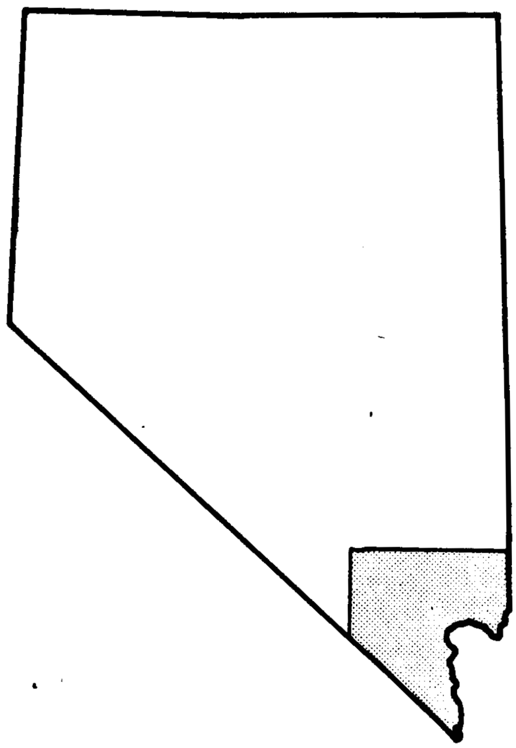
FLOOD INSURANCE STUDY

OFFICE COPY
Regional Flood Control District

OFFICE COPY
Regional Flood Control District

CLARK COUNTY, NEVADA
(UNINCORPORATED AREAS)



Federal Emergency Management Agency

COMMUNITY NUMBER - 320003

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

FIGURES

TABLES

EXHIBITS

FLOOD INSURANCE STUDY
CLARK COUNTY, NEVADA (UNICORPORATED AREAS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the unincorporated areas of Clark County, Nevada, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, Section 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by James M. Montgomery, Consulting Engineers, Inc. (the study contractor), for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-83-C-1197. This study was completed in August 1986.

The hydrologic and hydraulic analyses for the detailed study along the Colorado River were performed by PRC Engineering Inc., of Phoenix, Arizona, for FEMA, under Contract No. EMW-83-C-1193. These analyses were completed in March 1986.

1.3 Coordination

Flooding sources requiring detailed study were identified at a meeting attended by representatives of the study contractor, FEMA, and Clark County on April 14, 1983.

Results of the hydrologic analyses were coordinated with the U.S. Soil Conservation Service (SCS), Clark County Department of Comprehensive Planning, U.S. Army Corps of Engineers (COE), State of Nevada Division of Emergency Management, and the U.S. Geological Survey (USGS).

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Clark County, Nevada. The incorporated areas of the Cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite are not included in this study.

The area of study is shown on the Vicinity Map (Figure 1).

For the purposes of this study, Clark County was divided into three separate study areas: the Moapa Valley, the Laughlin Area, and the Las Vegas Valley.

The Moapa Valley includes the floodplains of the Muddy River and the major washes draining to it from the west. Streams studied by detailed methods are: Muddy River, from the Fish and Game diversion structure to the Wells Siding diversion structure, and from a point approximately 19,200 feet upstream of the Wells Siding diversion structure to a point approximately 15,500 feet upstream of Interstate Highway 15; Overton Wash, from a point approximately 3,900 feet above its mouth for a reach of approximately 12,600 feet; and West Branch Muddy River, from its convergence to its divergence from the main branch of Muddy River, a reach of about 7,000 feet. A portion of Muddy River between River Mile 8.1 and 11.7 was analyzed using approximate methods.

The Laughlin Area includes detailed riverine analyses along the Colorado River and detailed alluvial fan analyses along Bridge Canyon Wash, Dripping Springs Wash, Hiko Springs Wash, and the Southwest Unnamed Wash. The Colorado River was studied by detailed methods from 2.3 miles downstream of Davis Dam to the northern boundary of the Fort Mohave Indian Reservation (adjacent to the City of Bullhead City, Arizona).

The Las Vegas Valley area incorporates new approximate alluvial fan analyses along Blue Diamond Wash, Flamingo Wash, and Red Rock Wash.

In addition, new approximate alluvial fan analysis was performed along Peak Springs Canyon Wash in the Pahrump Valley area of Clark County.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through August 1991.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and

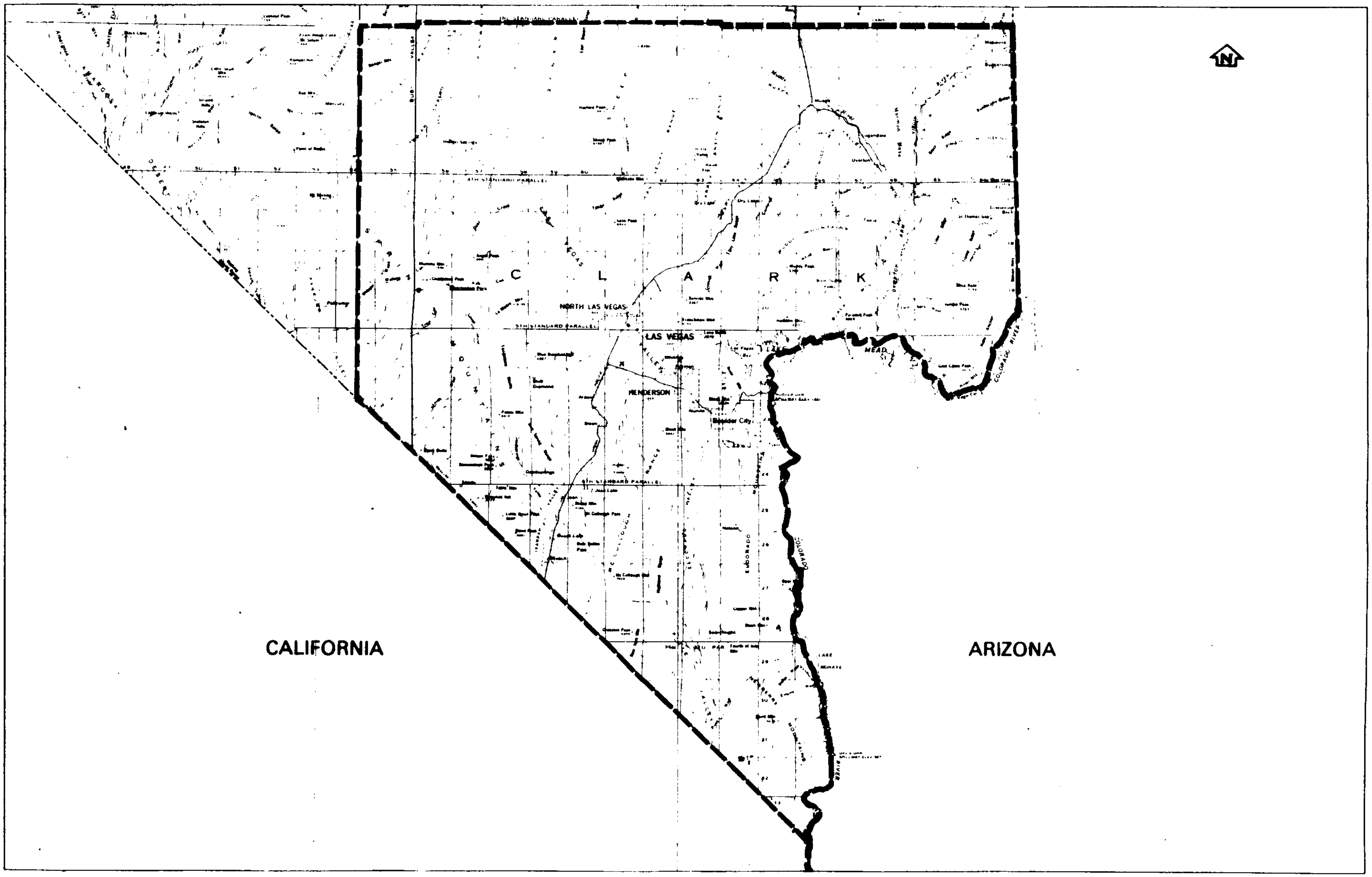


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

APPROXIMATE SCALE

23 0 23 46 69 MILES

VICINITY MAP

methods of study were proposed to, and agreed upon by, FEMA and Clark County.

2.2 Community Description

Clark County is located in Southern Nevada and is bordered to the west by Nye County, Nevada, to the north by Lincoln County, Nevada, to the east by the Colorado River and Mohave County, Arizona, and to the south by San Bernardino County and Inyo County, California.

Population growth has been rapid in Clark County over the past 60 years, increasing from less than 5,000 in 1920 to over 598,300 in 1986. Half of the total county population is located within the unincorporated areas of the county. The population of Clark County is concentrated in the Las Vegas Valley with 96 percent of the total county population, or 574,335 are located in the this valley. Of those, over 288,500 are within the unincorporated portion of the valley (Reference 1). The Cities of Las Vegas, North Las Vegas, Boulder City, and Henderson are the major incorporated population centers.

In addition to the permanent population, a significant visitor population is present in the Las Vegas Valley throughout the year. The visitor population is generated principally by the entertainment, gaming, and recreational opportunities of the area.

Legalized gambling has been the prime element in the economic development of the Las Vegas Valley. The valley has become principally a recreation area with tourism and gaming as the main economic activities. Mining and agriculture have become secondary industries.

The weather in the county is arid, characterized by sparse rainfall, low humidity, and wide extremes in daily temperatures. The average annual precipitation is approximately 3.95 inches. The average annual temperature is about 66°F with average daily maximums in the high 70's and average daily minimums in the mid-50's. Daily maximum temperatures in summer usually exceed 100°F (Reference 2).

Winter storms in the area are regional in nature. These storms are associated with broad low-pressure systems that develop over the Pacific Ocean and move easterly. Precipitation from these storms is generally widespread and is intense only on rare occasions. Summer storms, however, occur as localized thunderstorms and can be intense. These local convective storms are associated with moisture from the Gulf of California and the southern Pacific Ocean that move northeasterly. Floods occurring in the area in and around Clark County are generally associated with precipitation from the summer convective thunderstorms originating in the mountains, occurring mainly during the hotter months (July through September) (References 3 and 4).

Due to the arid nature of the desert in which Clark County is located, the area is dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and concentrates in a short period of time. Consequently, resultant floodflows are of the flash flood type, having sharp peaks and short durations.

Natural vegetation in the area around Clark County is typical of the Mojave Basin desert region and includes creosote brush, a variety of yuccas, mesquite, and sagebrush. Soils are coarse and rocky in the foothill areas, producing rapid runoff. Soils on the plain are more porous, particularly where modified by agricultural activity.

The topography of Clark County is characterized by north-south-trending mountain ranges eroding laterally to vast desert valleys. The ranges rise to elevations as high as 11,918 feet (Mt. Charleston, Spring Mountain Range). Other range crests are between 9,000 and 6,000 feet. Wide alluvial fans or aprons extend from the base of the mountains. The alluvial fans gently level out of the basin lowlands, where sediments from the gullies and washes draining the aprons are deposited. The basin lowlands have been continually filling with sediment since the mountains were formed. Sediment deposition is attributed to the reduced runoff velocities and associated low scouring in the valley bottom areas. Storm drainage channels in the lowlands are poorly defined, and most storm runoff occurs as sheetflow, which is concentrated ultimately in major wash areas with very high speed and intensity.

The Moapa Valley is 50 miles northeast of Las Vegas. Meadow Valley Wash is a major tributary of Muddy River entering from north. Muddy River flows southeasterly into Lake Mead, southeast of the Town of Overton.

In the Lower Moapa Valley, the irrigated land is intensively farmed, and the prime crops are vegetables, other cash crops, and forage crops, which are fed to dairy cattle and horses. More recent irrigation development has occurred in the Upper Moapa Valley. The Moapa Indian Reservation covers a large portion of the irrigated land in this area. In the Meadow Valley Wash area, there is minimal agricultural development, but residential development has begun west of Glendale.

The nonirrigated areas have either phreatrophytes tree and shrub cover or grass and desert brush. The vegetation of the surrounding watershed is very sparse desert brush.

Alluvium is the dominant valley-fill material in the Moapa Valley and Mesquite-Bunkerville area. It is generally very thick and consists of gravel, sand, silt, and clay of sedimentary origin. The soils in the area are generally fine to moderately coarse textured in the valley bottom, and moderately coarse or coarse textured and gravelly on the upper terraces. Colors are usually pale or light brown. There is little organic matter or nitrogen in the native soil. Deposits of gypsum and other salts originating from the Muddy Creek Formation are found in parts of the valley.

The Laughlin Area is located 70 miles south and slightly east of the City of Las Vegas. The development consists of a coal-fired power plant and a small casino-resort complex located on the west bank of Colorado River.

Soils in the Laughlin area consist of: Carrizo-Gunsight, sloping sandy loam surface; rock outcrop Gachado, a very cobbly fine sandy loam surface; Gunsight-Carrizo-Ajo, a sandy gravelly loam; and Gilman-McClellan-Coachella, loam and loamy fine sand.

2.3 Principal Flood Problems

The typical flood-producing storm causing flooding problems in Clark County are associated with summer thunderstorms of short duration and high intensity which result in significant runoff rates. These storms result from tropical depressions which approach Clark County from the south or southeast. Summer or winter general storms of longer duration and lower intensity have not contributed to significant discharges in the past.

Severe storms have occurred in the Clark County area in the past decade. There are only three first-order rain gages in Southern Nevada (at Las Vegas Airport, Boulder City, and Searchlight). Thus, much of the information regarding historical storms comes from other scattered gages and eyewitness accounts. Recent major flood events have occurred in August 1981, August 1983, and July 1984. The 1981 event was the result of a severe thunderstorm which occurred on August 10, 1981, moving from north to south across southeastern Nevada. Heaviest rainfall was reported over the Moapa Valley (Reference 5), with at least one inch of rain falling over approximately 10,000 square miles. In the area of greatest intensity, 6.5 inches of rain was estimated to fall in less than one hour.

On August 10, 1983, an intense flash-flood thunderstorm occurred over the upper portion of Flamingo Wash (Reference 6), moving from south to north and causing flooding in the Las Vegas Valley area of Clark County. The storm produced at least one inch of rain over 100 to 150 square miles. The maximum total storm depth was estimated to be 4 inches occurring over a 3-hour period.

A series of thunderstorms swept through southern Nevada in July and August 1984 and caused flooding in the Las Vegas Valley, the Moapa Valley, and the City of Boulder City. The total storm depth at the City of Boulder City was 3.25 inches in a 2.5-hour period. (Reference 3).

Most of the stream channels located on debris cones or alluvial fans are inadequate to pass even minor floods, and flows rarely spread out evenly over the surface of an alluvial fan. Typically, flow is concentrated in a temporary channel or confined to a portion of the fan surface. The flow paths are prone to lateral migration and sudden relocation to other areas of the fan during a single flood event. This erratic, unpredictable behavior subjects all portions of the fan to potential flood hazard.

Channel migration is considerably less on larger well-defined washes, especially where channel stability measures have been constructed (i.e., reinforced concrete lining or rock riprap). On washes where protective measures have not been constructed, rapid alteration may occur in the channel banks due to the highly erosive materials that produce an alluvial fan. In undeveloped areas, floodflows on alluvial fans are essentially unmodified, and processes such as fanhead trenching, braiding of distributary channels, and channel abandonment occur.

Urban development on alluvial fans are subjected to major flood-related hazards to such as high velocities, rapid bank erosion, and sediment deposition.

Flood within the Moapa Valley are of two types: (1) Major storms on the upstream watershed of Muddy River and its tributary, Meadow Valley Wash; and (2) intense convective storms on the watershed of local side washes. Flooding of both types has always been a problem in the developed and irrigated areas.

On August 17, 1922, a large flood damaged much of the Moapa Valley. The flood came through Arrow Canyon into the upper end of the valley and was augmented by flow from side washes emptying into the valley. Roads and bridges were washed out, and the drugstore and many houses were flooded in Overton. The estimated discharge for the lower Moapa area was 8,110 cubic feet per second (cfs) and had a recurrence interval of approximately 20 years.

A large flood hit Meadow Valley Wash and Lower Moapa Valley on March 3, 1983. The estimated discharge was 10,000 cfs, and the recurrence interval was 30 years.

On August 11, 1941, the largest flood recorded in the Lower Moapa Valley occurred. An intense short-duration storm over the Lower Moapa Valley and California Wash produced estimated discharges of 10,000 cfs at California Wash and 12,000 cfs at Glendale. The latter is estimated to be a 36-year flood. The discharge on California Wash is estimated to be a 100-year flood.

The most recent large flood in the Moapa Valley occurred in November 1960. The estimated discharge near Glendale was 7400 cfs, with a return period of 16 years.

Vegetation in channels of Muddy River and Meadow Valley Wash obstruct floodflows. In many areas, trees and shrubs grow on the channel banks and bottom and thereby increase roughness and decrease the effective flow area of the channel. There are several culverts and bridge crossings along Muddy River. The culverts are often overtopped by floodwaters, and erosion and washing occurs.

In past floods, bridges have been washed out and carried downstream, thus aggravating flood problems.

The Laughlin area is subject of flash floods coming from west of the area. There are few well-defined channels to concentrate the floodflows. Most of the damage consists of roads being covered with silt, boulders, and other debris, making travel impossible at times.

The Colorado River has been a major flooding source in the Laughlin area of Nevada and the entire Mohave Valley. This valley is of alluvial origin and prior to the construction of levees for channelization, the river twisted and meandered through the area. Prior to the construction of Hoover Dam and other dams on the Colorado River, major snowmelt floods caused damage to the lower Colorado River basin each spring. Peak floodflows of 300,000 cfs occurred in 1884, and 220,000 cfs occurred in 1921 (Reference 4). These flows are far in excess of the present 500-year frequency flood used in this study.

During the spring and early summer of 1984, higher than normal snowmelt in the Colorado River Basin filled the storage capacity of the Colorado River dam system. Releases in excess of 40,000 cfs from Davis Dam were required for a period of time during the late summer and fall of 1984. Several residential structures adjacent to the Colorado River experienced flood damage as a result of these releases.

2.4 Flood Protection Measures

Development occurred in Clark County without any significant flood control structures until the Civilian Conservation Corps (CCC) was sent to Nevada in 1933. After the CCC left in 1935, no major flood control improvements were made in the county for over 20 years.

The North Las Vegas Detention Basin is a 2,600 acre-foot facility located in the northern Las Vegas Valley, on Las Vegas Wash. The amount originally funded for the project was $2.8 million and was budgeted by the 1981 Clark County Flood Control Bond Issue. An additional $500,000 was requested and received from Clark County when this amount proved to be insufficient to complete construction. Construction of the project began in September 1983, and work was completed by April 1984. The basin is located 3.5 miles north of Craig Road on Losee Road. It is the largest detention basin in the State of Nevada. Flows from the north on Las Vegas Wash are routed through the basin, which diverts up to 9,000 cfs from the wash and reduces the flow to a 4,500 cfs outflow. When full, the basin is designed to contain a 100-year floodflow on Las Vegas Wash. Flows from storms of a frequency higher than the 100-year event will cause some overtopping of the diversion berm in the wash.

The Angel Park Detention Basin is located upstream of the Las Vegas Expressway and currently has a storage capacity of approximately

950 acre-feet. The project was funded in phases through the 1981 Clark County Flood Control Bond Issue and a cooperative agreement between the City of Las Vegas and Clark County for appropriation of bond issue funds for design and construction of the basin. This agreement was dated July 1982. The final phase (Phase IIB) of the project was completed in late 1985.

The Red Rock Detention Basin is located in the southwestern Las Vegas Valley, on the alluvial fan portion of Red Rock Wash, downstream of the Charleston Boulevard crossing. The facility has a storage volume of 1,673 acre-feet at the spillway crest. It reduces the 100-year peakflow on Red Rock Wash to 1,390 cfs through a pair of 60 inch RCP outlet works.

Current county ordinances require that any new construction be elevated 18 inches above the 100-year water-surface elevation, as determined by the developer.

Several flood control structures have been built on Muddy River and Meadow Valley Wash in the Moapa Valley.

In 1935 and 1936, Wells Siding Diversion Dam and Bowman Reservoir were constructed by the CCC. These structures are located near the upper end of the Lower Moapa Valley. The Wells Siding Diversion Dam diverts Muddy River flows into the Lower Moapa Valley Canal System and into Bowman Reservoir. The feeder canal to Bowman Reservoir has a capacity of approximately 1,000 cfs. Bowman Reservoir is approximately 1 mile east of Wells Siding Dam and is approximately 30 feet high and 780 feet long. The reservoir is used to store excess winter flows to supplement the normal Muddy River discharge during the heavy irrigation season. Runoff from a small side wash is collected in Bowman Reservoir, but this has a minor effect on reducing peak flows on Muddy River.

The Muddy River channel was enlarged for 2 miles in the vicinity of Logandale by the CCC.

Arrow Canyon Dam was built by the CCC on Muddy River. This dam is approximately 30 feet high and is constructed of rubble masonry. At the time of compiling this study, the storage area of the dam was filled with sediment and no longer controlled floodflows.

A channelization project completed in the early 1960s, between the Union Pacific Railroad and the upstream boundary of the Moapa Indian Reservation, affords some flood protection to the lands within this portion of Muddy River.

Two COE dams, Pine Canyon and Mathews Canyon Dams, are located in the drainage area of Meadow Valley Wash above the Town of Caliente, Lincoln County, Nevada. The SCS has constructed a watershed protection and flood prevention project in the headwaters of Meadow Valley Wash. Because of the distance from the study area, their effect on major floodflows in the study area is minimal.

In the Laughlin area, flows in Colorado River are regulated by Hoover Dam and Davis Dam, north of the area. These structures offer flood protection from events larger than the 100-year flood on Colorado River.

Additionally, the U.S. Bureau of Reclamation (USBR) has constructed a levee for flood protection along the Colorado River through the area. The levee, designed to contain the 100-year discharge, is armored with rock riprap to protect it from erosion.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each riverine flooding source studied by detailed methods affecting the community.

Peak discharges for the desired return periods were computed for flooding sources in Clark County primarily through the use of the TR-20 Project Formulation-Hydrology computer program (Reference 8) or by using log-Pearson Type III procedures. The TR-20 program was developed by the SCS to implement the SCS unit hydrograph procedures.

Aspects for the hydrologic analysis which are common to all of the study areas are discussed in the following paragraphs, after which specific procedures applied to each individual area are described.

An investigation of flood-producing storms typical of Southern Nevada was conducted. It was determined, based on a review of published historical storm events, that thunderstorms in the study area are generally of approximately 3-hour duration, and cover at most 150 to 200 square miles. Qualitative descriptions of historical events were used to develop a synthetic cumulative time distribution for a 3-hour thunderstorm in Southern Nevada. This distribution was adopted rather than any of the SCS standard dimensionless storm patterns. This approach was coordinated with local meteorologists.

Point precipitation values for the 10-year, 50-year, and 100-year 3-hour storms were obtained from the NOAA Precipitation-Frequency Atlas for the State of nevada (Reference 9). Depth-area reduction factors from a recent publication of NOAA called HYDRO-40 (Reference 10) were used to estimate average rainfall over each of the study watersheds. Although HYDRO-40 was developed using actual storm data from Arizona and western New Mexico, common storm-producing mechanisms would appear to justify application of the results to Southern Nevada as well. Peak 500-year floodflows for the study streams analyzed with TR-20 were estimated by extrapolating graphically from the computed 10-, 50-, and 100-year discharges.

All peak flows adopted for use in this study are considered to be clear water flows. That is, no sediment or debris bulking factors have been applied to the results of the TR-20 or log-Pearson Type III analyses. Bulking has not been used in this study based on discussions with Clark County Public Works engineers, who indicated that channels and storage facilities in the study reaches do not seem to exhibit large widespread amounts of sedimentation or erosion.

The primary flooding a source in the Moapa Valley is Muddy River. This is a major watercourse with a USGS stream gage located in "The Narrows" between the Upper and Lower Moapa Valley. The gage has a 33 year period of systematic record, as well as historical peak estimates, which was considered adequate for use in a statistical analysis. The log-Pearson Type III method recommended by Water Resources Council Bulletin 17B (Reference 11), was used to determine 10-, 50-, 100- and 500-year peak flows at the gage site. This analysis made use of the full systematic record up to the 1983 water year, and incorporated the 15 historical peaks as per Bulletin 17B.

Subsequent to the initial statistical analysis and preliminary hydraulic calculations, a large flood occurred on the Muddy River in August 1984, which generated the highest peak flow in the systematic record. As a result, frequency statistics were recomputed, including the new flow. However, it was determined that the previously estimated discharges fell within the 50 percent confidence interval of the more recent estimates and thus, in accordance with Flood Insurance Study Guidelines, the original discharges were adopted.

Peak discharges at the Muddy River gage were translated downstream by two compensating methods: (1) flows were increased by the ration of the increased drainage area; and (2) flows were routed through the Moapa Valley floodplain using the normal depth routing method, assuming a hydrograph shape similar to that developed by the COE in the Flood Plain Information Report for the Muddy River (Reference 12). In addition, peak flows for all recurrence intervals were reduced by 1,000 cfs downstream of Wells Siding to account for water supply diversions to Bowman Reservoir. This is the maximum capacity of the diversion facility.

Peak flows for Muddy River upstream of Meadow Valley Wash were determined by a discharge-drainage area relationship developed using log-Pearson analyses of records from two gages: Muddy River near Glendale and Meadow Valley Wash near Caliente.

Peak floodflows for Overton Wash were originally scheduled to be determined using a regional regression approach. However, two factors-questionable reliability of the best available regional methods, and a recent TR-20 analysis of the sources by the SCS-resulted in the use of TR-20 for Overton Wash hydrology.

Peak 100-year floodflows at the apexes of the four major alluvial fans in the Laughlin area (Hiko Springs Wash, Bridge Canyon Wash, Drippings Springs Wash, and Southwest Unnamed Wash) were computed using a TR-20 model developed by the Clark County Department of Comprehensive Planning. The flood magnitude-frequency relationships for these washes were assumed to be normal distributions of the base 10 logarithms of the peak discharges. The distributions were assumed to have a standard deviation of 0.8.

This area had originally been scheduled for analysis with regional regression methods. However, during the course of the study, the Department of Comprehensive Planning conducted a floodplain study for the Laughlin Area which included a TR-20 model for each of the fan tributary areas. After review and some minor revisions, this model was adopted for the Flood Insurance Study hydrology as the best available information. There is no historical rainfall-runoff data available from the Laughlin flooding sources with which to calibrate the hydrologic model. Critical storms were assumed to occur independently over each of the four dam watersheds, which have areas ranging from 4 to 18 squares miles.

Peak discharge-frequency relationships for the Colorado River were based on operating procedures for the Hoover Dam (Reference 13) and USBR information (Reference 7). These discharges were adopted for the Bullhead City study area. The 100-year peak discharge is equivalent to the "levee design flood" used by the USBR. The 10-, 50-, and 500-year peak discharge relationships were based on operating procedures for Hoover Dam and additional information provided by the USBR (Reference 7 and 13).

Peak discharge-drainage area relationships for all of the flooding sources studied by detailed methods are shown in Table 1.

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Colorado River					
At Bullhead City, Arizona	169,300	28,000	40,000	50,000	73,000
Muddy River					
At Cooper Avenue	4,035	5,250	14,750	21,300	45,900
Downstream of Wells Siding	3,950	5,270	14,800	21,400	45,500
Upstream of Confluence with Meadow Valley Wash	1,360	3,620	10,900	16,000	34,400
Overton Wash					
At Upstream Limit of Detailed Study	21.7	2,170	4,510	5,680	8,200
West Branch Muddy River					
Downstream of Cooper Avenue	--[1]	100	2,450	9,000	20,900
Hiko Springs Wash					
At Apex	17.9	1,220	5,070	8,370	23,130
Bridge Canyon Wash					
At Apex	7.3	650	2,680	4,430	12,240
Dripping Springs Wash					
At Apex	4.5	460	1,910	3,150	8,710
Southwest Unnamed Wash					
At Apex	3.9	260	1,070	1,770	4,890

[1]Flow due to overflows from Muddy River

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Cross sections for the backwater analyses of the detailed riverine study streams were obtained from an aerial survey conducted in May 1984. This information was augmented by relative channel sections obtained by field measurement. All bridges and culverts were field surveyed to obtain hydraulic data and structural geometry.

Cross sections for the backwater analyses of Colorado River were obtained from the USBR (Reference 7). The below-water sections were obtained by field measurement. Ground topography was joined with the river cross section information at appropriate locations. Ground topography was obtained from three sources:

1. From aerial photogrammetry, flown in 1984 and compiled at a map scale of 1 inch = 400 feet with a 4-foot contour interval (Reference 14).

2. From aerial photogrammetry, flown in 1977 and compiled at a map scale of 1 inch = 100 feet with a 2-foot contour interval (Reference 15).

3. From USGS quadrangle maps at a scale of 1 inch = 2,000 feet with a 5-foot contour interval (Reference 16).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Roughness coefficients (Manning's "n") used in the hydraulic analysis were selected based on field observation and engineering judgment. For the Colorado River, a roughness value of 0.030 was used for the main channel, and a value of 0.125 for the overbank areas. For the Muddy River, roughness values range from 0.050-0.070 for the main channel, and from 0.040-0.065 for the overbank areas. For Overton Wash, roughness values ranged from 0.040-0.050 for the main channel, and from 0.040-0.070 for the overbank areas. For West Branch Muddy River, roughness values ranged from 0.050-0.060 for the main channel, and from 0.040-0.050 for the overbank areas.

Water-surface elevations of flood of the selected recurrence intervals were computed through the use of the COE HEC-2 step-backwater computer program (Reference 17).

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The starting water-surface elevations for Muddy River, Overton Wash, and West Branch Muddy River were calculated using the slope-area method.

This starting method assumes that floods on the tributary stream are independent of floods on the main stream. The large difference in watershed areas between these tributaries and their main streams makes it very unlikely that concurrent floods would occur on both sources.

Starting water-surface elevations for the Colorado River were determined by constructing stage/discharge curves from information supplied by the USBR and USGS.

In evaluating the floodplains for Muddy River and Overton Wash, it was determined that channel overflows occurred, particularly for the more infrequent flood events. These overflows leave the channel and do not return to it. Overflow magnitudes were determined by modeling the full flow over the entire floodplain (including the overflow area), and using either the flow distribution routine of HEC-2 or hand calculations to estimate the percentage of flow occurring in the overbanks. For determination of natural profiles, the overflow was subtracted from the full flow and the cross sections were modified to show effective flow area only in the main floodplain (excluding the overflow areas). Thus, flows in the HEC-2 model may decrease in a downstream direction as overflows are progressively subtracted from the main flow area at subsequent cross sections.

Normal depth calculations were made at cross sections taken from USGS maps (Reference 18) for the reach of Muddy River analyzed using approximate methods.

The FEMA alluvial fan methodology was used to determine the flood depths and velocities on the alluvial fans in the Laughlin area (Reference 19). For two of the four fans in the area (Bridge Canyon Wash and Southwest Unnamed Wash), it was determined that the flood events consist of multiple channels. Therefore, the methodology for multiple flood channels was used to analyze the multiple channel regions of those alluvial fans.

In alluvial fan areas subject to flooding from more than one flooding source, flood depths and velocities were computed by assuming that the event of inundation by a flood from any canyon is independent of the event of inundation by a flood from any other canyon. In accordance with FEMA guidelines, the union of such events, which has a probability of 0.01, was used to define depths and velocities in areas where multiple alluvial fans intersect.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using rectified photo-topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Reference 20).

For the Colorado River, floodplain boundaries were interpolated using topographic maps at scale of 1:4,800 with a contour interval of 4 feet (Reference 14).

Approximate floodplain boundaries on Muddy River were delineated on USGS 7.5-Series Topographic Maps (Reference 18).

The alluvial fan boundaries were also delineated using rectified photo-topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Reference 20).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and AO); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2.)

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map for Clark County (Reference 21).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100- year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated at selected cross sections (Table 2). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASs
Colorado River								
A	262.3	945/660	10,764	4.6	491.3	491.3	492.3	1.0
B	263.0	971/640	11,259	4.4	492.1	492.1	493.0	0.9
C	263.4	962/680	9,308	5.4	492.6	492.6	493.4	0.8
D	264.4	459/210	7,618	6.6	494.6	494.6	495.2	0.6
E	265.4	681/290	9,562	5.2	496.9	496.9	497.3	0.4
F	266.5	663/370	8,853	5.6	499.3	499.3	499.5	0.2
G	267.3	639/225	8,098	6.2	500.9	500.9	501.3	0.4
H	268.0	569/320	9,555	5.2	502.0	502.0	503.0	1.0
I	269.0	552/280	9,509	5.3	503.3	503.3	504.2	0.9
J	269.8	1001/375	11,444	4.4	504.8	504.8	505.5	0.7
K	270.5	561/160	7,773	6.4	505.8	505.8	506.4	0.6
L	271.2	563/220	10,276	4.9	507.4	507.4	507.8	0.4
M	271.9	763/380	15,626	3.2	508.1	508.1	508.5	0.4
N	273.0	746/360	11,052	4.5	508.7	508.7	509.1	0.4

[1]Miles Above Mexican Boundary
[2]Width/Width Within County Boundary

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

COLORADO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Muddy River								
A	0	1,886	4,080	5.2	1,240.2	1,240.2	1,240.2	0.0
B	890	1,444	4,975	4.3	1,242.4	1,242.4	1,242.8	0.4
C	1,680	1,477	6,555	3.3	1,243.7	1,243.7	1,244.5	0.8
D	2,650	1,726	6,460	3.3	1,245.5	1,245.5	1,246.4	0.9
E	3,600	2,222	9,317	2.3	1,248.3	1,248.3	1,249.2	0.9
F	4,520	1,331	5,026	4.2	1,249.7	1,249.7	1,250.5	0.8
G	5,440	1,418	5,846	3.7	1,252.6	1,252.6	1,253.5	0.9
H	6,280	1,942	5,105	4.2	1,254.9	1,254.9	1,255.9	1.0
I	7,240	2,289	7,198	3.0	1,257.1	1,257.1	1,258.0	0.9
J	8,220	2,350	4,458	4.8	1,258.6	1,258.6	1,259.6	1.0
K	9,070	2,009	3,467	4.0	1,262.5	1,262.5	1,263.1	0.6
L	10,200	1,350	2,409	5.7	1,268.0	1,268.0	1,268.1	0.1
M	11,170	700	2,131	6.5	1,273.7	1,273.7	1,274.6	0.9
N	12,180	545	2,355	5.9	1,278.5	1,278.5	1,279.2	0.7
O	13,390	807	2,034	6.8	1,285.7	1,285.7	1,285.7	0.0
P	14,470	808	3,918	3.5	1,288.8	1,288.8	1,288.8	0.0
Q	15,290	121	1,078	12.8	1,288.9	1,288.9	1,289.0	0.1
R	16,500	1,511	4,314	4.9	1,299.0	1,299.0	1,299.9	0.9
S	17,410	2,065	10,672	2.0	1,303.3	1,303.3	1,304.3	1.0
T	18,190	1,818	6,260	3.4	1,303.7	1,303.7	1,304.6	0.9
U	19,130	117	1,463	14.6	1,305.0	1,305.0	1,305.6	0.6
V	20,070	649	2,352	9.1	1,314.9	1,314.9	1,314.9	0.0
W	21,160	600	2,607	8.2	1,319.8	1,319.8	1,320.8	1.0
X	22,220	700	2,665	8.0	1,325.2	1,325.2	1,325.9	0.7
y	23,320	700	2,981	7.1	1,330.0	1,330.0	1,330.7	0.7
Z	24,260	822	3,013	7.1	1,333.1	1,333.1	1,334.2	1.1

[1]Feet Above Fish and Game Diversion Structure

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

MUDDY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Muddy River								
AA	25,330	626	2,977	7.2	1,336.8	1,336.8	1,337.9	1.1
AB	26,390	185	1,932	11.0	1,340.1	1,340.1	1,340.8	0.7
AC	27,420	155	2,211	9.7	1,344.6	1,344.6	1,345.0	0.4
AD	28,560	147	2,816	7.6	1,347.6	1,347.6	1,348.0	0.4
AE	29,870	128	2,065	10.4	1,349.9	1,349.9	1,350.3	0.4
AF	31,170	234	2,534	8.5	1,358.3	1,358.3	1,359.0	0.7
AG	32,090	176	2,498	8.6	1,361.2	1,361.2	1,361.7	0.5
AH	33,140	150	2,329	9.2	1,364.2	1,364.2	1,364.9	0.7
AI	33,980	152	2,159	10.0	1,367.8	1,367.8	1,368.6	0.8
AJ	35,162	104	1,125	19.0	1,378.8	1,378.8	1,379.5	0.7
AK	36,412	170	3,138	6.8	1,389.0	1,389.0	1,389.7	0.7
AL	37,462	334	4,143	5.2	1,390.7	1,390.7	1,391.3	0.6
AM	38,682	303	3,613	5.9	1,392.2	1,392.2	1,392.6	0.4
AN	39,622	235	2,890	7.4	1,394.0	1,394.0	1,394.3	0.3
AO	40,562	121	1,247	17.2	1,399.0	1,399.0	1,399.0	0.0
AP	41,482	571	2,230	9.6	1,412.5	1,412.5	1,412.5	0.0
AQ	42,182	548	3,016	7.1	1,418.7	1,418.7	1,418.9	0.2
AR	42,832	445	3,719	5.8	1,422.0	1,422.0	1,422.1	0.1
AS	61,780	245	2,705	7.9	1,491.6	1,491.6	1,491.6	0.0
AT	63,530	715	5,969	3.6	1,494.4	1,494.4	1,494.8	0.4
AU	65,200	1,021	5,978	3.6	1,495.6	1,495.6	1,496.4	0.8
AV	66,950	669	3,319	6.4	1,498.2	1,498.2	1,499.1	0.9
AW	68,630	462	5,430	3.9	1,501.3	1,501.3	1,502.1	0.8
AX	70,420	364	2,831	7.5	1,504.1	1,504.1	1,504.5	0.4
AY	71,910	529	3,564	6.0	1,510.4	1,510.4	1,511.2	0.8
AZ	73,250	598	3,337	6.4	1,515.6	1,515.6	1,516.3	0.7

[1]Feet Above Fish and Game Diversion Structure

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

MUDDY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Muddy River								
BA	74,600	351	3,676	5.8	1,519.9	1,519.9	1,520.7	0.8
BB	75,880	512	3,390	4.7	1,523.3	1,523.3	1,524.0	0.7
BC	76,450	500	4,139	3.9	1,524.4	1,524.4	1,524.9	0.5
BD	77,476	508	4,147	3.9	1,526.4	1,526.4	1,526.7	0.3
BE	78,686	343	3,271	4.9	1,527.8	1,527.8	1,528.3	0.5
BF	79,826	370	4,172	3.8	1,531.5	1,531.5	1,532.1	0.6
BG	81,016	306	3,527	4.5	1,532.9	1,532.9	1,533.5	0.6
BH	82,476	358	3,614	4.4	1,535.2	1,535.2	1,535.8	0.6
BI	84,446	249	2,476	6.5	1,538.5	1,538.5	1,539.2	0.7
BJ	85,636	249	3,044	5.3	1,541.8	1,541.8	1,542.7	0.9
BK	86,666	326	3,638	4.4	1,544.1	1,544.1	1,545.0	0.9
BL	88,916	958	3,438	4.7	1,550.4	,550.4	1,551.1	0.7
BM	90,676	2,682	5,811	2.8	1,556.2	1,556.2	1,556.9	0.7

[1] Feet Above Fish and Game Diversion Structure

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

MUDDY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Overton Wash								
A	3,880	471	959	5.9	1,261.2	1,261.2	1,261.9	0.7
B	4,642	89	444	12.8	1,267.0	1,267.0	1,267.9	0.9
C	5,312	150	862	6.6	1,275.5	1,275.5	1,276.9	1.4
D	5,897	163	742	7.7	1,278.4	1,278.4	1,279.2	0.8
E	6,567	73	416	13.7	1,295.2	1,295.2	1,296.1	0.9
F	7,397	129	704	8.1	1,304.0	1,304.0	1,304.7	0.7
G	8,217	457	905	6.3	1,311.0	1,311.0	1,311.1	0.1
H	9,147	629	1104	5.1	1,320.9	1,320.9	1,320.9	0.0
I	10,387	321	684	8.3	1,341.3	1,341.3	1,341.3	0.0
J	10,927	840	945	6.0	1,352.8	1,352.8	1,252.8	0.0
K	11,817	317	824	6.9	1,365.0	1,365.0	1,365.0	0.0
L	13,297	750	897	6.3	1,390.2	1,390.2	1,390.2	0.0
M	15,097	555	993	5.7	1,417.9	1,417.9	1,417.9	0.0
N	16,477	371	716	7.9	1,437.4	1,437.4	1,437.4	0.0

[1]Feet Above Confluence with Muddy River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

OVERTON WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
West Branch Muddy River								
A	3,480	344	2,136	3.5	1,261.6	1,261.6	1,262.1	0.5
B	4,030	218	1,706	4.4	1,263.8	1,263.8	1,264.3	0.5
C	4,860	412	1,678	4.5	1,265.6	1,265.6	1,266.6	1.0
D	5,740	193	1,202	6.2	1,269.9	1,269.9	1,270.5	0.6
E	6,930	180	1,332	5.6	1,275.8	1,275.8	1,275.9	0.1
F	8,120	122	941	8.0	1,280.4	1,280.4	1,281.4	1.0
G	9,020	600	1,500	5.0	1,287.4	1,287.4	1,288.0	0.6
H	10,040	950	2,493	3.0	1,292.1	1,292.1	1,292.6	0.5

[1]Feet Above Confluence With Muddy River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOODWAY DATA

WEST BRANCH MUDDY RIVER

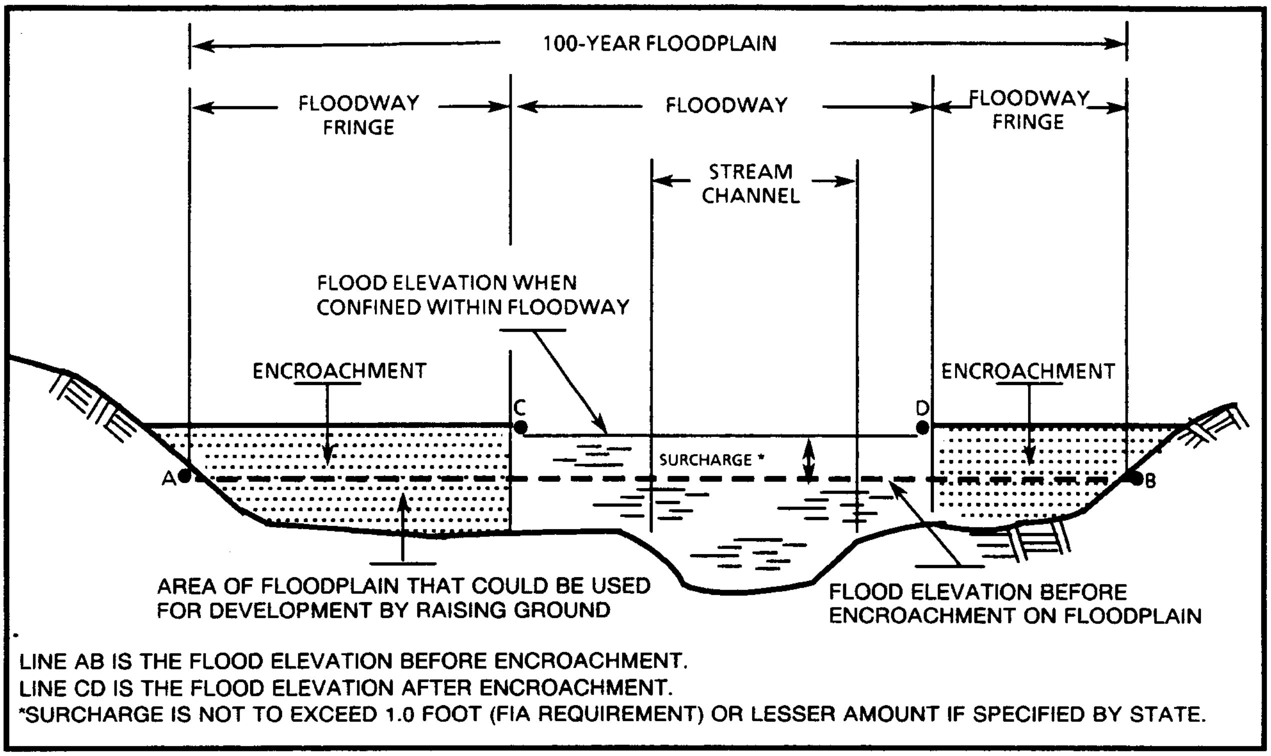


Figure 2. Floodway Schematic

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone. Alluvial fan flood hazard areas are shown on the Flood Insurance Rate Map as Zone AO, and average depths and velocities of flow are shown. In these areas, the 100-year flood depths may exceed 3 feet. Development on alluvial fans is subject to a more severe flood hazard than would normally be encountered in Zone AO because the velocities of flows in the alluvial fan are high and the locations of the flow paths on the alluvial fan are unpredictable.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, floodways, and locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

Flood Insurance Studies have been performed for the incorporated Cities of Las Vegas, North Las Vegas, Henderson, and Boulder City (References 22, 23, 24, 25, respectively). The information shown in those studies does not match the information shown in this study for Clark County because all flooding shown in the county that is contiguous to the above-mentioned communities is from approximate analyses taken directly from the Flood Hazard Boundary Map for Clark County. The four cities each have detailed Flood Insurance Studies.

A Flood Insurance Study was prepared for the City of Mesquite (Reference 26). The information in that study matches exactly with the information in this study for Clark County.

Detailed analyses of flooding along Colorado River matches exactly with the detailed analyses of flooding shown in the Flood Insurance Study for the City of Bullhead City, Arizona (Reference 27). Flood Insurance Studies for Nye County, Nevada; Lincoln County, Nevada; Mohave County, Arizona; San Bernardino County, California; and Inyo County, California have been performed (References 28, 29, 30, 31, and 32, respectively). The information in those studies generally agrees with the information given in this study for Clark County.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California 94129.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Clark County Department of Comprehensive Planning, Las Vegas, Nevada, August 27, 1986.

2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Climatological Data, State of Nevada.

3. Clark County Regional Flood Control District, Flood Control Master Plan, Volume 1, James M. Montgomery, Consulting Engineers, Inc., May 1986.

4. U.S. Department of the Interior, Geological Survey, Water-Resources Investigations, Open-File Report 80-963, Flood Potential of Topopah Wash and Tributaries, Eastern Part of Jackass Flats, Nevada Test Site, Southern Nevada, R.C. Christensen and N.E. Spahr, 1980.

5. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Report on the Moapa Valley Flash Flood, August 10, 1981, 1982.

6. U.S. Department of the Interior, Geological Survey, Flash Flood of August 10, 1983 in Las Vegas Valley, Nevada, Provisional records, 1983.

7. U.S. Department of the Interior, Bureau of Reclamation, Flood Plain Information, Colorado River, Davis Dam to Topock, Boulder City, Nevada, March 1969.

8. U.S. Department of Agriculture, Soil Conservation Service, TR-20, Computer Program For Project Formulation - Hydrology, 1982.

9. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Precipitation-Frequency Atlas of the Western United States, Volume VII-Nevada, NOAA Atlas 2, J.F. Miller, R.H. Frederick, and R.J. Tracey, 1973.

10. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Depth-Area Rations in the Semi-Arid Southwest United States, Technical Memorandum NWS HYDRO-40, August 1984.

11. U.S. Water Resources Council, Guidelines For Determining Flood Flow Frequency, Bulletin #17B, September 1981.

12. U.S. Department of the Army, Corps of Engineers, Flood Plain Information Report, Muddy River, June 1974.

13. U.S. Department of the Army, Corps of Engineers, Los Angeles District, Colorado River Basin, Hoover Dam: Review of Flood Control Regulations, Los Angeles, California, July 1982.

14. Kenney Aerial Mapping, Aerial Photogrammetry, Mohave County, Arizona, Map scale 1"=400', Phoenix, Arizona 1984.

15. U.S. Department of the Army, Corps of Engineers, Los Angeles District, Aerial Photogrammetry, Colorado River Needles Area, Map scale 1"=100', Los Angeles, California, May 18, 1977.

16. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Map Scale 1"=2000'.

17. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, Davis, California, September 1982.

18. U.S. Department of the Interior, Geological Survey, 7.5-Minute Topographic Maps, Scale 1:24,000, Contour Intervals 10 and 20 feet.

19. Federal Emergency Management Agency, Office of Natural and Technological Hazards, Computer Program for Determining Flood Depths and Velocities on Alluvial Fans, D.S. Harty, December 1982.

20. Cooper Aerial of Nevada, Stereoscopic Aerial Photography of Clark County, Nevada, Scale 1:4,800, Contour Interval 4 feet: 1984.

21. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Clark County, Nevada, Scale 1:24,000, June 27, 1978.

22. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Las Vegas, Nevada, October 18, 1983.

23. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of North Las Vegas, Nevada, December 15, 1983.

24. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Henderson, Nevada, June 15, 1982.

25. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Boulder City, Nevada, September 16, 1981.

26. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Mesquite, Nevada, unpublished.

27. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Bullhead City, Arizona September 4, 1987.

28. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Nye County, Nevada, April 12, 1983.

29. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Lincoln County, Nevada, February 17, 1988.

30. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Mohave County, Arizona, March 1, 1983.

31. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, San Bernardino County, California, August 5, 1985.

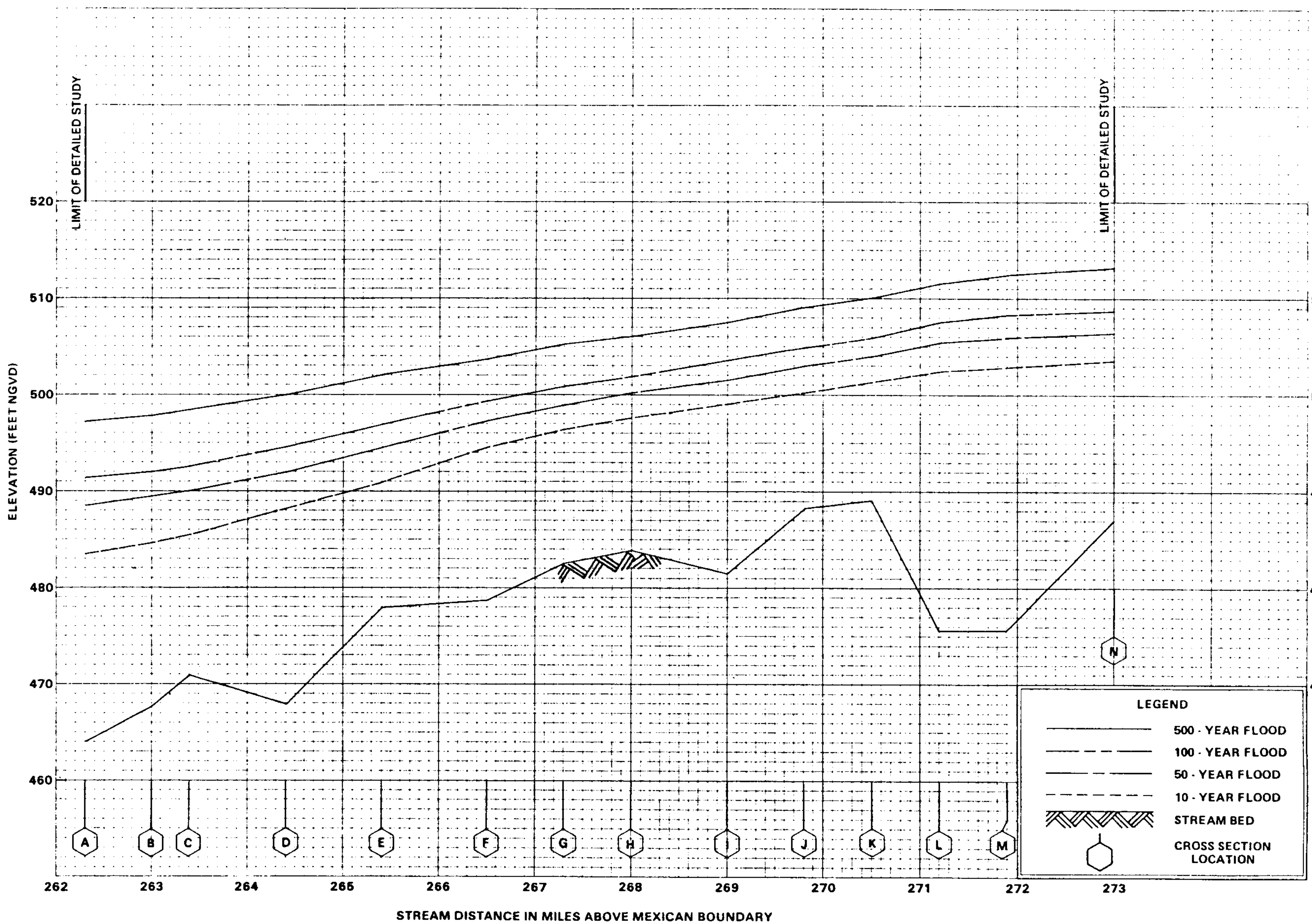
32. Federal Emergency Management Agency, Federal Insurance Administration Flood Insurance Study, Inyo County, California, September 4, 1985.

Chow, V.T., editor, Handbook of Applied Hydrology, A Compendium of Water-Resources Technology, 1964.

U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1849, Roughness Characteristics of Natural Channels, H.H. Barnes, Jr., 1977.

U.S. Department of the Interior, Geological Survey, Water Resources Data for Nevada, 1965-1976.

U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, Victor Mockus, 1969.



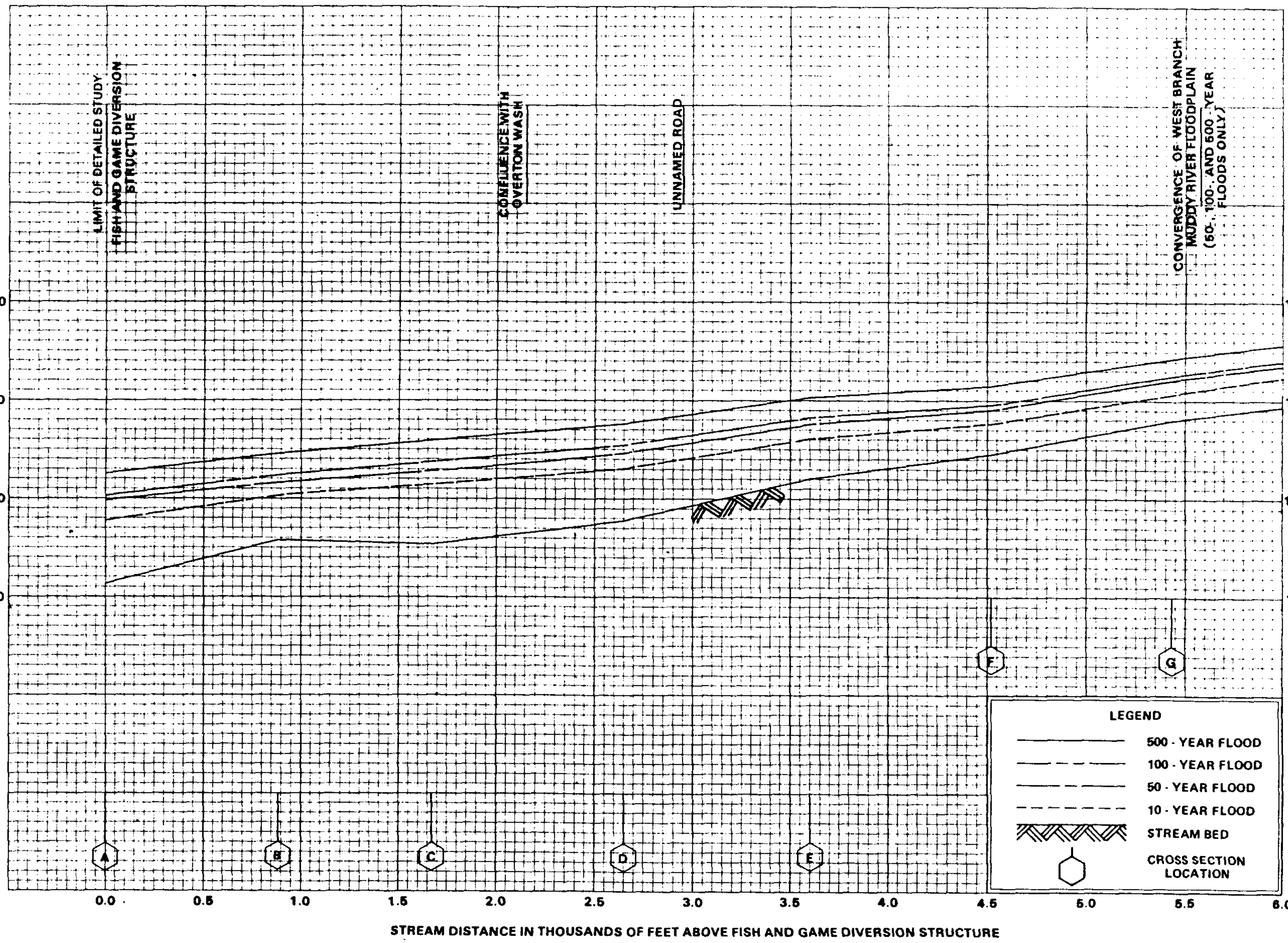
FLOOD PROFILES

COLORADO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

01P



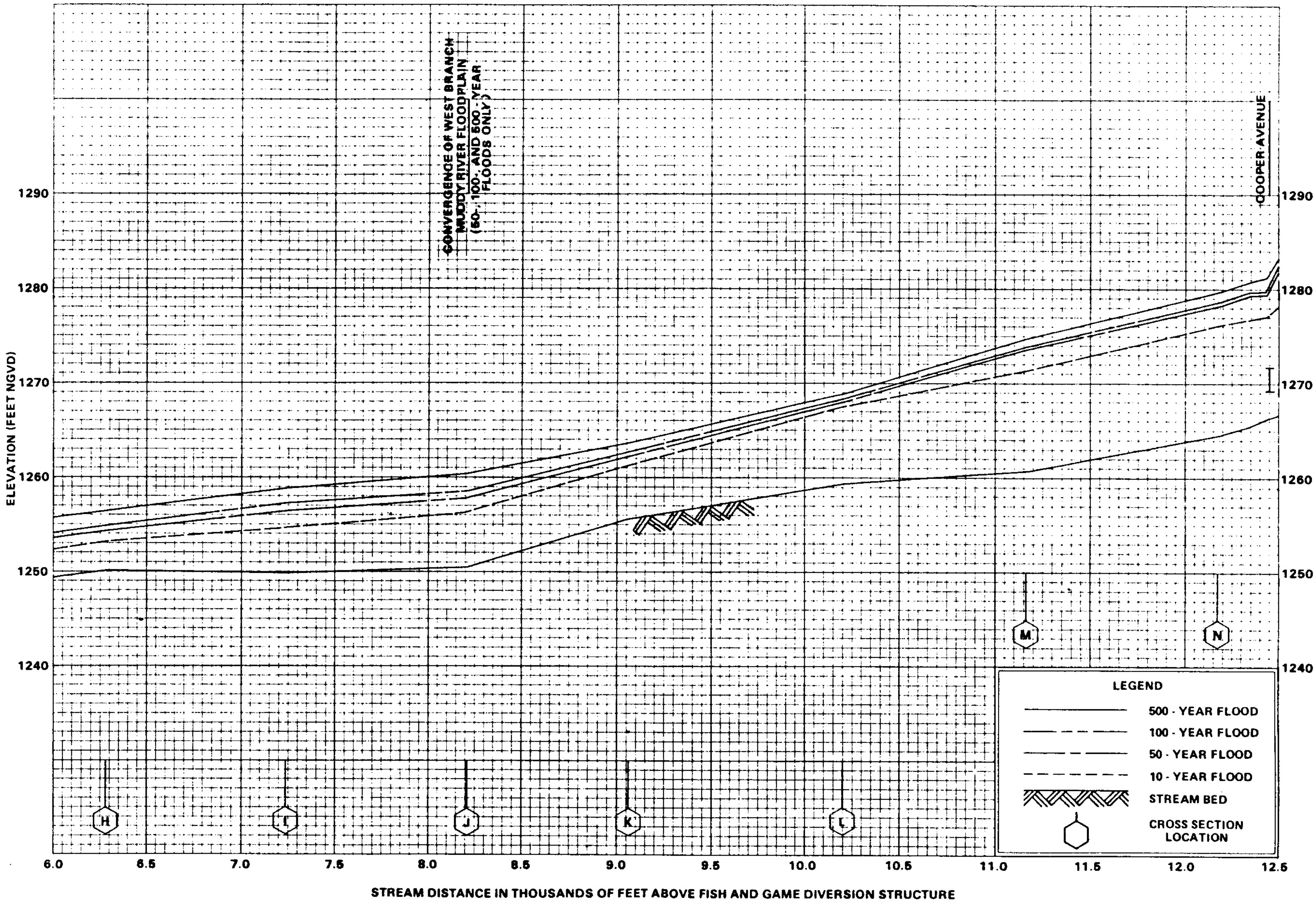
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

FLOOD PROFILES

MUDDY RIVER

02P



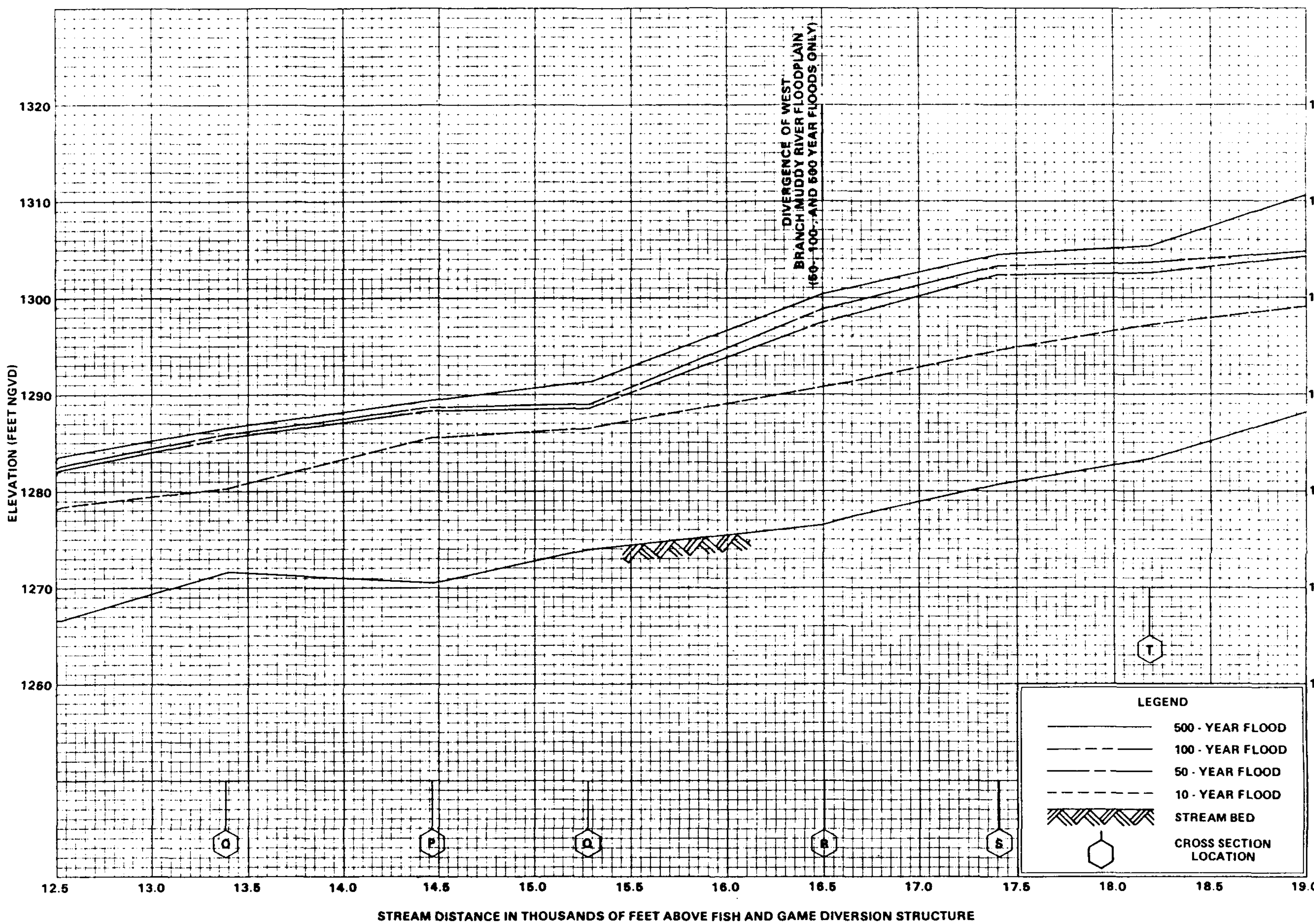
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

03P



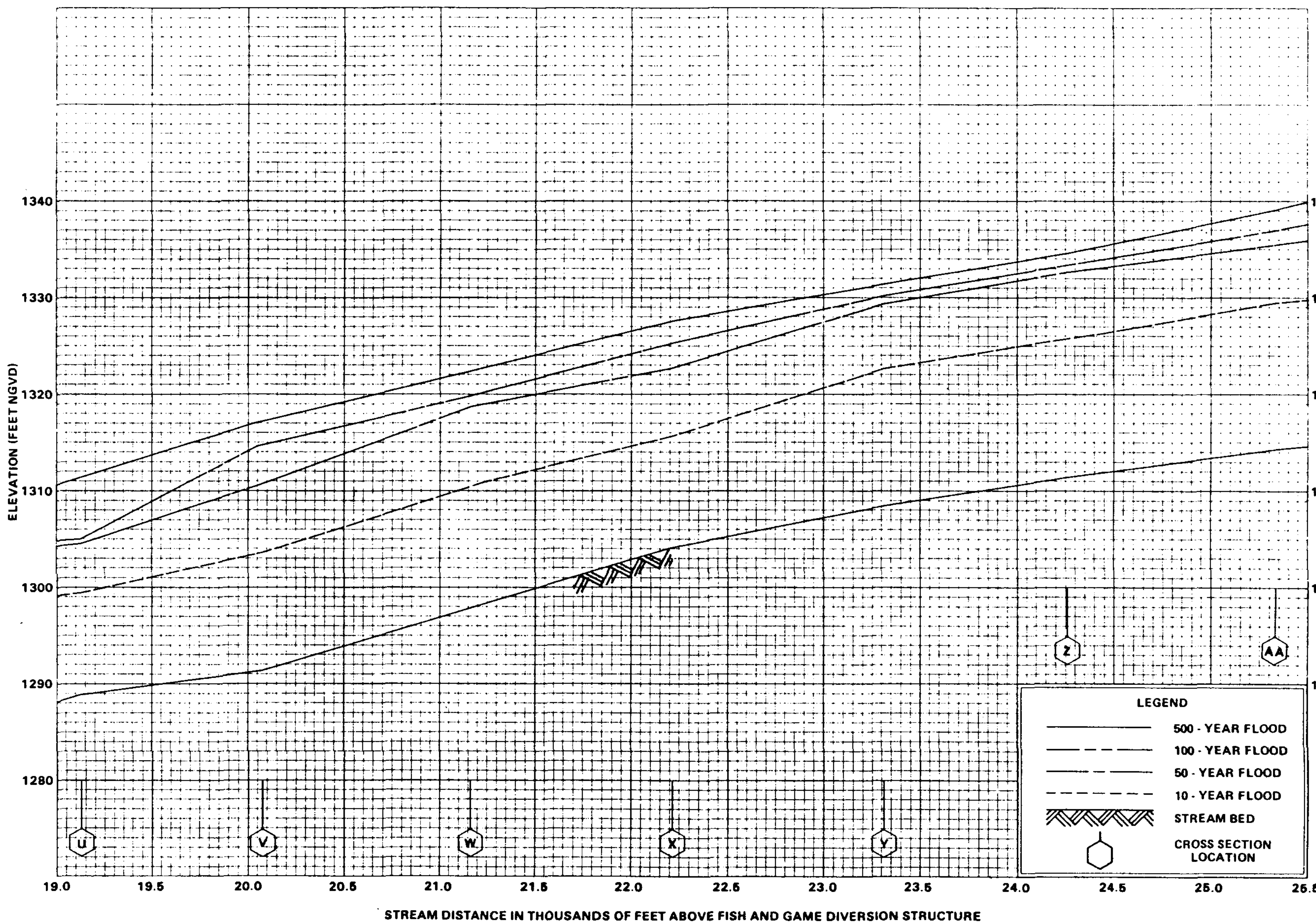
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

04P



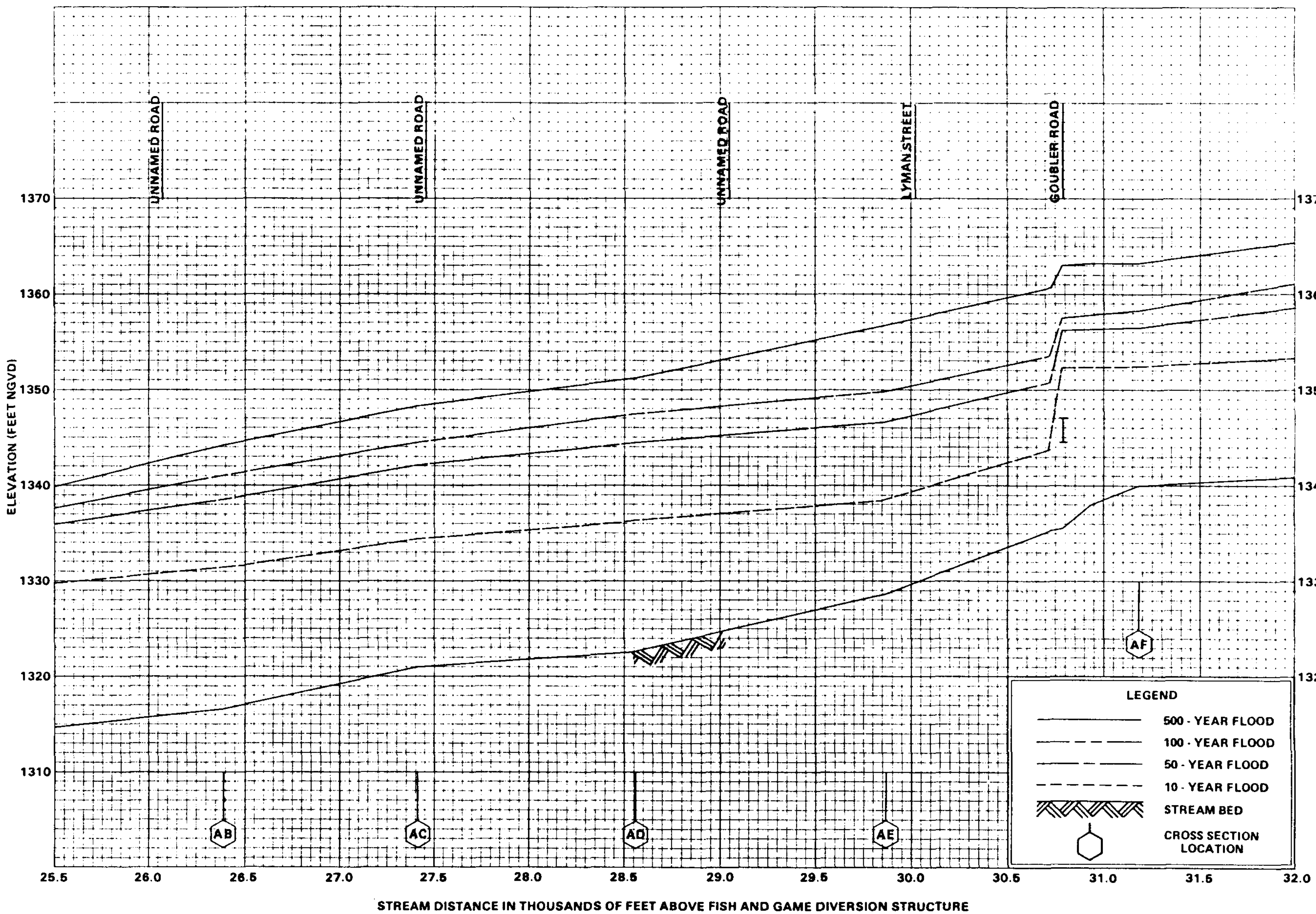
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV (UNINCORPORATED AREAS)

05P



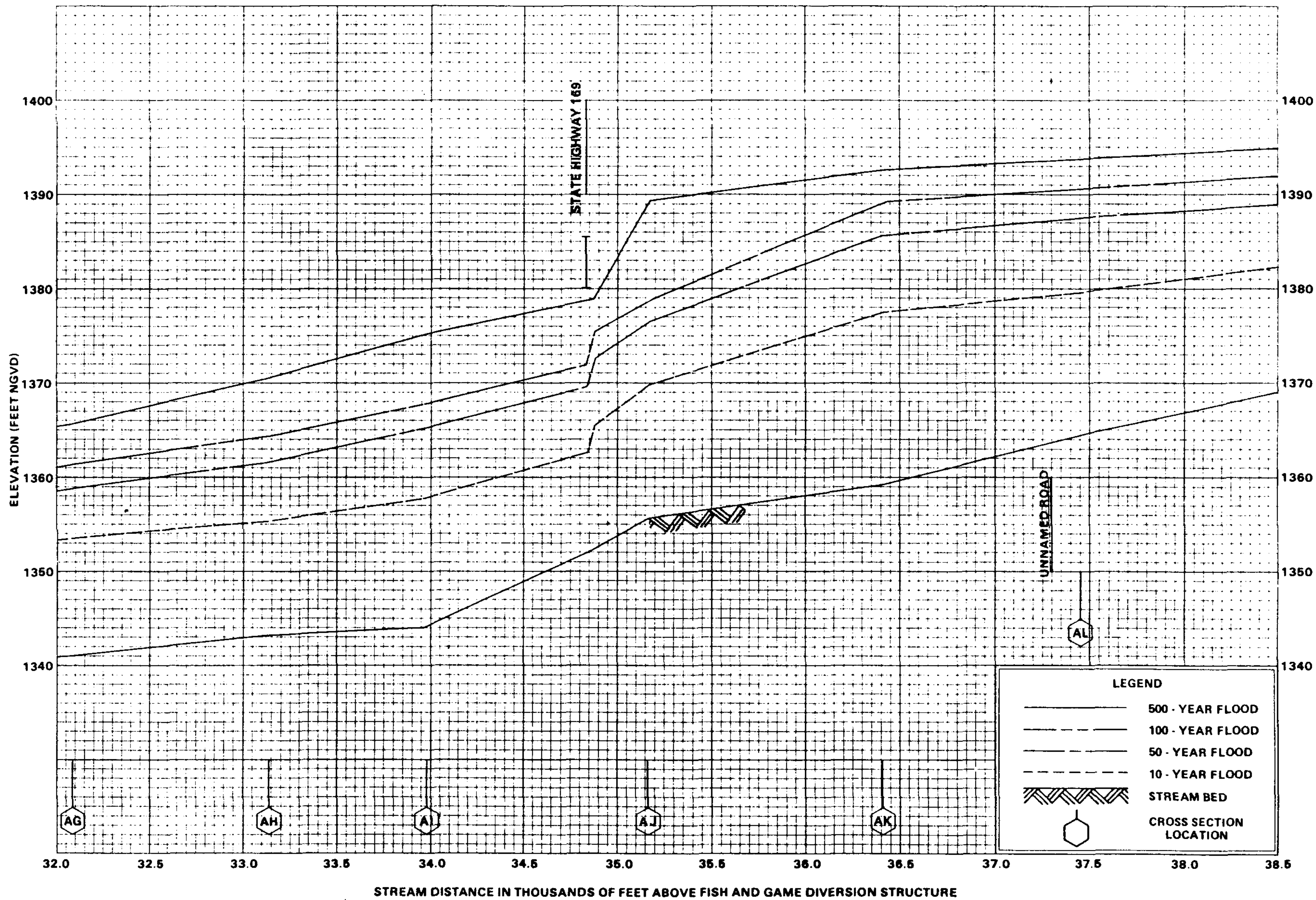
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

06P



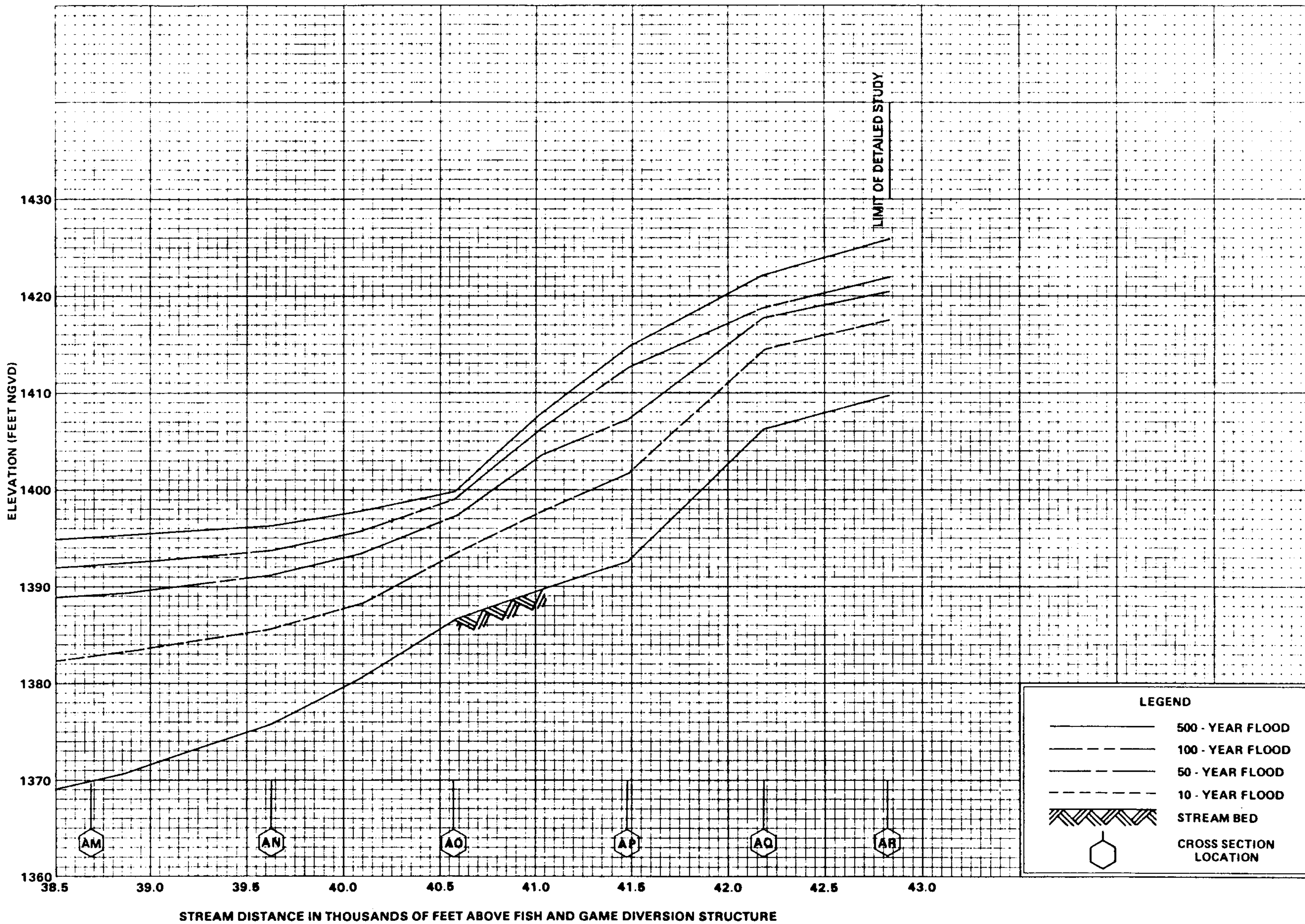
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

07P



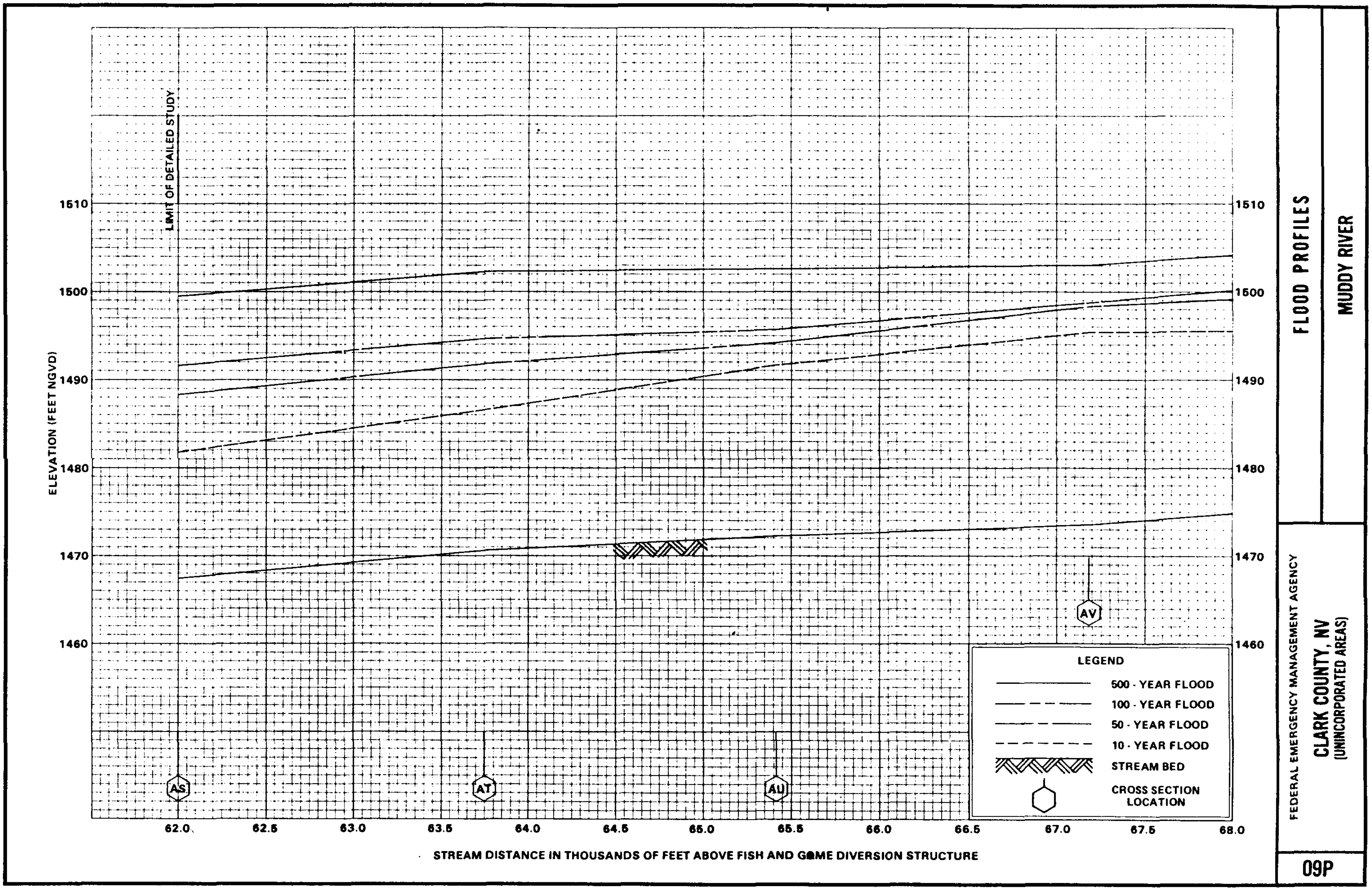
FLOOD PROFILES

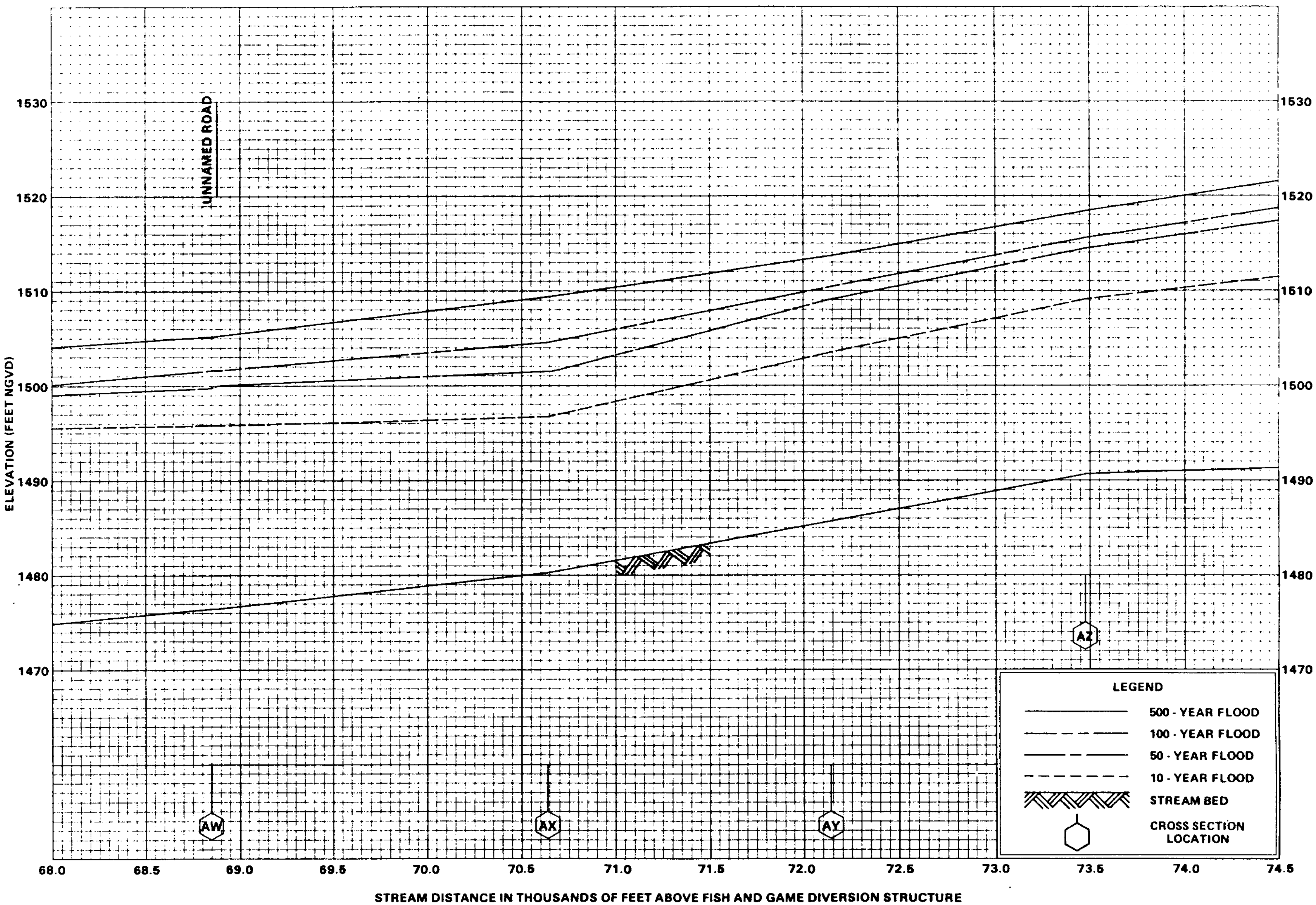
MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

08P


LIMIT OF DETAILED STUDY
ELEVATION (FEET NGVD)
1460
1470
1480
1490
1500
1510
62.0
62.5
63.0
63.5
64.0
64.5
65.0
65.5
66.0
66.5
67.0
67.5
68.0
STREAM DISTANCE IN THOUSANDS OF FEET ABOVE FISH AND GAME DIVERSION STRUCTURE
AS
AT
AU
AV
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
MUDDY RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
CLARK COUNTY, NV
(UNINCORPORATED AREAS)
09P



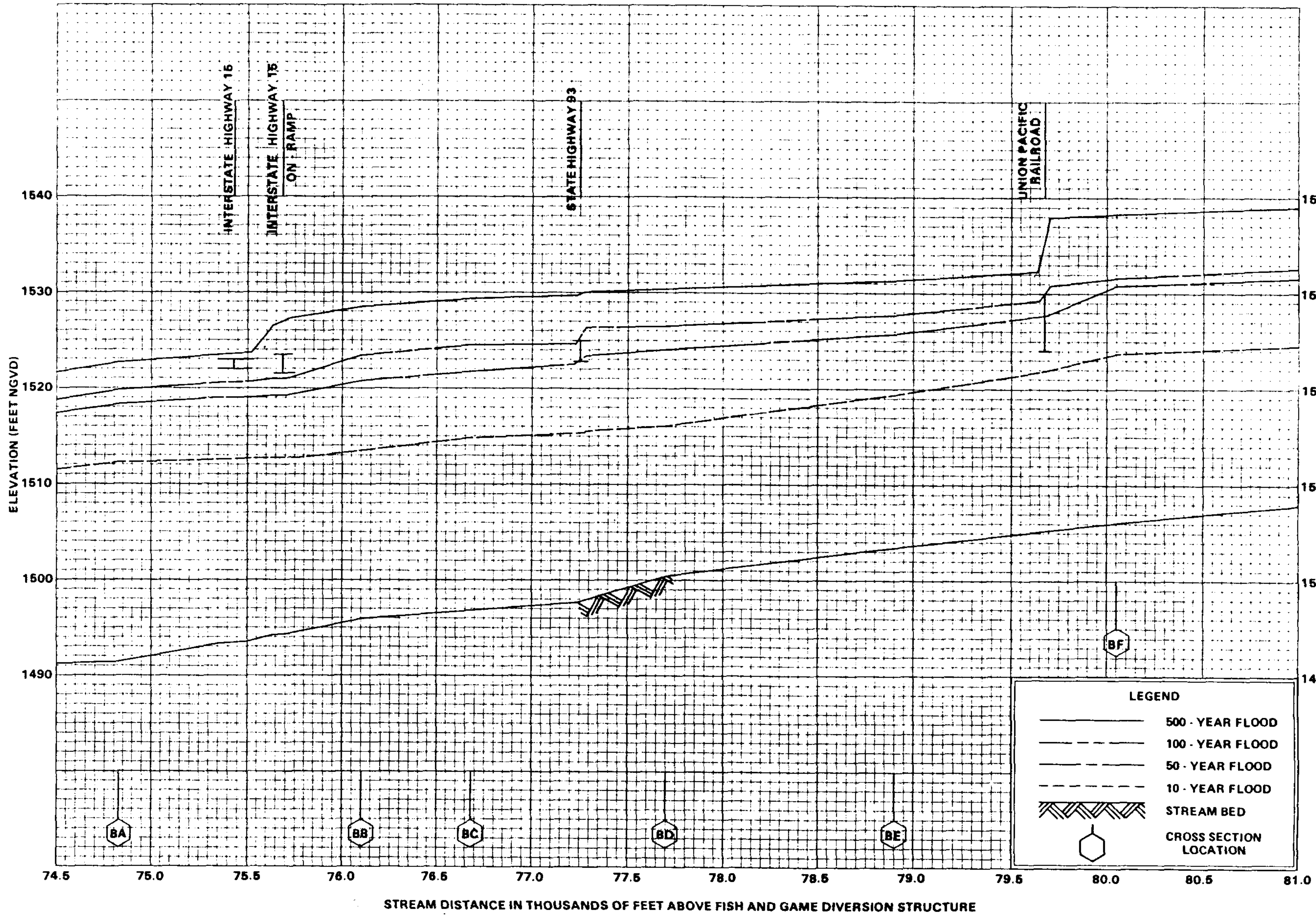
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

10P



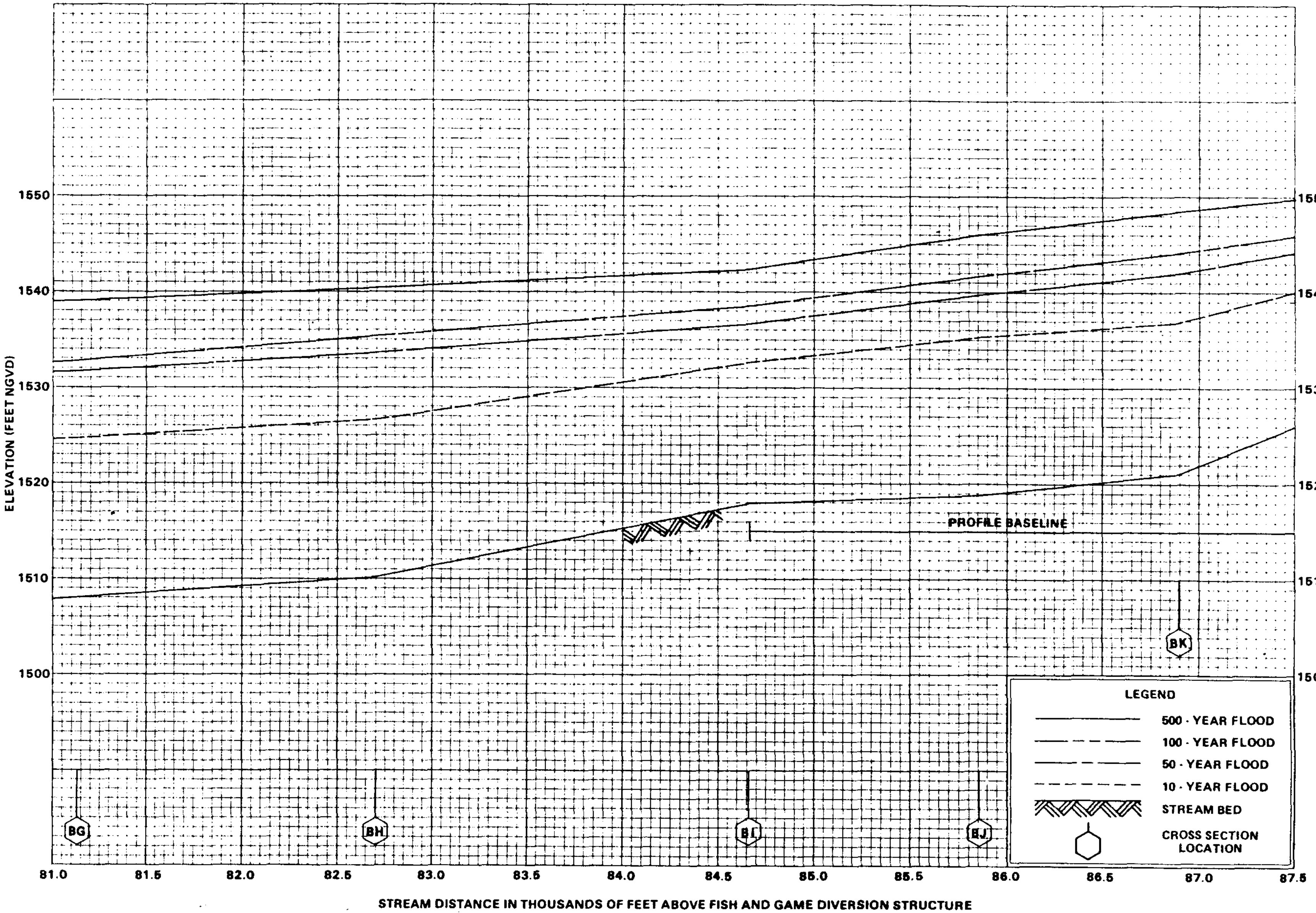
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

11P

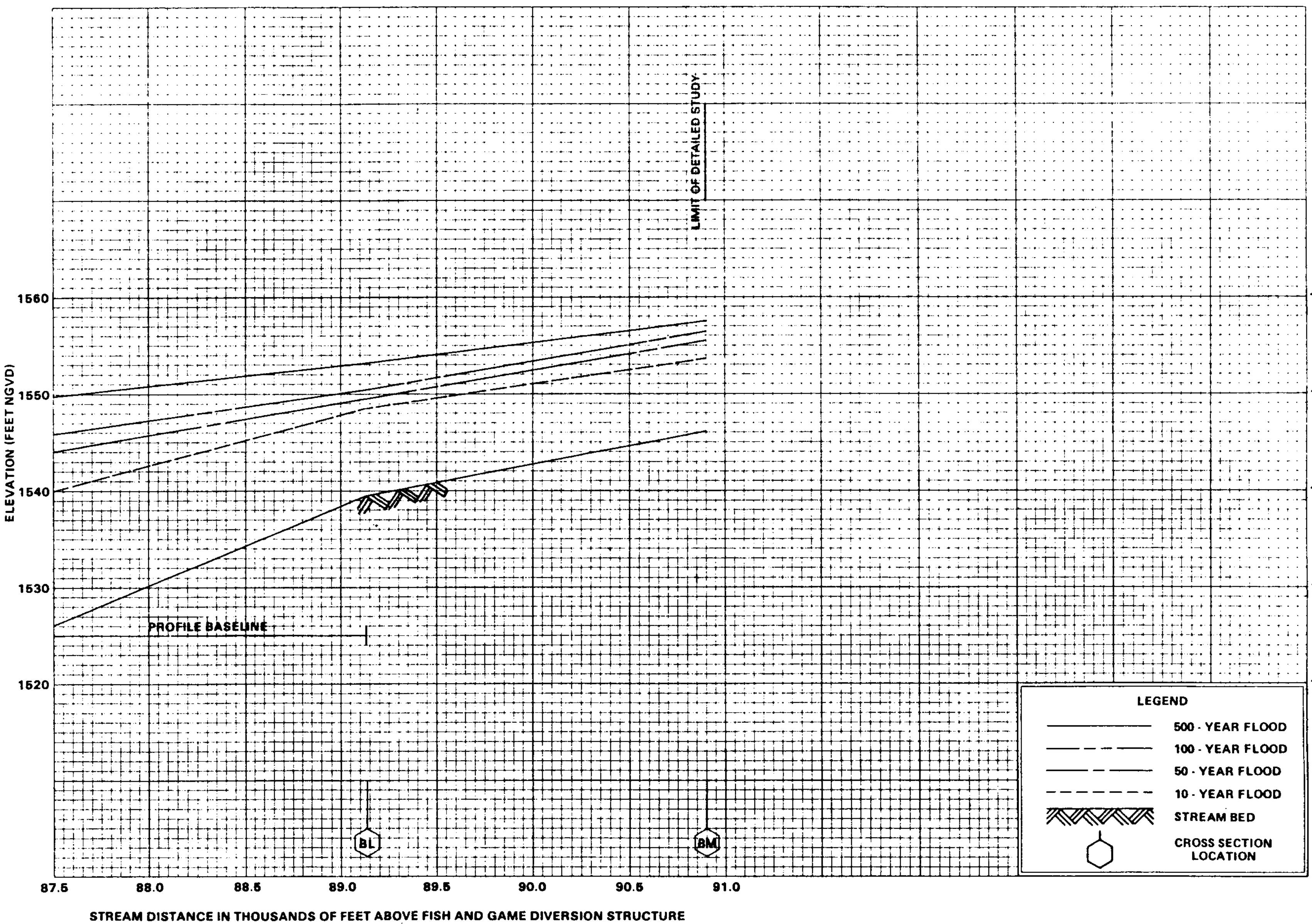


FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)



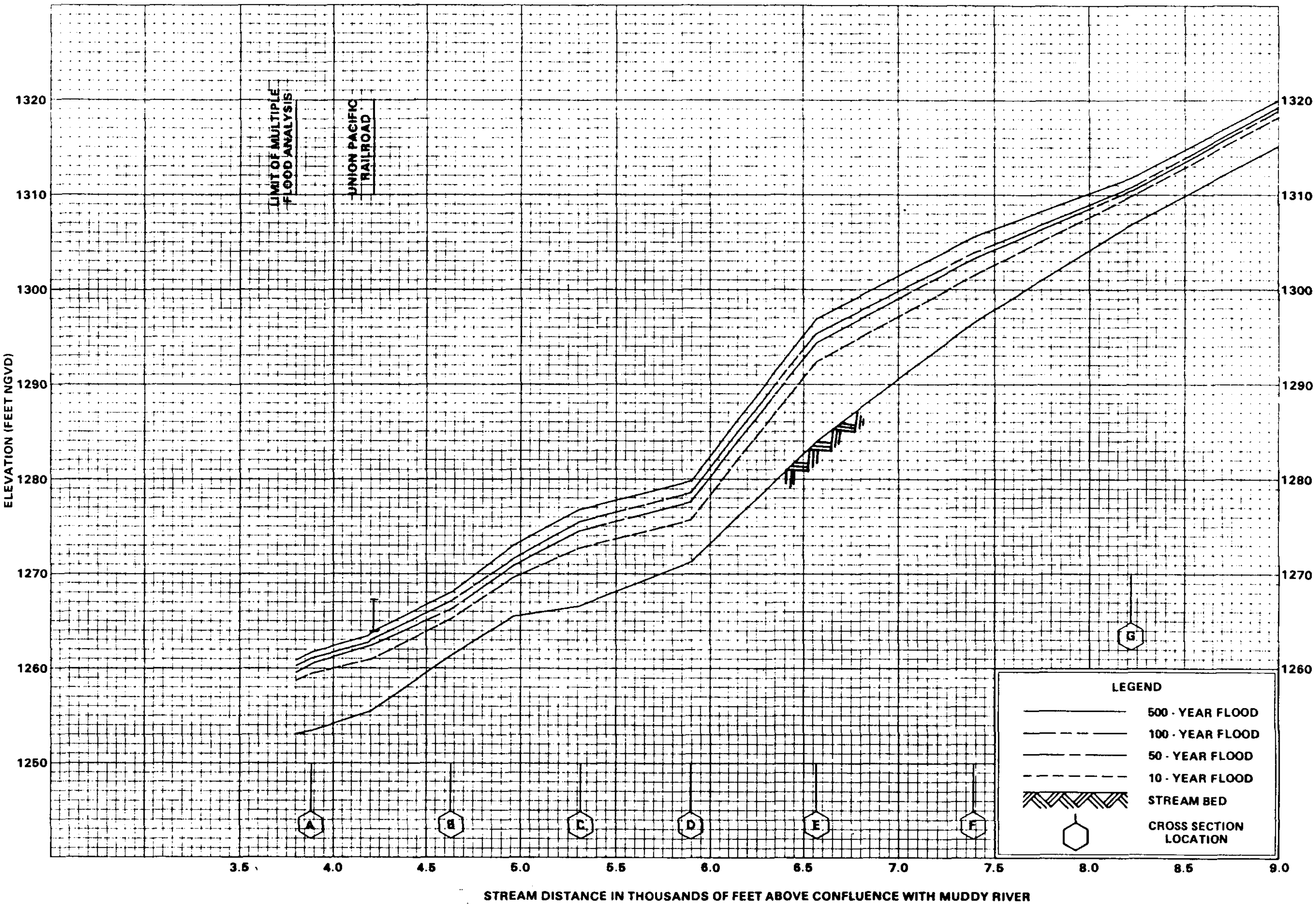
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

13P



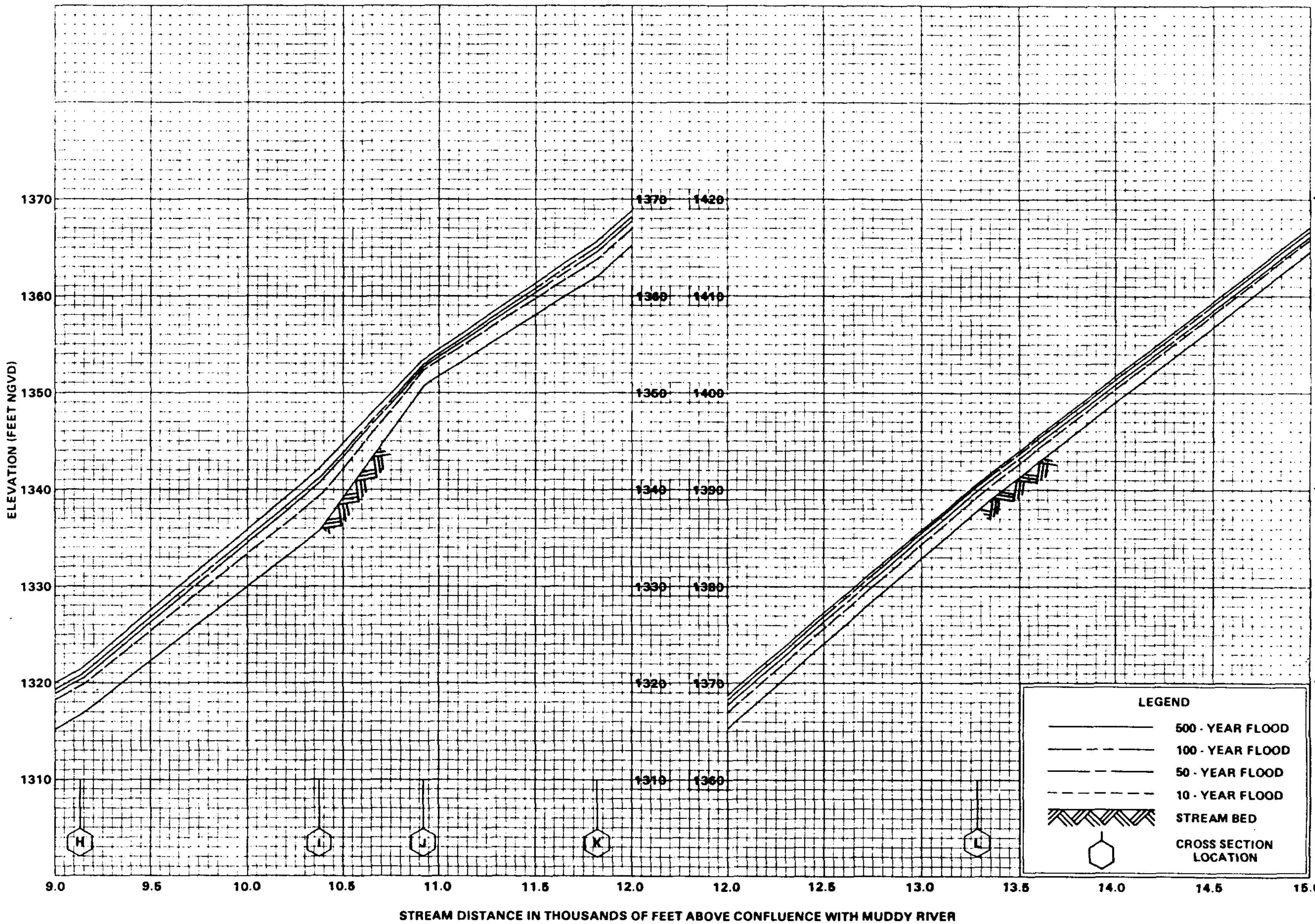
FLOOD PROFILES

OVERTON WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

14P



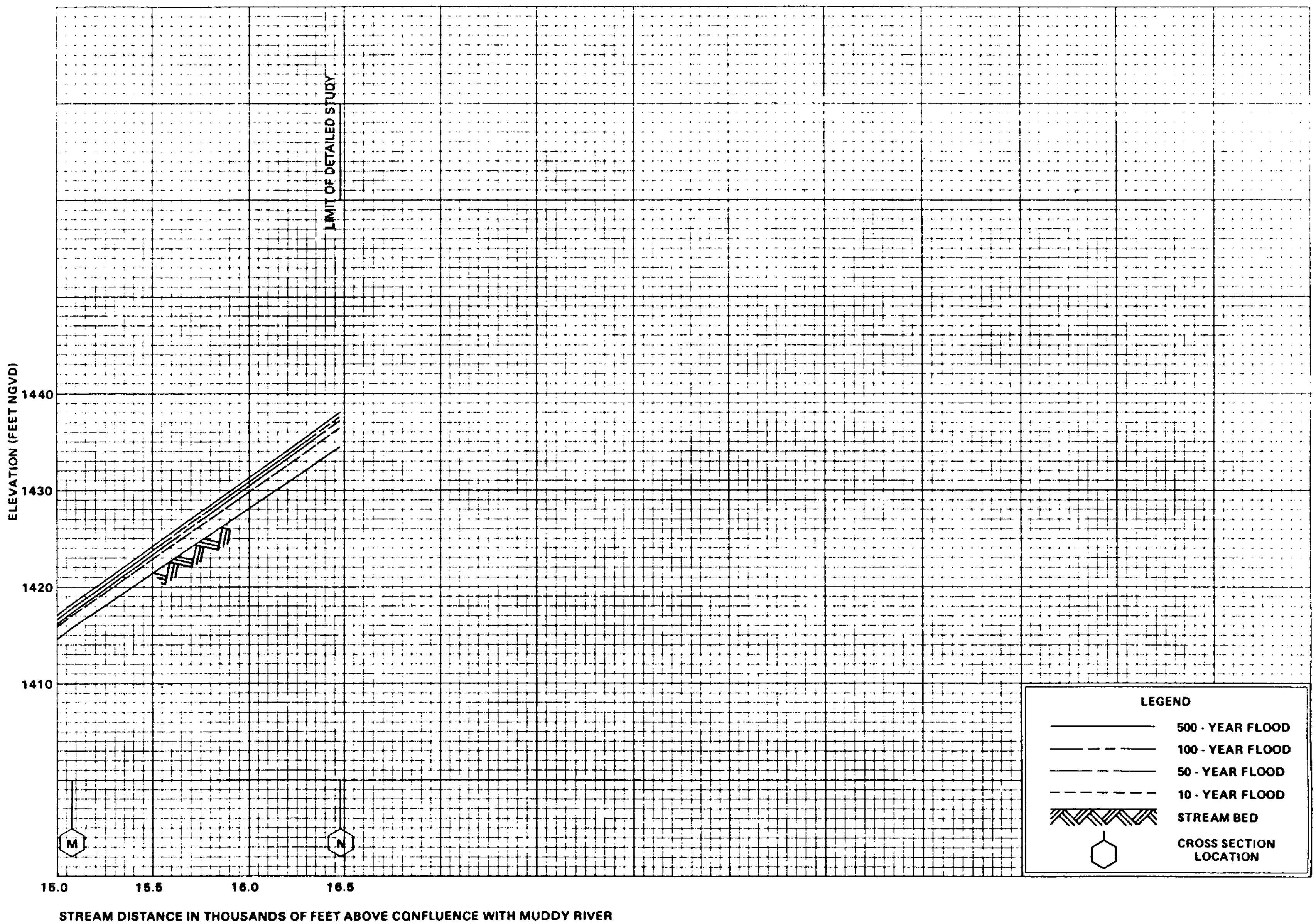
FLOOD PROFILES

OVERTON WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

15P

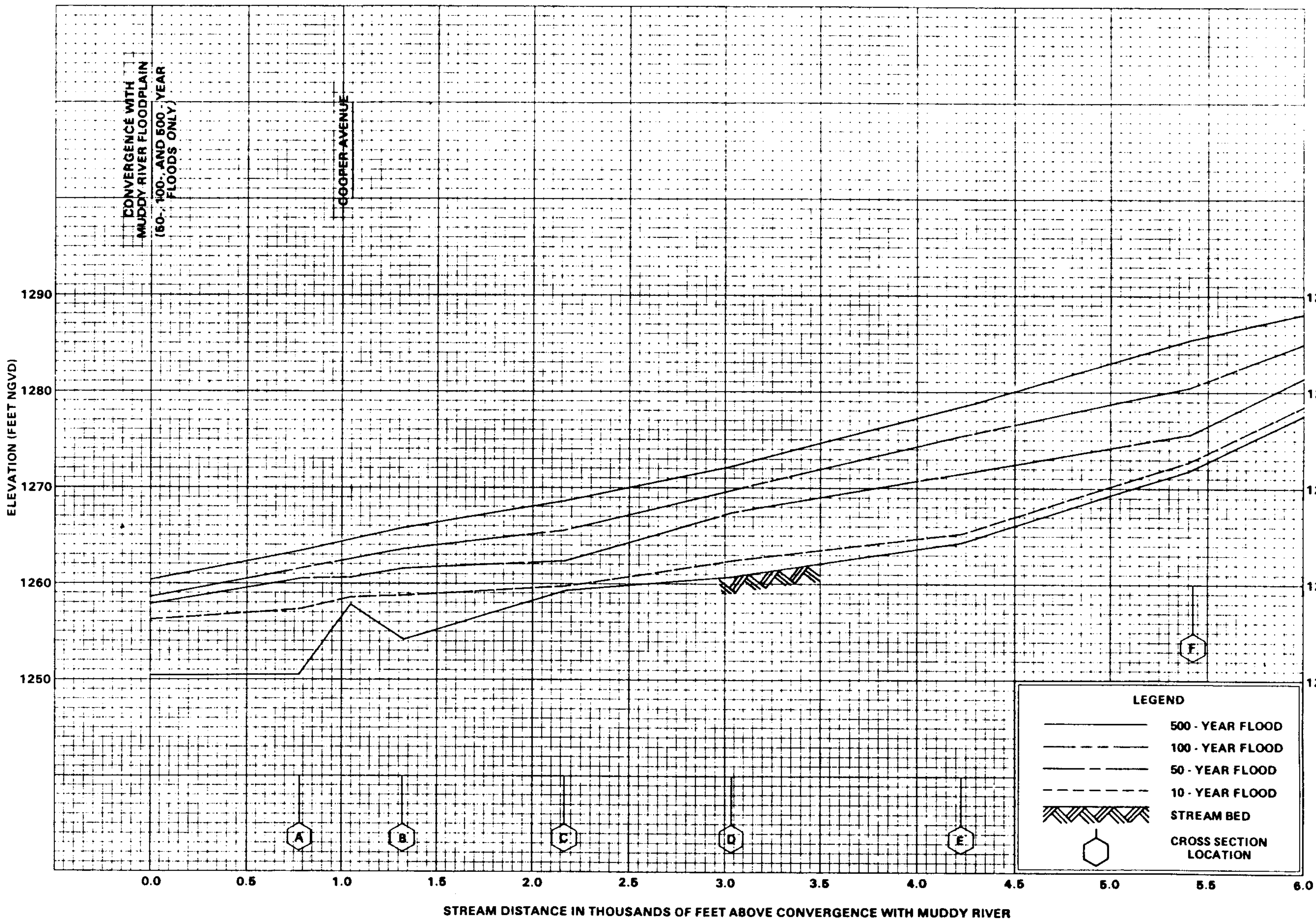


FLOOD PROFILES

OVERTON WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)



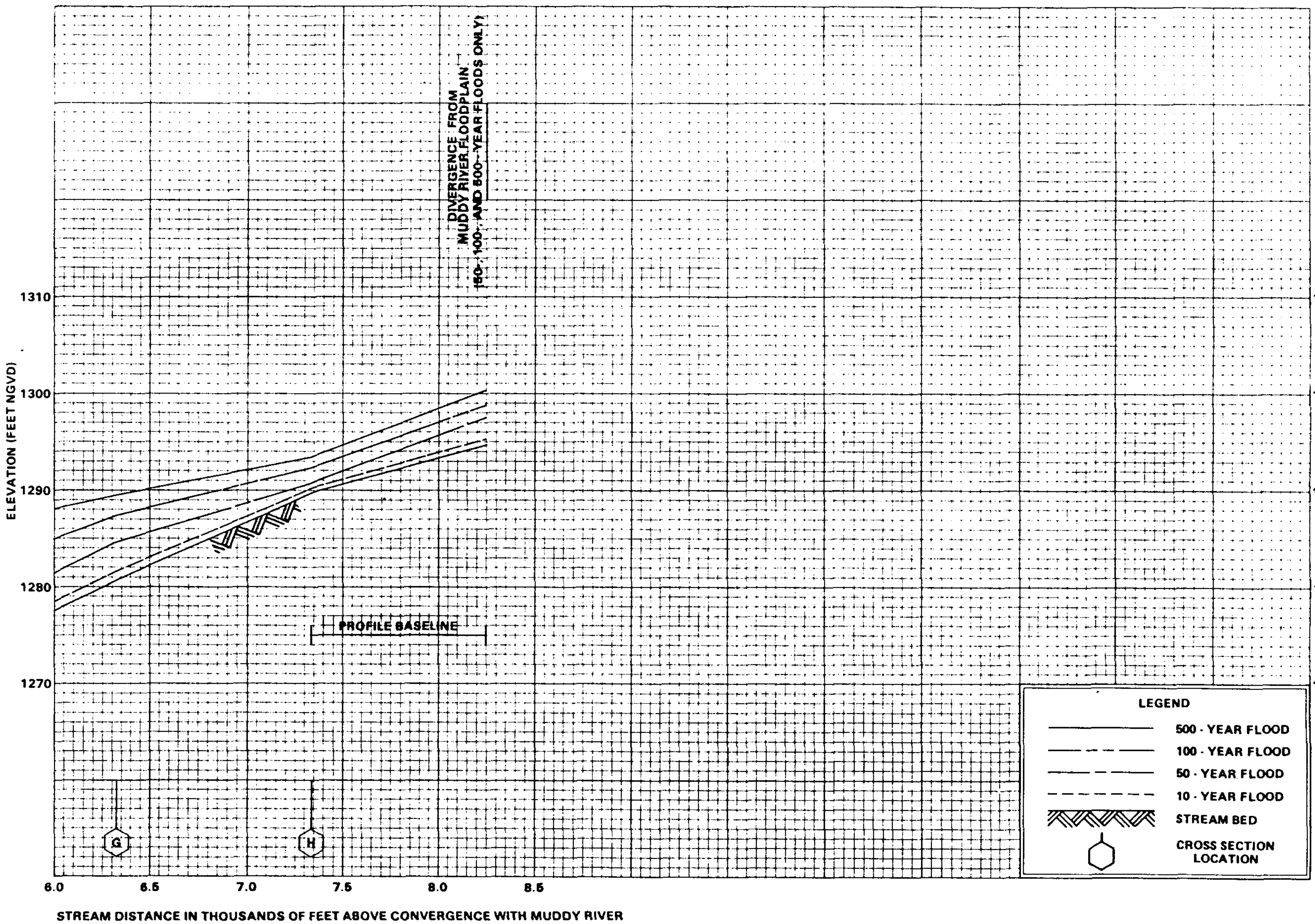
FLOOD PROFILES

WEST BRANCH MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

17P



FLOOD PROFILES

WEST BRANCH MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
(UNINCORPORATED AREAS)

18P

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	Elevation (feet NGVD)	Description of Location
RM1	2925.99	Township 20 South Range 60 East, BM C19NE01/railroad spike and flight cross at centerline of AC of Charleston Boulevard.
RM2	2795.32	Township 20 South, Range 60 East, BM C10NE06/railroad spike and flight cross at centerline of AC of Charleston Boulevard.
RM3	2663.94	Township 20 South, Range 60 East, BM C10NE05/BLM brass cap in Charleston Boulevard. Located 55 feet west and 50 feet north of northwest corner of fence in Nevada Power yard. Section Corner.
RM4	1713.62	United States Coastal & Geodetic Survey bronze disk M-140 2.4 miles southwest of Glendale along Interstate 15 at southwest corner of Section 10, Township 15 South Range 66 East.
RM5	1520.83	United States Coastal & Geodetic Survey bronze disk T-50 3.9 miles east of Union Pacific Railroad Station in Moapa along railroad tracks at mile pole 4.
RM6	1561.05	United States Coastal & Geodetic Survey bronze disk MUD R.M.2 0.15 miles northeast of Glendale Standard Station, 200 feet north of Interstate 15.
RM7	1503.00	Set re-bar 2.0 miles southeasterly along Union Pacific Railroad tracks, from Interstate 15, 200 feet southerly from centerline of tracks.
RM8	1421.80	Set re-bar 1.3 miles north of Whipple Avenue and 1,000 feet west of Highway 12 (169) on Dirt Lane.
RM9	1379.50	Set re-bar 0.5 miles south of Whipple Avenue and 800 feet west of Highway 12 (169) on Dirt Lane.

RM10	1393.50	Set re-bar 600 feet south and 400 feet east at east end of Gubler Avenue.
RM11	1352.62	United States Coastal & Geodetic Survey bronze disk Q-165 1 mile southeast of Logandale along Union Pacific railroad tracks. Pacific railroad tracks.
RM12	1316.60	United States Coastal & Geodetic Survey bronze disk N-165 2.1 miles northwest of Overton along Union Pacific railroad tracks.
RM13	1358.19	United States Coastal & Geodetic Survey bronze disk N-165 21 miles bronze disk H-315 on wind cone base at Overton Airport.
RM14	1261.35	United States Coastal & Geodetic Survey bronze disk E-165 in Overton at Highway 12 (169) and Cooper Avenue.
RM15	1255.30	Set re-bar 150 feet southeasterly of Robin Lane at easterly end in Overton (L-15).
RM16	1439.40	Set re-bar on hill (L-14).
RM17	2296.87	BM C21SW08/2 inch iron pipe with Registered Land Surveyor Tag #1798 in center. Located at the intersection of Valley View and Windmill Roads. Section Corner.
RM18	2380.87	Township 22 South, Range 60 East, BM C21131856/BLM brass cap on west edge of bladed road running north and south. Approximately 1.5 feet above natural ground. 1/16 Corner.
RM19	2872.00	Set P.K. nail in centerline of Blue Diamond Road approximately 2.7 miles west of Buffalo Drive.
RM20	4878.50	Set spike 35 feet east of dirt road; approximately 6.36 miles northeast of Highway 160 and 5.9 miles southeast of the junction of Highways 160 and 372.

RM21	2043.00	Set P.K. nail at intersection of Blue Diamond Road and Buffalo Drive.
RM22	4660.80	Set spike 40 feet east of dirt road; approximately 5.7 miles east of Highway 160 and 5.9 southeast of the junction of Highways 160 and 372.
RM23	2835.43	Pahrump (junction of State Highway 160 and 372), 6.4 miles southeast of, along State Highway 160; 0.2 mile southeast of Nye County-Clark County line, 70 feet southwest of road, 6 feet northwest of power line, 5 feet northwest of buried cable marker; set on 4 feet of copper-coated rod, encased in 5-inch white plastic pipe; standard tablet stamped "8 RBO 1981 2835."
RM24	3720.90	Starting at junction of Highways 160 and 372, go southeast on Highway 160 approximately 5.9 miles, then east on dirt road approximately 4.0 miles, then southeast approximately 4,066 feet on dirt road, then southwest approximately 2,798 feet on dirt road. Set spike approximately 4,805 feet west of dirt road.
RM25	4186.30	Starting at junction of Highways 160 and 372, go southeast approximately 5.9 miles, then east on dirt road approximately 4.0 miles, then southeast approximately 1.91 miles on dirt road. Set spike approximately 280 feet south of dirt road.
RM26	2929.30	Set spike approximately 3,749 feet west of Highway 160 and approximately 7.88 miles southeast of the junction of Highways 160 and 372.
RM27	3257.30	Set spike approximately 3,010 feet east of Highway 160 and approximately 9.25 miles southeast of the junction of Highways 160 and 372.
RM28	3774.10	Set spike approximately 260 feet south of dirt road; approximately 3.57 miles east of Highway 160 and approximately 9.41 miles southeast of the junction of Highways 160 and 372.

RM29	3066.40	Set spike approximately 1.0 mile south of Highway 160 and 8.42 miles southeast of the junction of Highways 160 and 372.
RM30	1756.15	Davis Dam, 5.6 miles west of U.S. Post Office along State Highway 163; 34 feet south of and 3 feet higher than center of highway; at highway station X 730-90; at west end of a cut; in rock ledge; standard tablet stamped "6 WR 1948 1756."
RM31	1396.99	Set spike approximately 1.39 miles west of Needles Highway and approximately 1.36 miles south of the intersection of Needles Highway and State Highway 163.
RM32	1178.24	Davis Dam 3.5 miles west of U.S. Post Office along State Highway 163; 48 feet south of center of highway; in concrete post; standard tablet stamped "7 WR 1948 1178."
RM33	656.89	Davis Dam, at parking lot; 330 feet south of flag pole; 167 feet north of south guardrail; 113 feet east of west guardrail; 73 feet north of Administration Building; cemented southeast end of and on concrete island in parking lot; standard disc stamped USBR. Located in Mohave County, Arizona.
RM34	956.60	Davis Dam, 2.5 miles west of U.S. Post Office along State Highway 163; 36 feet south of highway and country road crossing; 6 feet northeast of sign "SWAIN"; on rock projecting 4 inches above ground; chiseled square.
RM35	814.49	Davis Dam, 1.8 miles southwest of U.S. Post Office; in southeast corner of southeast quarter Section 10, Township 32 south, Range 66 east; along double pole powerline; 22 feet northwest of powerline road; in concrete post; standard tablet stamped "10 WR 1948 814."
RM36	749.06	Davis Dam 1.4 miles west of U.S. Post Office along State Highway 163; 43 feet north of and 4 feet higher than

		center of highway; in concrete post; standard tablet stamped "8 WR 1948."
RM37	827.03	Located approximately 1 mile southwest of Davis Dam; and 0.75 mile west of the Colorado River; on a sandy hill. Station mark: A standard GLO pipe and cap stamped "T32S S1 S2 S11 S12 R66E 1932," projecting 0.5 feet above ground.
RM38	1044.83	Set spike in dirt road approximately 2,640 feet west of Needles Highway and approximately 2.3 miles south of the junction of Needles Highway and Highway 163.
RM39	891.01	Located approximately 0.5 mile east of the intersection of Needles Highway and Edison Road, along Edison Road, on the south side. Station Mark: A standard GLO pipe and cap stamped "T32S R66E S16 S15 S21 S22 1932," projecting 0.4 foot above ground
RM40	662.78	Set spike approximately 600 feet west of dirt road; approximately 2,218 feet north of Edison Road and approximately 2.66 miles east of Needles Highway.
RM41	526.14	Set 1/2 inch rebar at the edge of the river between Pioneer and Edgewater Casinos on empty lot between 2 large salt cedar trees.
RM42	825.84	Davis Dam, 3.8 miles southeast of along a double pole powerline; 30 feet west of Powerline Road; 10 feet west of west powerline wire; in concrete post; standard tablet stamped "11 WR 1948 826."
RM43	611.04	Set Cotton Spindle on side of mountain on west side on Needles Highway.
RM44	504.44	Set 1/2 inch rebar on west bank of river on edge of Dike Road South and west of Hancock Road extension on Arizona side.

RM45	903.46	Round U.S. GLO B.C. quarter Corner Sections 5 and 6, Township 33 South, Range 66 East.
RM46	586.55	Set 1/2 inch rebar east side Needles Highway at pipeline pump station near northeast 1/16 corner of Section 8, Township 33 South, Range 66 East.
RM47	525.13	5.4 miles southwest of Davis Dam along dirt road, 500 feet east of a double pole powerline, 40 feet west of Y-road intersection with Needles Highway (just north of Needles Highway), in concrete post, standard tablet stamped "12 WR 1948 525."
RM48	657.70	PK nail in centerline of Needles Highway at point of curve of pavement.
RM49	704.50	Set 1/2 inch rebar approximately 1/4 mile east of east fence around Mohave Generating Station near Southeast corner Section 23, Township 32 South, Range 66 East.
RM50	542.71	Set 1/2 inch rebar west side river atop small bluff near intersection of west line Section 25, and river. Township 32 South, Range 66 East.
RM51	522.02	Set 1/2 inch rebar at centerline dike road west side of river, more or less opposite intersection of Arcadia Boulevard and Highway 95 on Arizona side of river.
RM52	517.84	Set 1/2 inch rebar on north river bank in empty lot opposite Langford Drive on south side of river in Arizona.
RM53	503.40	Found U.S. GLO B.C. Section Corner Sections 9, 10, 16, Township 33 South, Range 66 East.
RM54	507.19	Set 1/2 inch rebar west side of river and on northeast side of Dike Road along the north line of Section 15, Township 33 South, Range 66 East.

RM55	505.04	Set 1/2 inch rebar west side of river at fork in Dike Road in Section 15, Township 33 South, Range 66 East.
RM56	502.57	Set 1/2 inch rebar on turnout in Dike Road on west side of Dike Road on west side of river.
RM57	2820.37	Township 21 South Range 60 East, BM C10SW07/BLM brass cap with mound of rocks at Desert Inn Road (future).
RM58	2772.73	Township 21 South, Range 60 East, BM C1007184/BLM brass cap with large rock mound. 1/4 Corner at Desert Inn Road.
RM59	2519.97	BM C10SW03/CLV brass cap at Sahara Avenue and Buffalo Drive Section Corner.
RM60	2750.91	Township 21 South, Range 60 East, BM C10SW18/BLM brass cap on south side of dirt trail going east to west approximately 100 feet south of wash.
RM61	2551.32	BM C10SW16/railroad spike in power pole #15/11. Pile is 50 feet south and 35 feet from the intersection of Flamingo Road and Durango Drive.
RM62	2446.50	BM C10SW15/Concrete nail in AC pavement at the intersection of Flamingo Road and Buffalo Drive. Section Corner.
RM63	2484.35	Township 21 South, Range 60 East, BM C10SW32/BLM brass cap in large rock mound. East side of dirt road running north and south. Section Corner.
RM64	2588.01	Township 21 South Range 60 East, BM C10SW32/BLM brass cap about 200 feet north of Pipeline Road with large rock mound. Section Corner.
RM65	2338.12	BM C1036D1/spike in power pole #17902T, South of Russell Road and 350 feet east of Jones Boulevard.
RM66	2517.66	Township 21 South, Range 60 East, BM C10SW34/brass cap in middle of bladed

		road (Sunset) with white cross painted on it. Section Corner.
RM67	2455.11	BM CLN020L/Clark County brass cap set in concrete at Rainbow Boulevard and Sunset Road. Section Corner.
RM68	2273.83	BM CLN042/railroad spike in AC on Sunset Road. 0.1 mile west of Valley View Boulevard.
RM 69	2192.98	BM CLM008H/Nevada Highway Department. Brass Cap in center median of I-15. 130 feet south of north-bound "Tropicana Avenue/Exit 1 Mile" sign.
RM70	2599.30	Set railroad spike approximately 528 feet south of Windmill Lane and approximately 2.5 miles west of Decatur Boulevard.