	0.74	1.93	3.0	1.7	19		0.07
81	2.44	0.29	2.15	2.8	1.0	30		0.07
82	2.16	0.00	2.16	3.2	1.7	19	0.05	0.07

TABLE 3

FLOOD ROUTING PARAMETERS

MUSKINGUM ROUTING PARAMETERS

REACH [1]	ITQR [2]	LENGTH (FT)	NRCHS [3]	AMSK [4]	X [5]
46 TO 4	15	23,000	17	0.25	0.0
11 TO 4	15	3,800	1	0.25	0.15
4 TO 5	15	2,800	1	0.25	0.15
36 TO 5	15	22,600	17	0.25	0.0
5 TO 51	15	3,400	1	0.25	0.15
26 TO 51	15	12,100	9	0.25	0.0
51 TO 6	15	3,000	1	0.25	0.15
11 TO 15	15	5,860	4	0.25	0.0
15 TO 6	15	5,200	4	0.25	0.0
54 TO 55	15	18,000	13	0.25	0.0
55 TO 12	15	14,250	11	0.25	0.0
12 TO 1	15	3,500	1	0.25	0.15
1 TO 2	15	8,500	2	0.25	0.15
64 TO 65	15	11,600	9	0.25	0.0
65 TO 2	15	16,400	12	0.25	0.0
2 TO 31	15	3,500	1	0.25	0.15
74 TO 75	15	12,000	9	0.25	0.0
75 TO 31	15	16,000	12	0.25	0.0
31 TO 3	15	3,400	1	0.25	0.15
84 TO 3	15	17,000	13	0.25	0.0

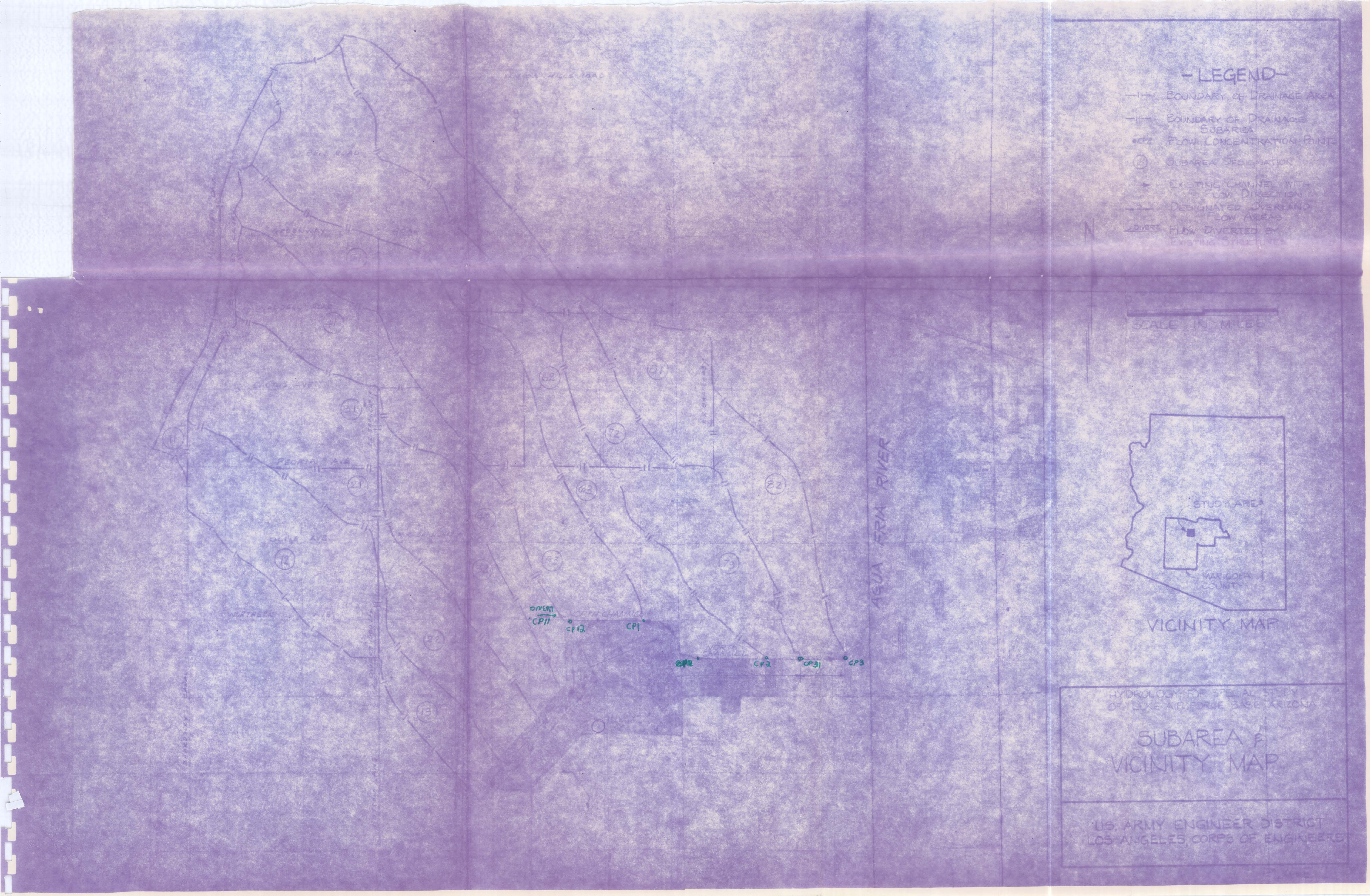
[1] NUMBERS REFER TO LOCATIONS SHOWN ON PLATE 3

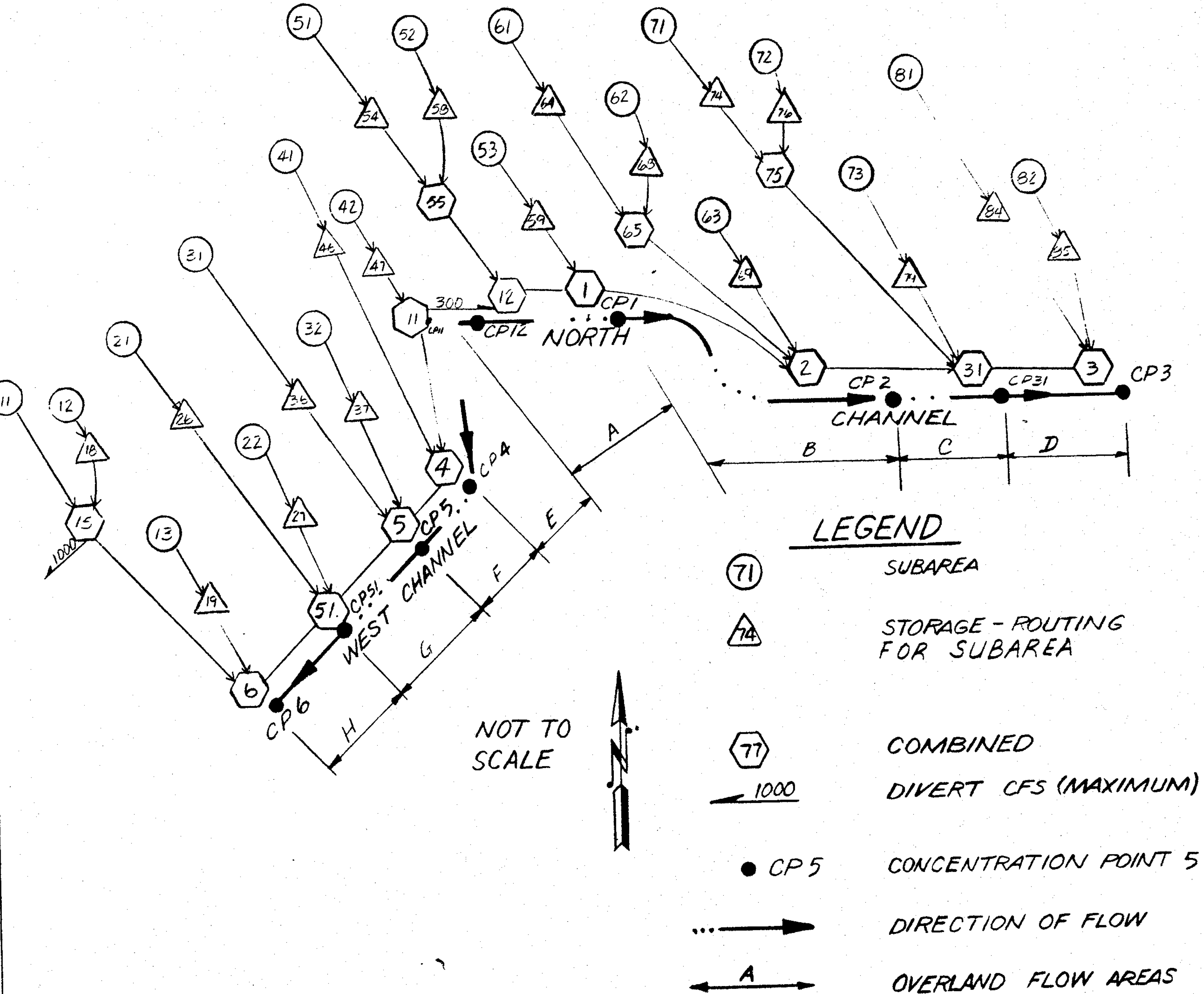
[2] ROUTING INTERVAL IN MINUTES

[3] NUMBER OF SUCCESSIVE REACHES TO BE ROUTED WITH IDENTICAL ROUTING SPECIFICATIONS

[4] K COEFFICIENT FOR MUSKINGUM ROUTING

[5] X COEFFICIENT FOR MUSKINGUM ROUTING


- LEGEND -
BOUNDARY OF DRAINAGE AREA
BOUNDARY OF DRAINAGE SUBAREA
CP2 FLOW CONCENTRATION POINTS
SUBAREA DESIGNATION
EXISTING CHANNEL WITH FLOW DIRECTION
DESIGNATED OVERLAND FLOW AREAS
DIVERT FLOW DIVERTED BY EXISTING STRUCTURES
N
SCALE IN MILES
STUDY AREA
MARICOPA COUNTY
VICINITY MAP
AGUA FRIA RIVER
DIVERT
CP11
CP12
CP1
CP2
CP31
CP3
HYDROLOGY FOR SPECIAL STUDY
OF LUKE AIR FORCE BASE, ARIZONA
SUBAREA & VICINITY MAP
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

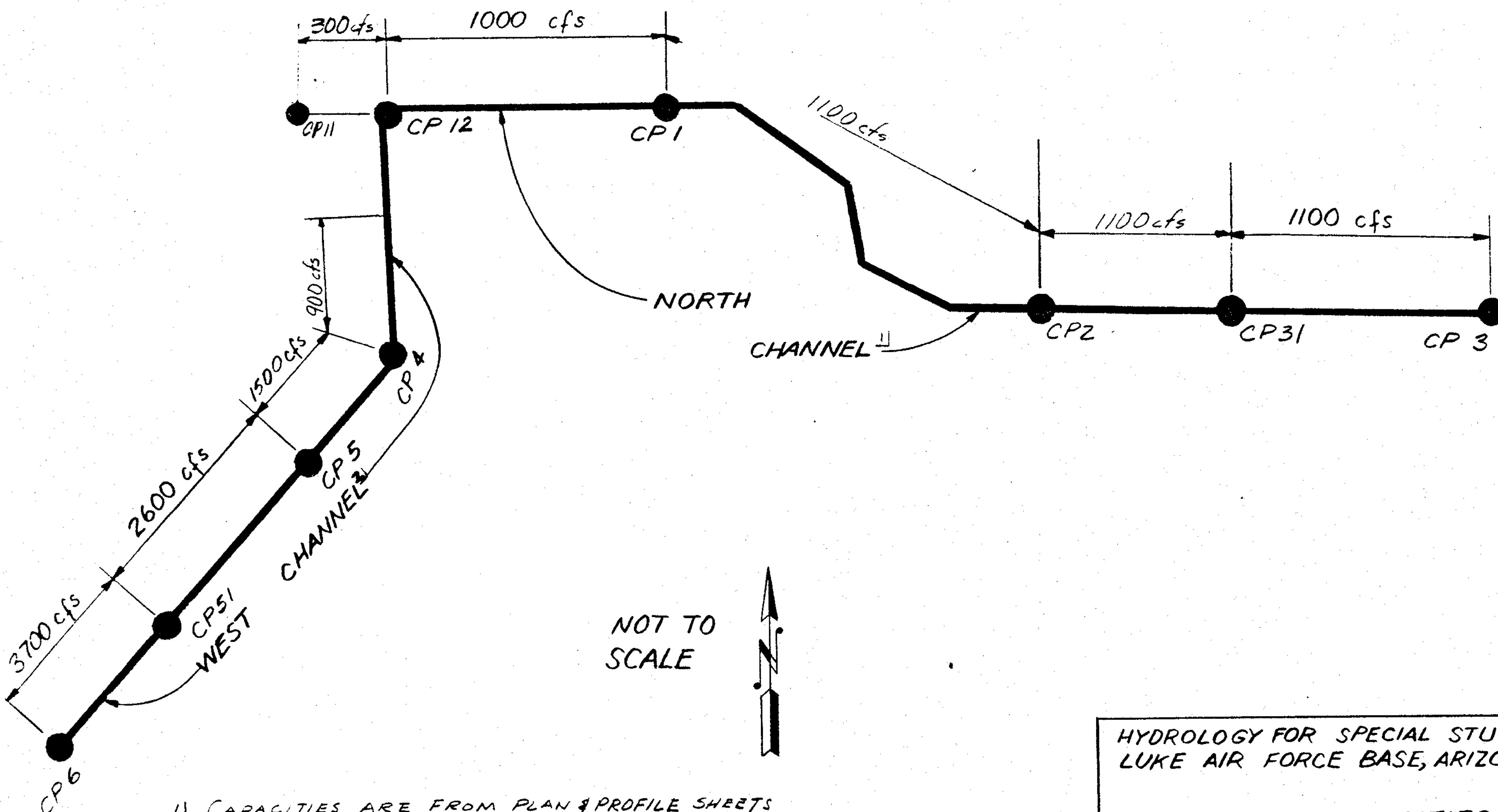


HYDROLOGY FOR SPECIAL STUDY C
LUKE AIR FORCE BASE, ARIZONA

SCHEMATIC FLOW DIAGRAM
EXISTING CONDITIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEE

PLATE 3



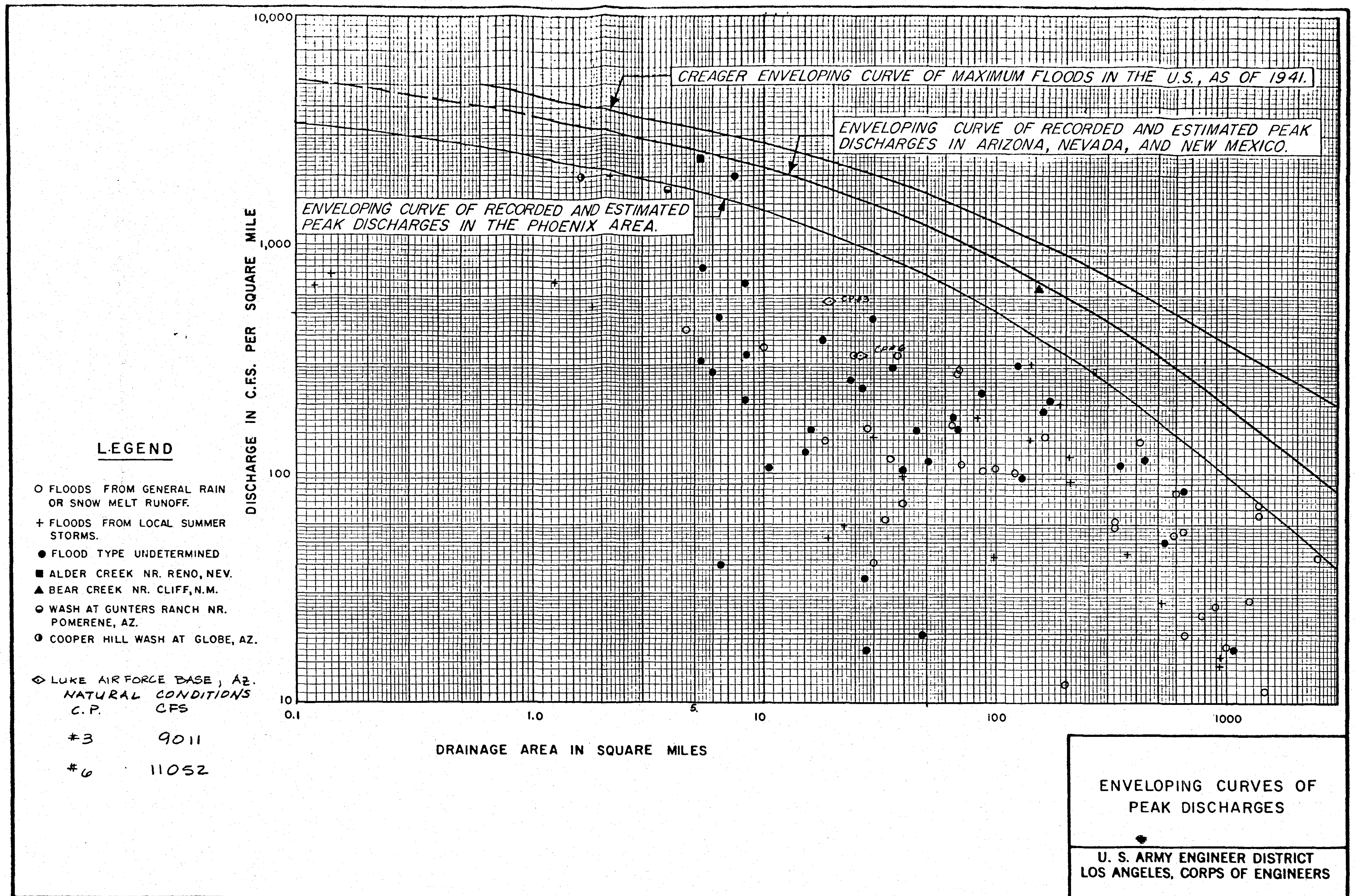
1/ CAPACITIES ARE FROM PLAN & PROFILE SHEETS & FIELD INVESTIGATIONS

2/ CAPACITIES ARE FROM CROSS SECTIONS & NORMAL DEPTH CALCULATIONS

HYDROLOGY FOR SPECIAL STUDY OF LUKE AIR FORCE BASE, ARIZONA

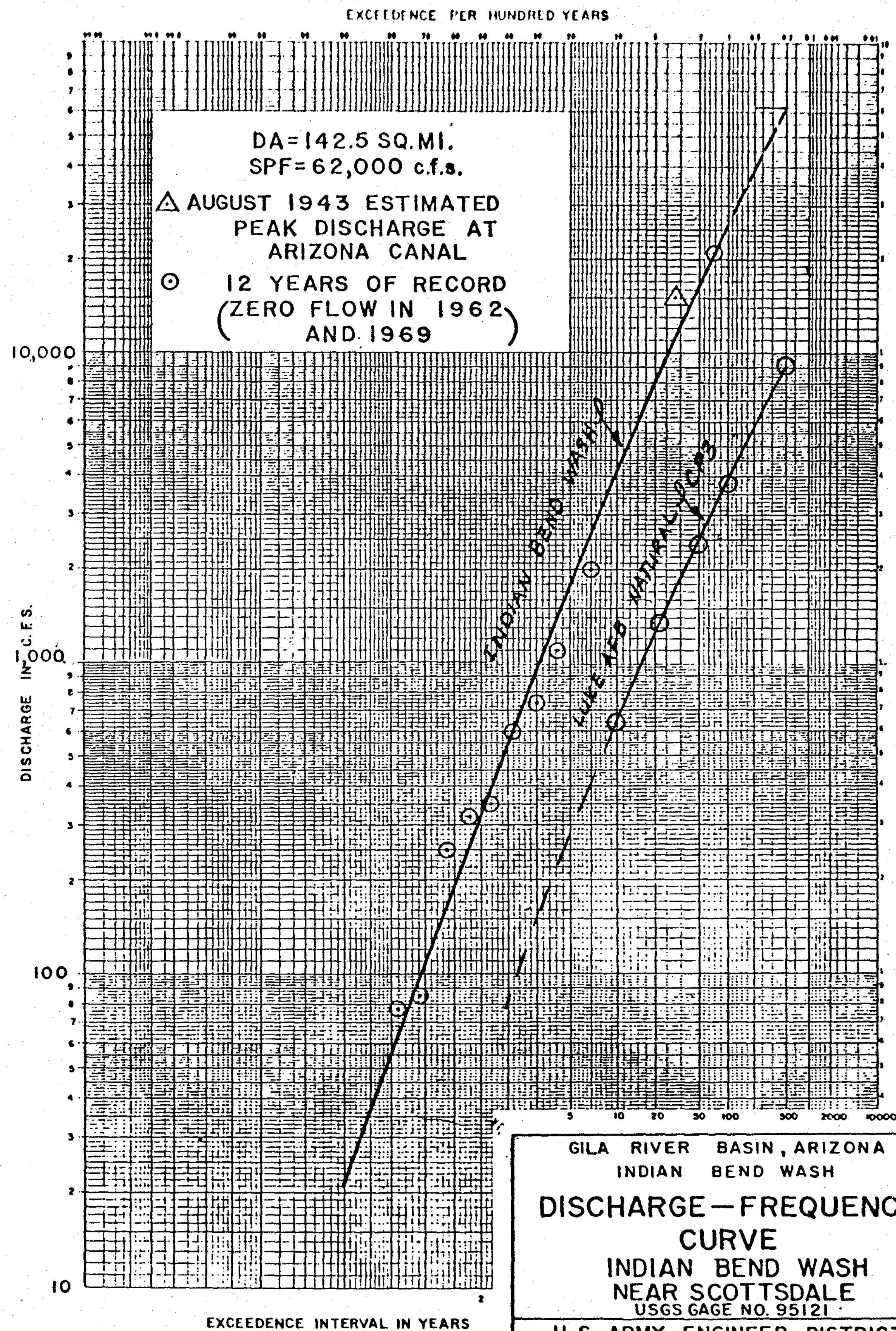
CHANNEL CAPACITIES

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS



CREAGER ENVELOPING CURVE OF MAXIMUM FLOODS IN THE U.S., AS OF 1941.
ENVELOPING CURVE OF RECORDED AND ESTIMATED PEAK DISCHARGES IN ARIZONA, NEVADA, AND NEW MEXICO.
ENVELOPING CURVE OF RECORDED AND ESTIMATED PEAK DISCHARGES IN THE PHOENIX AREA.
CP#3
CP#6
10,000
1,000
100
10
0.1
1.0
5.
10
100
1000
DISCHARGE IN C.F.S. PER SQUARE MILE
DRAINAGE AREA IN SQUARE MILES
LEGEND
O FLOODS FROM GENERAL RAIN OR SNOW MELT RUNOFF.
+ FLOODS FROM LOCAL SUMMER STORMS.
● FLOOD TYPE UNDETERMINED
■ ALDER CREEK NR. RENO, NEV.
▲ BEAR CREEK NR. CLIFF, N.M.
⊖ WASH AT GUNTERS RANCH NR. POMERENE, AZ.
◑ COOPER HILL WASH AT GLOBE, AZ.
◇ LUKE AIR FORCE BASE, AZ.
NATURAL CONDITIONS
C.P. CFS
#3 9011
#6 11052
ENVELOPING CURVES OF PEAK DISCHARGES
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 4



GILA RIVER BASIN, ARIZONA
INDIAN BEND WASH

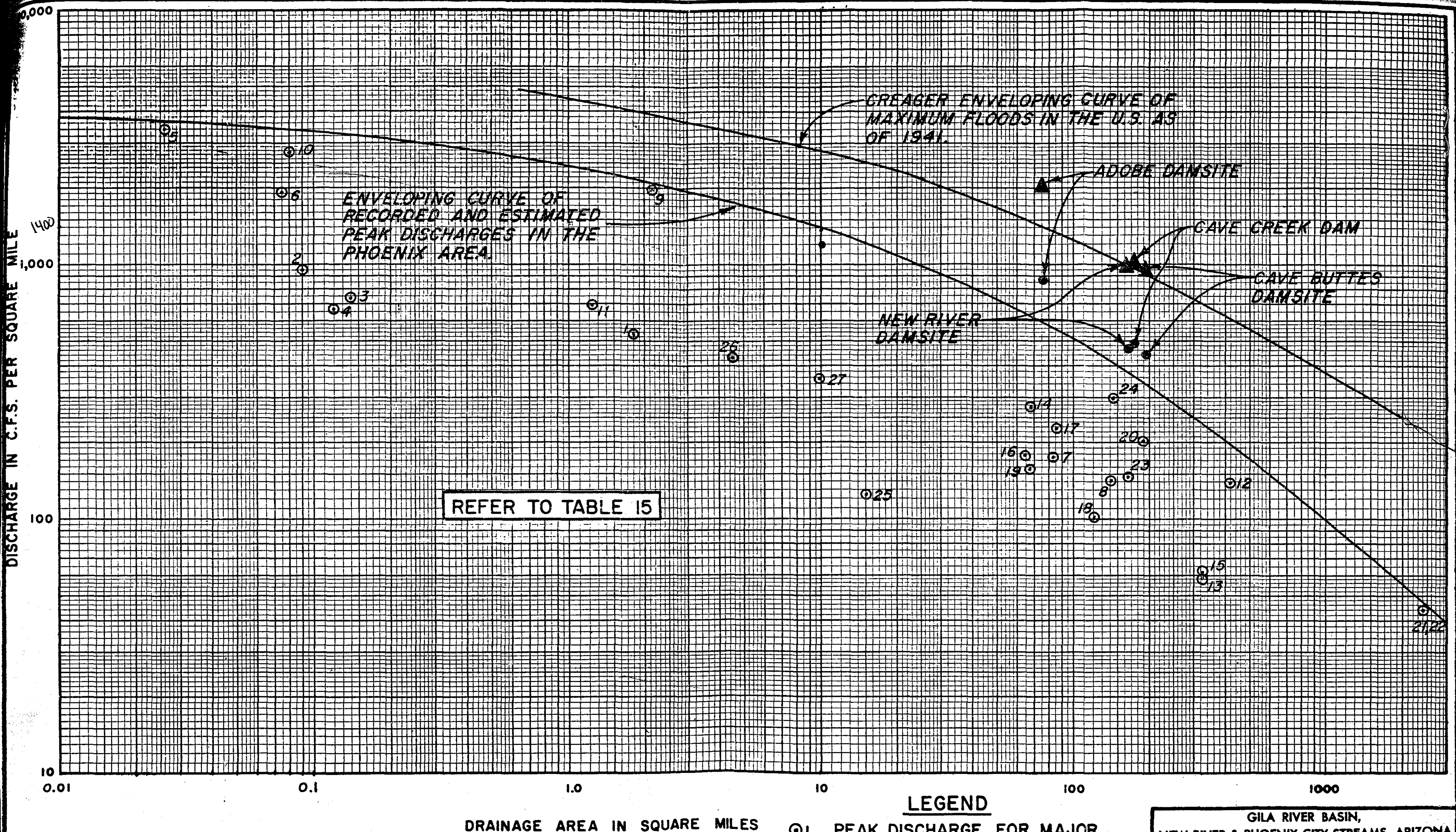
DISCHARGE—FREQUENCY CURVE

INDIAN BEND WASH NEAR SCOTTSDALE

USGS GAGE NO. 95121

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

PLATE 5



LEGEND

⊙1 PEAK DISCHARGE FOR MAJOR RECORDED FLOOD (SEE TABLE 15).

● STANDARD PROJECT PEAK DISCHARGE AT DAM OR DAMSITE.

▲ PROBABLE MAXIMUM PEAK DISCHARGE AT DAM OR DAMSITE.

GILA RIVER BASIN,
NEW RIVER & PHOENIX CITY STREAMS, ARIZONA

ENVELOPING CURVE OF PEAK DISCHARGES STREAMS IN THE PHOENIX AREA

**U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS**

TO ACCOMPANY DESIGN MEMO NO. 2

14840-032
Rec 9/21/87
[signature]

DRAFT REPORT

SPECIAL FLOOD HAZARD STUDY

LUKE AIR FORCE BASE--GLENDALE, ARIZONA

PERFORMED BY: LOS ANGELES DISTRICT, U.S. ARMY CORPS OF ENGINEERS

Figures

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Tables

Appendix

TABLE OF CONTENTS

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Missing Sect
6.0 and 5.2
Plus Append of
Drainage Reports

1.0 ACKNOWLEDGEMENT

We like to express our appreciation to the Luke Air Force Base, Civil Engineering Department for their assistance in providing topographic maps and general information on past floods, which was useful in this study.

2.0 INTRODUCTION

On July 1977 the Luke Air Force Base Civil Engineer, Lt. Col., Robert O. Ferrell, requested from the Corps of Engineers, Los Angeles District, to evaluate the increased flood threat on the Base immediately following the breach of McMikan Dam.

The Flood Plain Management Section of Los Angeles District has prepared this Special Flood Hazard Report in response to the request from Luke AFB. Since the McMikan Dam has not been repaired after 5 years following the breach, the original study scope of work is expanded to include the level of flooding on the Base both with and without the Dam breached. This report presents the severity of flooding on the base and alternatives to remedy the situation.

2.1 Purpose

The purpose of this Special Flood Hazard Report is to determine the depth of flooding at Luke Air Force Base with and without the McMikan Dam repaired. The study included determining the following; (a) the discharge values at Luke AFB, (b) the perimeter channel capacities, (c) the residual flows overtoping the perimeter channels, (d) the depth of flooding on the base. As a result of this report, several alternatives are evaluated to decrease the chance of flooding at Luke Air Force Base.

2.2 Scope

This report presents a background information on Luke AFB and its present flood threat. The report provides the 100-year flood limits on the Base with flood depth values.

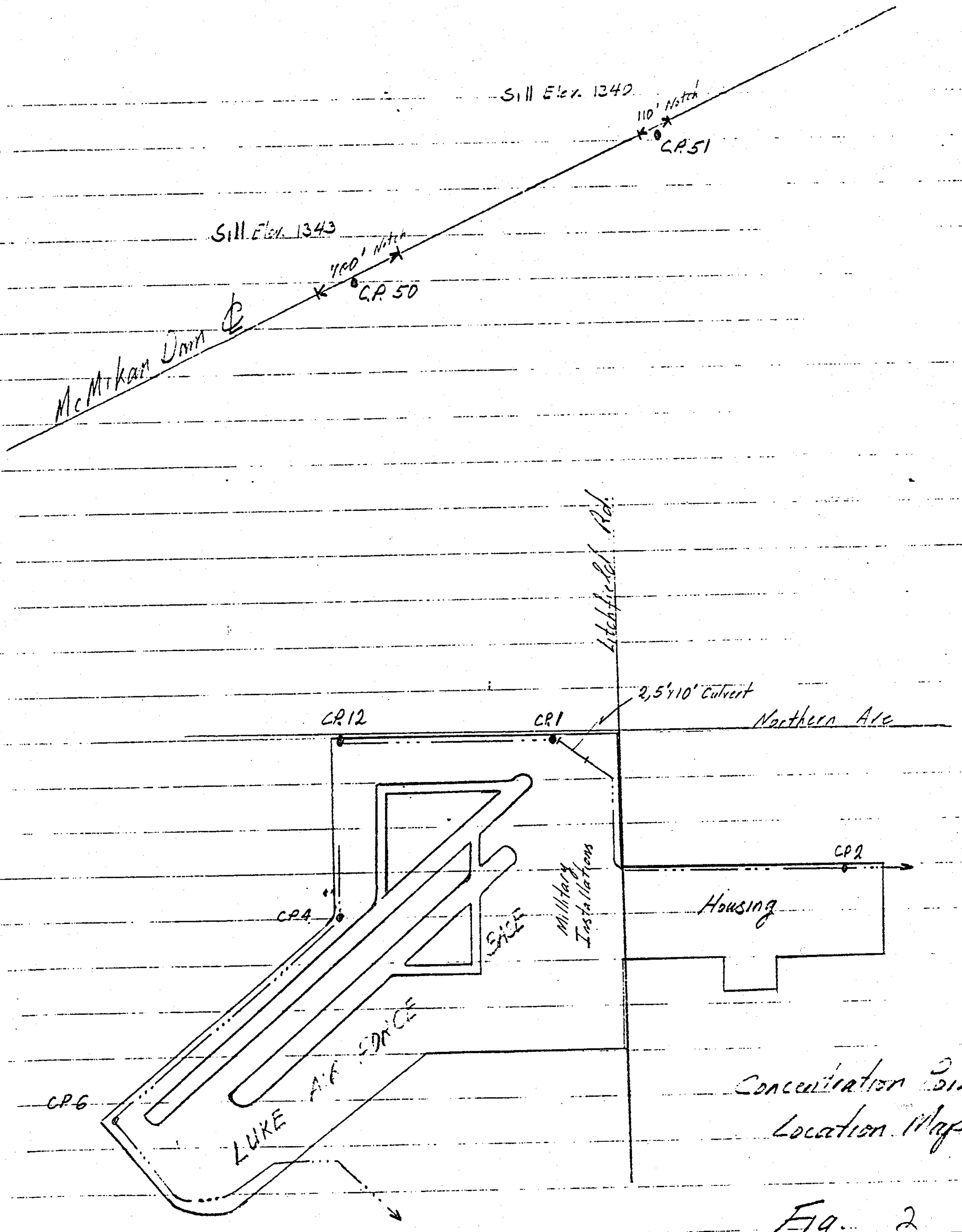
The existing perimeter channels are evaluated for flow convergence capacity and alternatives are suggested for improving the existing channels. The report also provides data on floodproofing of present and future structures by several conventional methods.

3.0 BACKGROUND INFORMATION

The McMikan Dam, which is also called the Trilby Wash Detention Basin, is located on Trilby Wash and adjacent streams about 4 miles west of Beardsley, and 10 miles northwest of Luke Air Force Base. The project location is shown on figure 1. The McMikan Dam controls drainage from 247 square miles. See table 1 for pertinent data on McMikan Dam which was built by the Corps of Engineers on July 1956. There is about 46 suare miles of uncontrolled drainage area below the dam which also affects the flooding situation on Luke Air Force Base. In order to handle these flows, U.S. Army Corps of Engineers constructed perimeter channels to collect and convey the floodwater to the east and south of the base.

Table 1. Summary of Discharges in CFS
With
McMikan Dam Repaired

Location and CP#	SPF	100-yr.	50-yr.	25-yr.
North Channel				
12	300	300	300	160
1	2600	1250	900	500
2	3100	1650	1250	700
West Channel				
4	1400	600	370	210
6	5800	2550	1300	700



Concentration Points
Location Map

Fig. 2

3.1 McMikan Dam

The McMikan Dam consists of an earth levee approximately twenty feet high and about nine miles long. The construction of the Dam was completed in 1956 which funds provided by the United States Congress following the devastating flood of 1951 that damaged nearly 200 buildings on Luke Air Force Base. In early 1977, several major cracks were discovered on the Dam embankment. Consequently, the Corps of Engineers determined that the dam was unsafe. Therefore, in July 1977, two large notches were cut into the Dam which essentially eliminated the flood protection which the Dam had originally provided for Luke Air Force Base, the agricultural fields, and communities downstream such as Goodyear, Litchfield Park and Avondale. Figure 2 shows the location of these two notches in the Dam. One notch is 700 feet wide, (Sta. 320+00 along the centerline of the Dam), with the sill elevation at 1343 feet. The other notch is 110 feet wide, (Sta. 481+25), with the sill elevation at 1340 feet (mean sea elevation). Only the 110 ft. notch has a concrete sill on the invert and up the side slopes to prevent expansion of the notch.

3.2 Perimeter Channels

In order to divert the local flows from the 46 square miles of drainage below the mcMikan Dam, Corps of Engineers also constructed the North and West Channels at the perimeter of the Base. The North Channel provides flood protection to the Base residential and military structures. The North Channel is partly earth and partly concrete tapezoidal channel as shown on figure 3. The earth trapezoidal channel reach is from the west corner of the Base, along Northern Avenue up to the double 5' x 10' underground culvert, and the concrete channel reach starts downstream of this culvert. The North Channel extends east all the way to the Agua Fria River. Table 2 shows the North Channel original and present channel convergence capacity.

The West Channel is an earth trapezoidal channel along the west side of the Base and mainly protect the runways from flooding. A typical channel configuration is shown on figure 4. The West Channel is larger than the North Channel can convey much higher flows because of its greater invert slope compared to the North Channel. Table 2 also shows the West Channel capacity.

Table 2. Present Channel Capacity (in cfs)

	Original Design	Present Condition
North Channel		
Upstream of double culverts	520-800	400-700
5'x10' double culverts	1100	1250
Downstream of double culverts	1100	1250
East of Litchfield Road	1100	500
West Channel		
CPU South of Demolition Area	900	600
Near Waste Disposal site	1500	1650
Between Waste Disposal site and Picnic Grounds	2600	1850
Southwest of Picnic Grounds	3700	2550

4.0 PAST FLOODS

On March 2, 1982, Trilby Wash experienced its first major run-off after the breach of McMikan Dam. This event provided the opportunity to observe the flow path of the discharges from the notches at the Dam. Our field reconnaissance provided the following information. Floodwaters about one (1.0) foot deep had flowed over the 700 feet wide notch at McMikan Dam. These flows were interrupted temporarily by the Beardsley Irrigation Canal, which is located immediately below McMikan. Since this canal did not have sufficient convergance capacity, it was overtopped and floodwaters continued flowing southeast toward Luke Air Force Base. The flow path from McMikan Dam to Luke Air Force Base is vertually flat, with minor irrigation dikes which were easily erroded or overtopped by the flow from McMikan Dam and local run-off. The outflow from 700-foot notch could be only discerned about six miles downslope of the dam embankment.

The March 2, 1978 flow, reaching Luke Air Force Base, filled North Perimeter Channel within inches of overtopping it. To prevent the area from flooding, sand bags were placed at two locations on the south bank of the North Channel. One low point was at the unpaved segment of the channel, west of the double 5' x 10' culvert. The other one was along the paved segment, North of the Luke Air Force Base family housing area. Although the 1978 floodwaters did not break over the North Channel, it demonstrated the existance of a significant flood threat to the mission, equipment, facilities, personnel, and flooding potential of the 875 on-base family housing units. The West Channel functioned adequately during the 1978 floods.

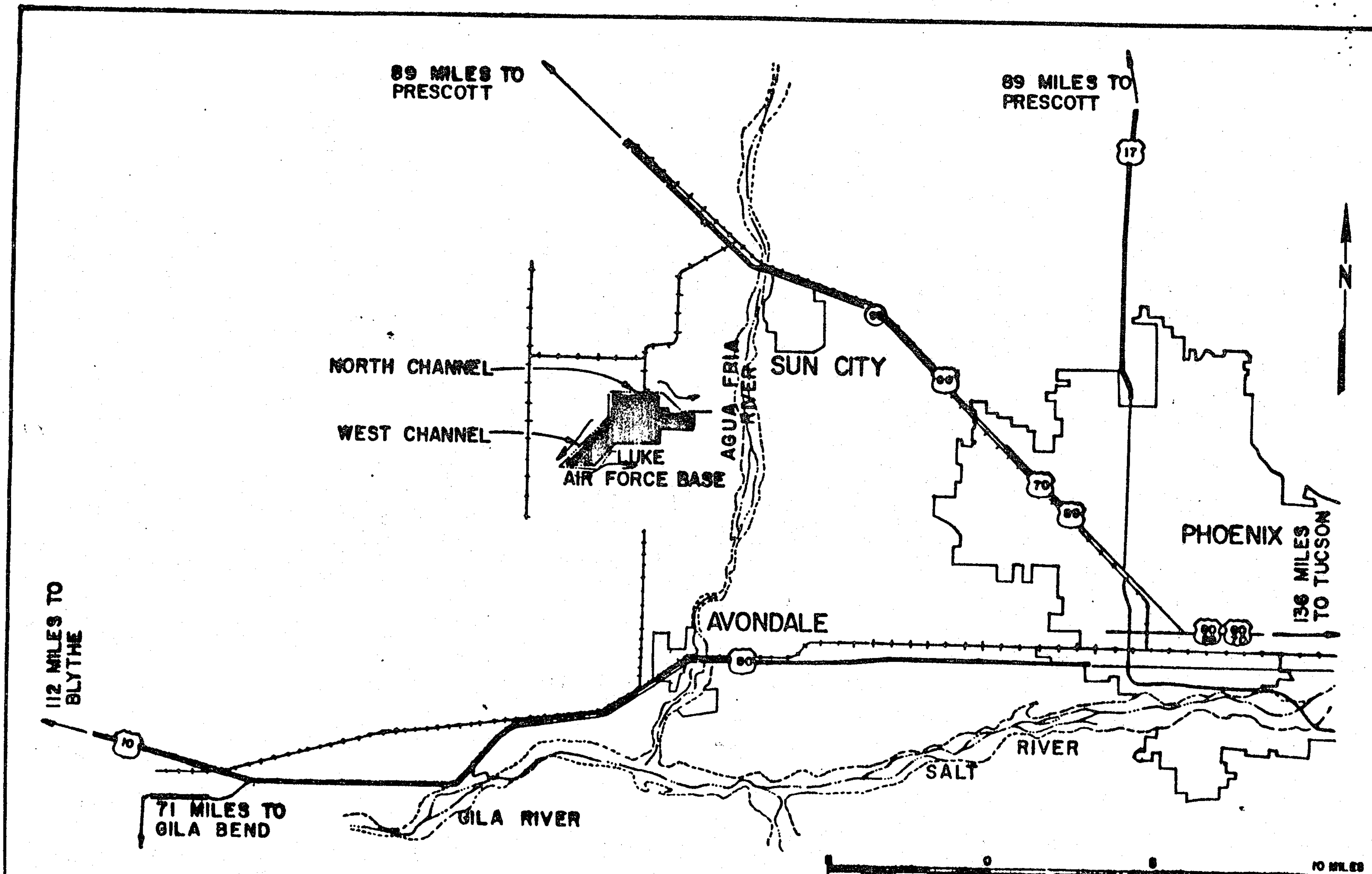


FIGURE 1

VICINITY MAP
SPECIAL FLOOD HAZARD STUDY
LUKE AIR FORCE BASE

Subsequent to the 1978 flood, the Luke Air Force Base personnel have observed that following a significant rainfall run-off would fill the North Channel more quickly now than before the Dam was breached. This condition can be explained by the fact that the present channel has gradually lost its original design capacity and is only adequate to convey very small flows.

5.0 FLOOD SITUATION

The flat terrain at Luke Air Force Base and its surrounding area leads itself to sheet flow type of flooding. Often shallow floodwaters can be controlled by collector channels, which divert flow away from an urban area. The existing North Channel at Luke Air Force Base is such a collector channel which has served its purpose adequately until March 1978, when it almost filled up to the top, and had it not been for the floodfighting efforts, it would have overtopped.

Investigations indicated that the capacity of the North Channel has decreased because of severe channel invert subsidance and poor channel maintenance. The North Channel invert, east of Litchfield Road, has experienced about 2.5 feet of settlement compared to its original design. This area has often ponded water in the channel and it is one of the weak points along the North Channel. In addition, the earth channel along Northern Avenue is severely plugged with brush. Since the flow in this reach is severely hindered, the chance of floodwater overtopping the channel has greatly increased. Table 2 shows the present and original channel capacities along the North and West channels. If the earth channel along Northern Avenue is cleared for increased conveyance, the concrete channel downstream would not be able to handle the extra flow. Therefore, the entire North Channel should be improved in order to provide a complete flood protection to the Base. To this end we have determined the discharge values reaching the Base and the extent of flood on the Base, with and without the McMikan Dam repaired.

5.1 Peak Flow Hydrology.

The flows reaching the Luke Air Force Base are computed under two separate conditions. The first case is assumed that McMikan Dam is repaired and only the flow below the Dam reach the Base. For this case, a special hydrology report was prepared and is shown in Appendix I. The second case is to calculate the outflow from the breached dam and combine it with the flow below the dam and route the flows to Luke Air Force Base. Appendix II contains the details on hydrology computation for the second case.

The discharges from McMikan Dam were routed down to Luke Air Force Base by modified puls reservoir routing procedure. The flood peaks were reduced substantially due to the fact that the floodwater would spread out in less than 2 feet depth and about 1 mile to 1 1/2 miles wide. Consequently the floods could not concentrate in any one defined channel and thus the peaks quickly diminish.

Figure 2 shows the location of various concentration points. The discharge values at these concentration points are shown in table 3. For discharge values with the Dam breached, the values include contribution from the drainage area below the Dam.

Table 3. Summary of Discharge in cfs

With

McMikan Dam Breached

Location and CP. #	SPF	100-yr.	50-yr.	25-yr
Flows from 110' notch				
51	5700	3500	2360	1460
Flows from 700' notch				
50	26000	14800	9300	4800
Flows at North Channel				
1	15000	6300	2300	500
2*	3100	1650	1250	700
Flow at West Channel				
4*	1400	600	370	210
Flow at West Channel				
6*	5800	2550	1300	700

*Flows not changed under the condition of McMikan Dam repaired.