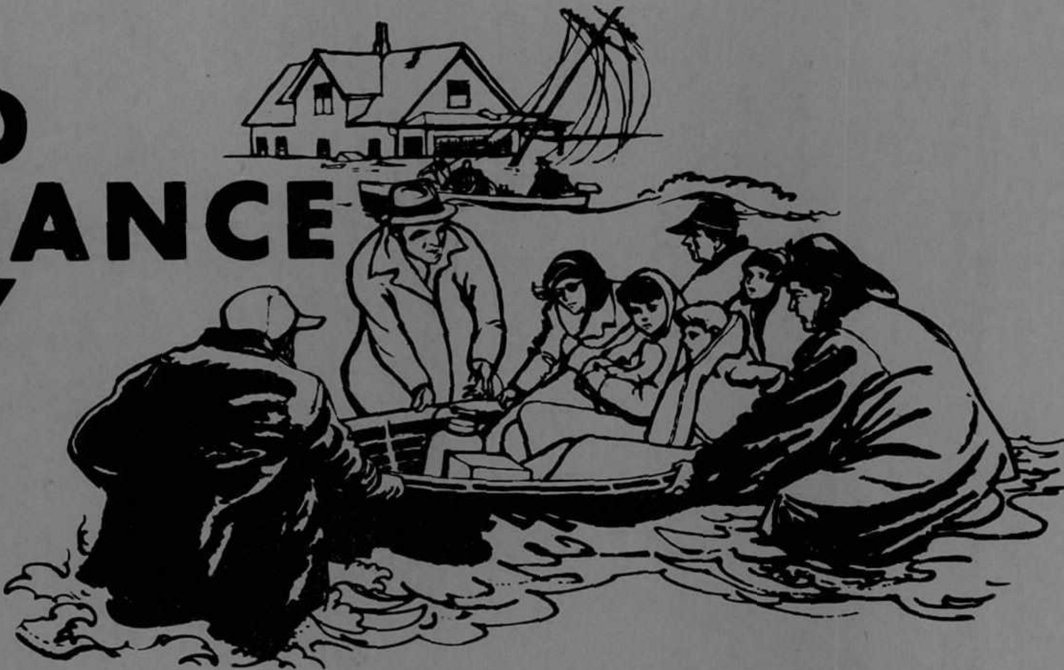
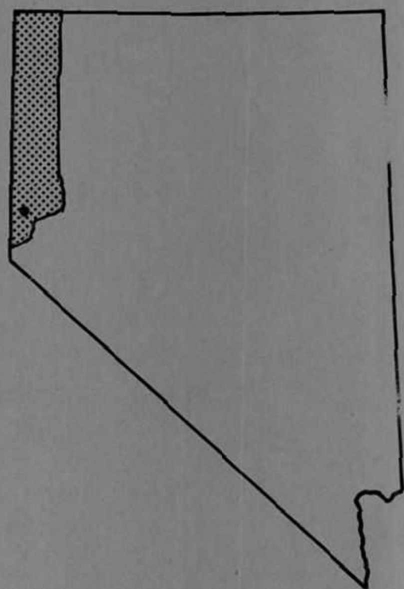
# FLOOD INSURANCE STUDY



## CITY OF RENO, NEVADA
### WASHOE COUNTY



REVISED: APRIL 16, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER - 320020

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.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 9.0.

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PUBLISHED SEPARATELY:

FLOOD INSURANCE STUDY
CITY OF RENO, WASHOE COUNTY, NEVADA

# 1.0 INTRODUCTION

## 1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Reno, Washoe County, Nevada, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The original study was used to convert the City of Reno to the Regular Program of flood insurance by the Federal Emergency Management Agency (FEMA); the restudy was made to develop a regulatory floodway for the Truckee River from Vista gage to Glendale Avenue and for Steamboat Creek from the Truckee River confluence to Pembroke Drive and to update the floodplain fringe areas where development has occurred since the original study. Local and regional planners will use this study in their efforts to promote sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the floodplain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, however, it shall be understood that the State (or other jurisdictional agency) shall be able to explain these requirements and criteria.

## 1.2 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for the original study were performed by Tudor Engineering Company, for FEMA, under Contract No. H-4033. This work, which was completed in July 1979, covered all significant flooding sources affecting Reno.

Additional hydraulic analysis for the Truckee River between Vista gage and Glendale Avenue, Steamboat Creek from its confluence with the Truckee River to Spanish Springs Road, and hydrologic analysis of Lemmon Valley Playas were performed by Nimbus Engineers under Contract No. EMW-86-C-2239. This work was completed in December 1987.

## 1.3 Coordination

Streams requiring detailed study were identified at a meeting attended by representatives of FEMA, the study contractor, and the City of Reno on June 2, 1976.

A total of seven trips to Reno and Carson City, lasting from 2 to 5 days at a time, were made by study contractor representatives to obtain information and discuss flood problems. During these visits, contacts were made with representatives of the city, county, and State Engineers; the Regional Planning Commission; the University of Nevada; the Chamber of Commerce; and private citizens. Contacts were also made with a retired forest and river basin specialist of the U.S. Forest Service in Carson City who wrote extensively on the flood problems in the Great Basin and published a book on the flood chronology of the Truckee River (Reference 1). The U.S. Soil Conservation Service (SCS) and the U.S. Bureau of Reclamation (USBR) offices in Carson City were also visited.

A visit was made to the U.S. Geological Survey (USGS) office in Carson City with subsequent contacts by telephone and written correspondence to obtain flow records of the Truckee River and detailed information on the latest big flood of February 1963.

A total of five visits were made to several branches of the U.S. Army Corps of Engineers (COE) office in Sacramento along with numerous telephone contacts and written correspondence to obtain background material used by the COE in preparing the Flood Plain Information report for Reno, Sparks, and Truckee Meadows (Reference 2) for possible use in this Flood Insurance Study. Some of the information obtained included recently surveyed cross sections of the Truckee River, data and other pertinent information used to establish peak floodflow-frequency relationships for the major flooding sources, and data used to estimate peak flow of the February 1963 flood at Vista gage. Consultations were also carried out to achieve concurrence and to resolve possible differences between the results of this Flood Insurance Study and past and ongoing studies of the COE.

An intermediate community meeting was held on September 20, 1978, to present preliminary results of the study. The meeting was attended by representatives of the FEMA, the study contractor, the city engineer, the Regional Planning Commission, the City Council, Washoe County, the State Coordinator, and the COE.

The final coordination meeting was held on October 22, 1981, and was attended by representatives of FEMA, the study contractor, and the city. All problems raised at the meeting have been resolved.

The portions of the Truckee River, Steamboat Creek, North Truckee Drain, and the Playas in Lemmon Valley requiring restudy using detailed methods were identified at a time and cost meeting attended by representatives of FEMA, the study contractor (Nimbus Engineers), the City of Reno, Washoe County Department of Public Works, Washoe County Department of Comprehensive Planning, and the City of Sparks on January 22, 1986.

The hydrologic analysis of Lemmon Valley performed by Nimbus Engineers was sent to the COE, the National Weather Service, SCS, USGS, the City of Reno, and Washoe County for review. Coordination was also done with the National Weather Service and Washoe County Department of Comprehensive Planning on historic and statistical information to be used in the hydrologic analysis for the Lemmon Valley area.

Washoe County, the City of Reno, and the City of Sparks provided the funds for obtaining additional digitized cross sections for the Truckee River and Steamboat Creek and spot elevations for the Lemmon Valley Playas. Coordination meetings to define the extent of the topographic information to be obtained were held with representatives from the City of Reno, Washoe County, the City of Sparks, Nimbus Engineers, Great Basin Aerial Surveys, and Consulting Engineering Services, Inc., in October and December 1986.

The intermediate community coordination meeting for the 1987 restudy was held on August 11, 1987. The meeting was attended by representatives of FEMA, the study contractor (Nimbus Engineers), Washoe County, the City of Reno, and the City of Sparks.

A second intermediate community coordination meeting for the 1987 restudy was held on December 11, 1987. The meeting was attended by representatives of FEMA, the study contractor (Nimbus Engineers), Washoe County, the City of Reno, the City of Sparks, the Sacramento District of the COE, and the Nevada Department of Transportation.

On November 22, 1988, the results of the study were reviewed at the final meeting attended by representatives of FEMA, the study contractor (Nimbus Engineers), and the community. The study was acceptable to the community.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Reno, Washoe County, Nevada. The area of study is shown on the Vicinity Map (Figure 1). Unincorporated Washoe County land within the City of Reno was not included in this study.

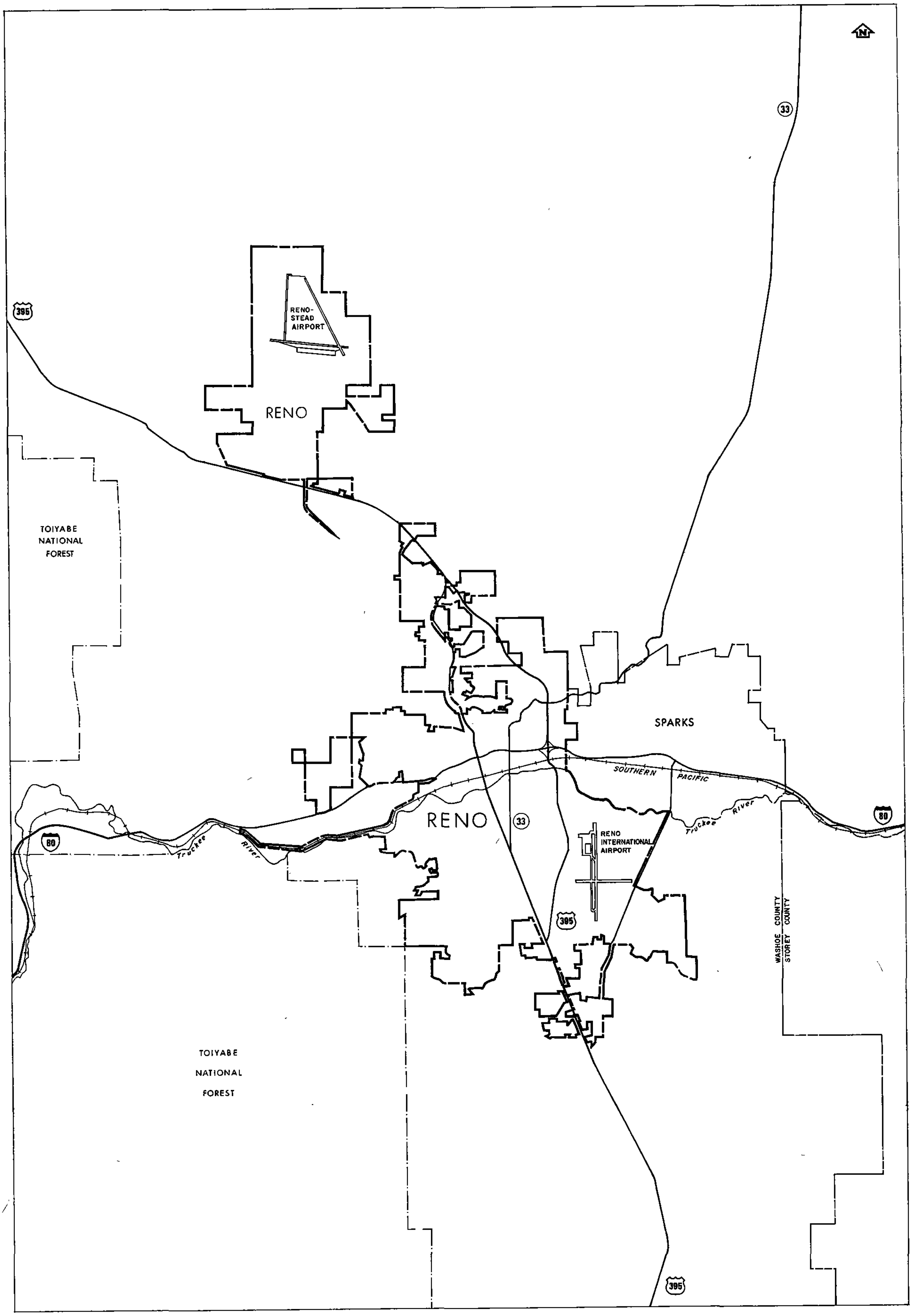



FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

APPROXIMATE SCALE

1 0 1 2 3 MILES

VICINITY MAP

Floods caused by the Truckee River, Steamboat Creek, Boynton Slough, and Thomas, Evans, and Dry Creeks were studied by detailed methods.

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1984.

The Truckee River from Vista to Glendale Avenue, Steamboat Creek from its confluence with the Truckee River to Pembroke Drive and the North Truckee Drain from its confluence with the Truckee River to Spanish Springs Road were restudied in 1987, using detailed methods. Four playas in Lemmon Valley were also restudied in 1987, using detailed methods.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Reno.

## 2.2 Community Description

The City of Reno is at an elevation of 4,500 feet at the base of the Sierra Nevada and on the western edge of the Nevada deserts. Its geographical coordinates are 39° 31' North and 119° 49' West. Reno is in south-central Washoe County, in western Nevada.

Carson City, the Nevada State capital, is 30 miles south on U.S. Highway 395, and the California-Nevada State line is 14 miles west of Reno on Interstate Highway 80. The Truckee River forms the northeastern corporate limits between Reno and its twin city, Sparks. Unincorporated Washoe County land borders the rest of Reno.

The establishment of the City of Reno began on May 9, 1868, when the Central Pacific Railroad completed the transcontinental line to Lakes Crossing. Lakes Crossing was formerly called Fullers Crossing after C.W. Fuller, who was the first person to obtain a charter from the Nevada Territorial Legislature and build a toll bridge across the Truckee River at about the location of the present day Virginia Street bridge in downtown Reno. Myron C. Lake bought the bridge from Fuller and further expanded his claim. Upon the arrival of the railroad construction to Fullers Crossing, Central Pacific acquired 80 acres from Lake on the condition that a station be located thereon. The city was named Reno in honor of General Jesse Lee Reno, a hero of the Union Army in the Civil War (Reference 2).

Although Reno was started as a railroad city and grew to be an important one, its primary economic base is tourism and recreation, with over ten million annual visitors. Warehousing, mining, manufacturing, transportation, and agriculture also contribute to the Reno economy.

The population of Reno in 1978 was estimated to be 99,482 by the Regional Planning Commission (Reference 3). The U.S. Bureau of the Census decennial census figures for 1960 and 1970 are 51,470 and 72,863 respectively. The immigration rate into the state and into Reno, in particular, is very high, and the population forecast for Reno for the year 2000 is approximately 178,000.

The City of Reno is spread out on both sides of the Truckee River. The western edge of the city starts approximately 3 miles downstream from Lawton, Nevada. On its west to east course through the city, the Truckee River flows through residential areas for the first 3 miles, then through the downtown business and commercial district for another 1 mile until it reaches the Wells Avenue bridge. Between here and the South McCarran Boulevard bridge, which is the eastern edge of the city, the river flows through the industry and storage facility region of Reno, on the south side, and that of its twin city, Sparks, on the north side. East of South McCarran Boulevard bridge, the Truckee River meanders through the vast flatland formed by alluvial deposition known as the Truckee Meadows. At the eastern edge of the Meadows, the river enters a steep canyon course through the Virginia Range, at a point known as Vista. Steamboat Creek flows northeasterly to its confluence with the Truckee River. Development along the creek is very sparse, but there are few residential areas. The Steamboat Creek tributaries, Boynton Slough and Evans and Dry Creeks, flow through residential areas after leaving the sparsely developed foothill region. The downstream portion of Dry Creek has been diverted and incorporated into Boynton Slough.

The Truckee River originates above Lake Tahoe, which is at an elevation of 6,229 feet in the Sierra Nevada, and empties into Pyramid Lake at 3,792 feet, 50 miles northeast of Reno. The outflow from Lake Tahoe is regulated by an outlet structure. The river course between Lake Tahoe and Reno is approximately 55 miles long and drains 567 square miles of primarily mountainous terrain (excluding 500 square miles that drain into Lake Tahoe) (Reference 2).

Most of the runoff from the Truckee River and its tributaries originates on the eastern slopes of the Sierra Nevada. In recent years, multipurpose reservoirs with flood detention storage capacities as well as regulatory structures at the outlet of natural lakes were constructed to mitigate the flood hazards of the Truckee River.

The city is in a long north-south-trending valley and is virtually surrounded by mountains. The first ridge of the Sierra Nevada rises 3,000 feet from the southwest edge of the city; 6 miles to the east lies the Virginia Range. The Truckee River transects both the city and the mountains as it flows easterly into the Great Basin. The city is spread over mountain foothills, alluvial fans, and valley fill deposits covered with steppe-type vegetation of grass and sagebrush.

Steamboat Creek and its tributaries flow from the mountain foothills into alluvial fan areas. The soils consist of alluvial deposits and valley fill covered with grasses and sagebrush.

Reno has a semiarid climate characterized as midlatitude steppe with cold winters (32°F), hot summers (87°F), average annual precipitation of 7.2 inches, and average annual humidity of 44 percent (References 3 and 4).

## 2.3 Principal Flood Problems

Reno and the surrounding area have had a long history of flooding starting with the first settlement, Fullers Crossing, as early as 1861. A publication on the flood chronology of the Reno area describes the trauma as follows (Reference 1):

> When the 1861-1862 flood hit, Fuller's bridge was washed away, and his hotel residence-tollhouse was flooded out. The exact date of these events is not now known, but is generally thought to have been on January 1 or 2, 1862. Fuller's financial trauma resulting from this destruction of his means of livelihood must have been great, but he gamely rebuilt the toll bridge and tollhouse...
>
> Doubtless with the continuously haunting thought in mind that the treacherous Truckee would sooner or later deal him another staggering blow, in 1863 Fuller unloaded his bridge and toll station on Myron C. Lake, a veteran of the Mexican War who had come into the area. Lake improved Fuller's bridge into what was probably the log queen-truss structure seen in all the early 1860's photographs of Reno, and rebuilt Fuller's half-log half-dugout structure into a comfortable tollhouse, hotel and trading post. He also changed the name of the small wayside hamlet to Lake's Crossing...
>
> ...as in 1961-62, most of the known damage from the 1867-1868 event was inflicted there. However, it is known that the latter event did destroy Lake's bridge, and flooded and damaged his hotel...

Old newspaper reports show that floods occurred on January 15-21, 1874; January 13-20, 1875; January 18-20, 1886; April 20 - May 13, 1890; and February 21-25, 1904. Detailed accounts of these events are given in the flood chronology report of the Truckee River basin (Reference 1). There is no information on the magnitudes of the early floods.

Since records were begun in 1900 (Reference 5), it has been established that in general there are three major types of flooding in the Reno area. These are summer thunderstorms (otherwise known as dry mantel floods), warm heavy rain on either frozen ground or heavy snowpack, and runoff from spring snowmelt (wet mantel). The summer thunderstorms occur during the period of July through October. These are local phenomena that affect only small isolated areas at a time, such as single canyons, causing flash flooding. These often cause severe damage, such as occurred in the Peavine Creek area in northwest Reno in July 1956.

Flooding from rain falling on frozen ground or snowpack occurs generally from the middle of November through March. In particular, when rain in the fall is followed by a sequence of low temperature and heavy rain, flooding from rain on frozen ground takes place. This situation produced the February 1963 flood. The rain-on-snow type of flooding occurs in winter when a heavy snow crop is followed by warm air. This combination creates a moisture-laden convective current which, when acted upon by the orographic uplift of the Sierra Nevada, will fall as warm rain on the snowpack. The rain-on-snow type of flooding is more frequent than the rain on frozen ground in the Reno area. The 1964 flood is one example. Flooding from snowmelt occurs in spring from mid-March to mid-June. Flooding from thunderstorms has the least impact, and flooding from rain on snow (wet mantel) has been the most damaging for the Reno area.

Historic flood peaks at Reno are listed in Table 1. The approximate return period shown reflects the effect of the numerous flood control reservoirs located on the major tributaries of the Truckee River upstream of Reno. Thus, a repetition of those flood peaks which were relatively common prior to the 1960s is now considered a comparatively rare possibility.

Estimated costs of damage caused by recent large floods of the Truckee River in the Reno area, based on prices and economic conditions at the time of the flood, as reported by the COE (Reference 6) range up to $1,982,000 and total $3,720,000. Costs of flooding for both Reno and Vista total $4,899,000.

Photographs of past floods are shown in Figures 2 through 20.

Table 1. Historic Floods: Truckee River at Reno

| Rain Floods | | | Snowmelt Floods | | |
|---|---|---|---|---|---|
| Date | Peak Flow (Cubic Feet per Second) | Adjusted Return Period (Years) | Date | Peak Flow (Cubic Feet per Second | Adjusted Return Period (Years) |
| March 18, 1907 | 18,500 | 120 | May 7, 1906 | --[1] | --[1] |
| January 16, 1909 | 10,100 | 40 | April 14, 1907 | --[1] | --[1] |
| March 26, 1928 | 18,800[2] | 120 | April 26, 1911 | --[1] | --[1] |
| December 11, 1937 | 17,000[2] | 75 | May 15, 1938 | --[1] | --[1] |
| November 21, 1950 | 19,900 | 140 | May 3, 1952 | 7,950 | 22 |
| December 4, 1950 | 11,700 | 47 | May 20, 1958 | 6,090 | 14 |
| December 23, 1955 | 20,800 | 160 | May 22, 1967 | 6,800 | 17 |
| February 1, 1963 | 18,400 | 120 | | | |
| December 23, 1964 | 11,300 | 45 | | | |
| February 17, 1986 | 14,400 | --[3] | | | |

[1] Data Not Available
[2] Estimated From Records at Other Stations
[3] Data Not Available

The February 1986, flood was the latest major flood experienced in the Truckee River basin. This flood, however, was smaller than the flood of February 1963, in which peak flows equalled or exceeded the maximum flows previously recorded at several gaging stations on both the Truckee River and its tributaries. The upstream lakes and reservoirs, which were at low levels as a result of a severe 100-year winter drought, detained a significant amount of floodwater, thereby substantially reducing the magnitude of flood peaks, volumes, and extent of damage of a flood that otherwise would be the flood of record. Excerpts from a USGS report succinctly summarize the event (Reference 7).

> During the period January 28-February 4 these four reservoirs stored a combined total of about 190,000 acre-feet. The volume of runoff recorded at the Truckee River gage at Reno during this same period was 64,400 acre-feet, and the peak discharge of 18,400 cfs was only slightly less than that during the great flood of December 1955. The newly constructed Prosser Creek Reservoir began storing water on January 31 and accumulated a total of 16,500 acre-feet during the flood period. It is apparent that had Prosser Creek Reservoir not been in operation, the flood peak of February 1 would have exceeded that of 1955 at Reno.
>
> Extensive flooding occurred in the City of Reno, and about 20 square blocks in the downtown area were inundated to depths up to 4 feet. Ten of the twelve bridges in the city were closed for an extended period. Considerable damage to roads, bridges, and irrigation structures occurred in Washoe Valley and Truckee Meadows. Channel rectification work on the Truckee River main stem and on lower Steamboat Creek, completed after the flood of December 1955, was instrumental in draining Truckee Meadows much more rapidly than in previous periods of high water.

Figures 15 through 17 show typical flood scenes in the Reno area during the February 1963 flood (photographs by Reno Evening Gazette).

Reno has experienced no flooding solely from Steamboat Creek or its tributaries. However, because of the area known as Truckee Meadows, floodwaters collect creating a lake type situation which presents flood hazards throughout the area. The downstream and confluence areas of the Truckee River and its tributaries are affected by this condition.

Figure 2. The old Electric Light Company Bridge threatened by the 1907 flood (The March 18, 1907 flood was one of the greatest recorded rainstorm floods, causing severe property damage. It destroyed the bridges at Mayberrys and Poors Grove and carried away flumes located between Reno and Verdi. When the floodwater swept away a portion of the high dam at Floriston and threatened the buildings of the Floriston Pulp and Paper Company, the dam was blown up in order to save the buildings.

.Figure 3. Truckee River at Virginia Street near crest of the March 1907 flood. (This was the only safe crossing over the Truckee River.)

Figure 4. March 1907 flood at the Old Rock Street Iron Bridge (This structure was originally erected to serve as Virginia Street Crossing in 1877. It was moved to this location in 1905, where it stayed until it fell victim to the harsh blows of the November-December 1950 flood (Reference 1). Photograph courtesy of Professor S.G. Palmer, University of Nevada.)

Figure 5. March 1928 Truckee River flood at Arlington Avenue Bridge, looking north. (Photograph by Herman Davis, courtesy of the Nevada Historical Society.)

Figure 6. Wingfield Park during the December 1937 flood. (This flood damaged the south Bridge of Arlington Avenue seen in the preceding photograph. East Truckee Meadows was a virtual lake.)

Figure 7. Evacuation of an elderly person in the vicinity of North Street Bridge during the December 1937 flood. (Photograph by Reno Evening Gazette.)

Figure 8. November 1950 flood in Reno near Island Avenue (The November-December 1950 flood was the second largest flood in the Truckee River basin since recording began in 1900. It resulted from a succession of intense warm rainstorms covering an extensive area in northern California and Nevada. Some stations received up to 5 inches in 24 hours. A maximum peak flow of 19,000 cubic feet per second (cfs) occurred in Reno at approximately 1:00 a.m. on November 9, and was followed by a flow of 11,700 cfs at 9:15 p.m. on December 3 (Reference 5). The damage caused by this flood was a record high which has not been exceeded.)


Figure 9. A scene on Virginia Street during the November 1950 flood.


Figure 10. Rampaging waters of the November 1950 flood as seen from the corner of First and Center Streets, looking southeast. (The water was said to be nearly 4 feet deep here at the time of the peak.)

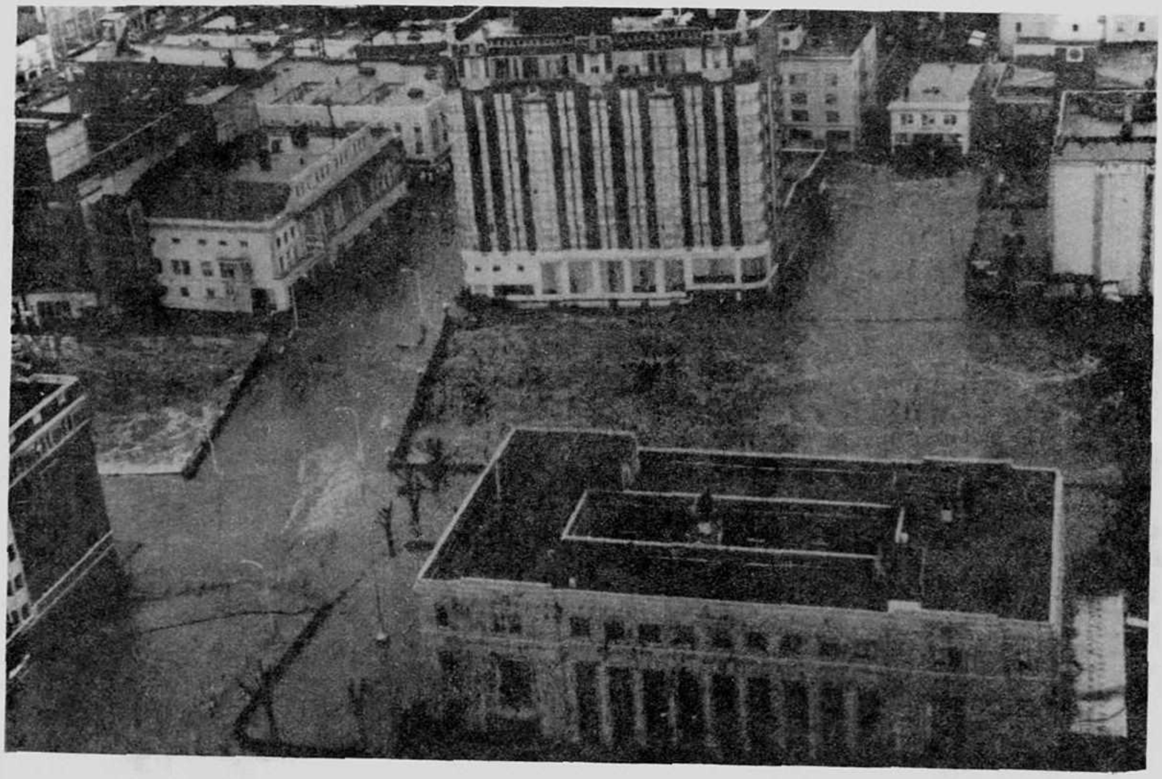


Figure 11. Scene of downtown Reno under the November 1950 flood (Riverside Hotel in the left foreground; the Post Office on the right; Virginia Street-bridge in the middle "in" the Truckee River; the Masonic Building, the Mapes Hotel, and the Majestic Theater from left to right along the north riverbank. Photograph courtesy of the Nevada Historical Society.)

Figure 12. 1955 flood scene of Truckee River in downtown Reno (Both Virginia Street and the bridge are under floodwater. The Post Office and the State Building are shown respectively on the left and right sides.) The December 1955 flood was the largest recorded flood experienced in the Reno-Sparks-Truckee Meadows area. It resulted from over 13 inches of warm rain that fell in a 3-day period, melting 15 inches of ripe snow pack (Reference 2). Although this was a larger flood than the November 1950 flood with a peak discharge of 20,800 cfs, the damage caused in the Reno area was only one-half as much as in 1950, because of improved prevention and coordination programs developed and implemented in 1955, based on the lessons learned from the 1950 events.

Figure 13. One of the major losses of the December 1955 flood was the newly completed Kietzke Lane Bridge.

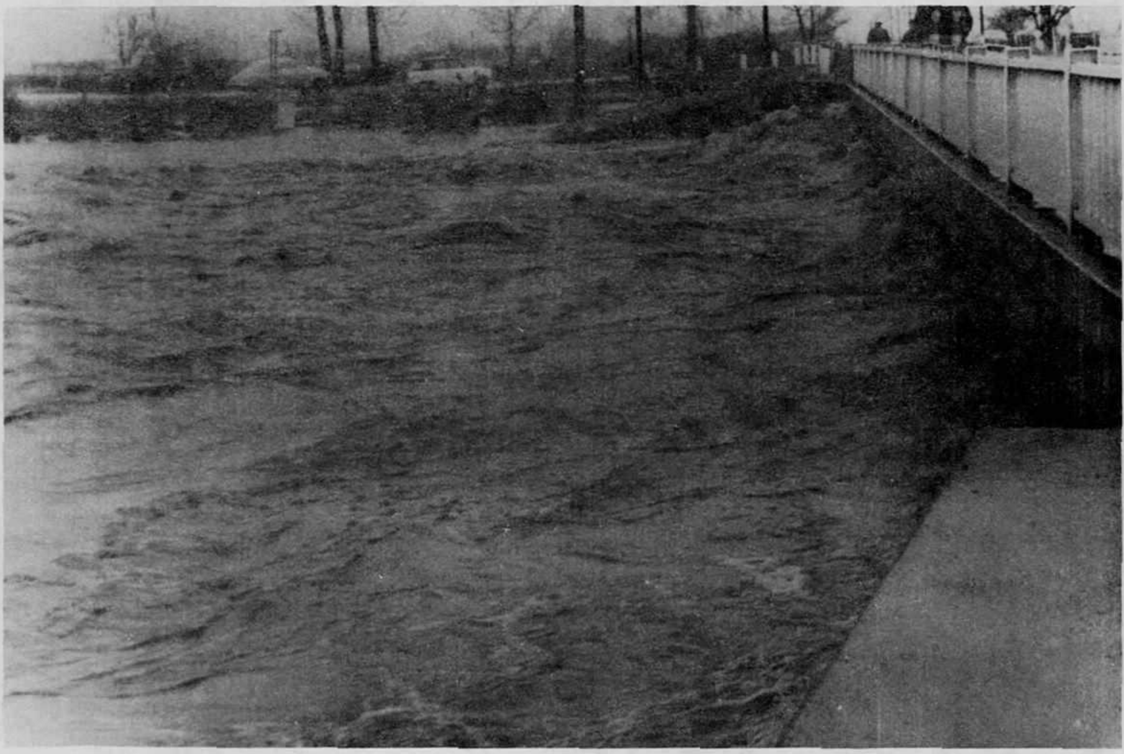


Figure 14. Truckee River at Glendale Bridge during the December 1955 flood (Photograph courtesy of the Nevada Historical Society.)

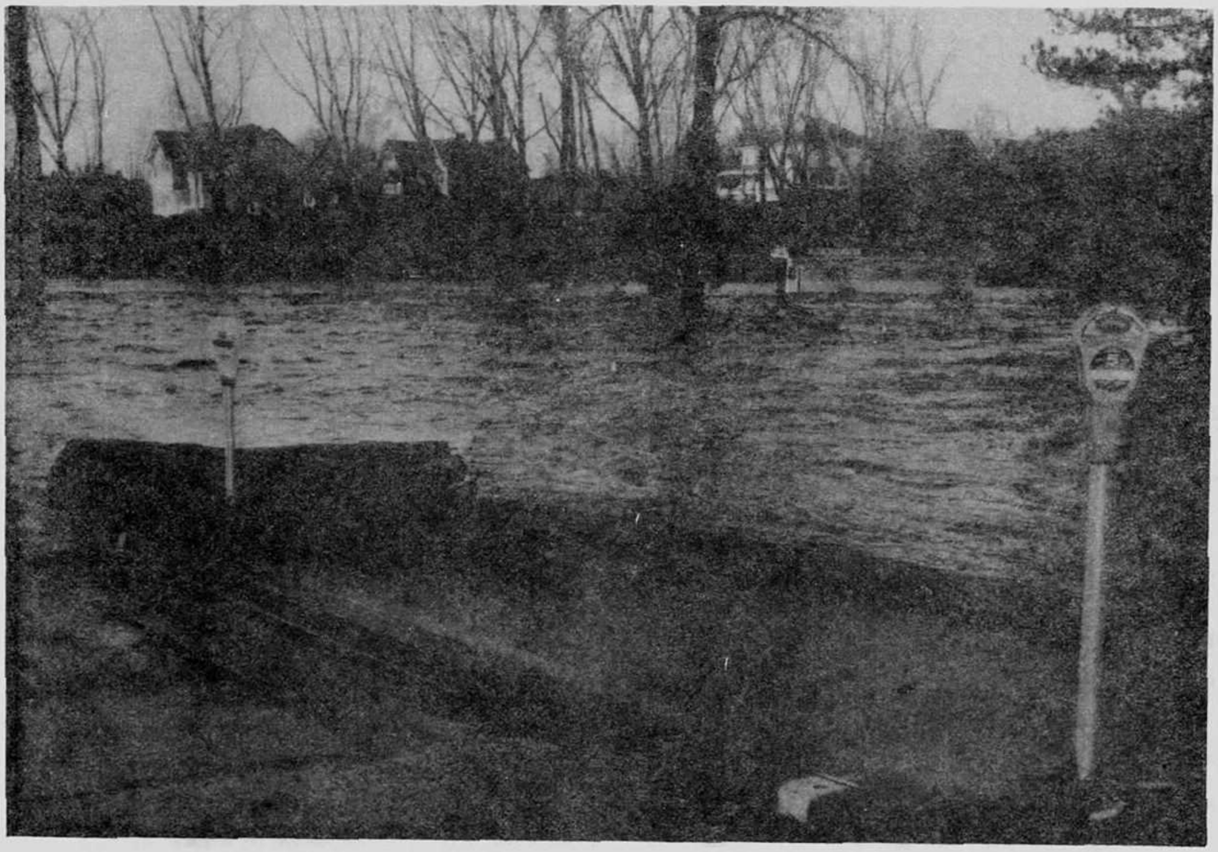


Figure 15. Truckee River during a major flood event, February 1963.


Figure 16. Scene of a major flood event in Reno, February 1963.

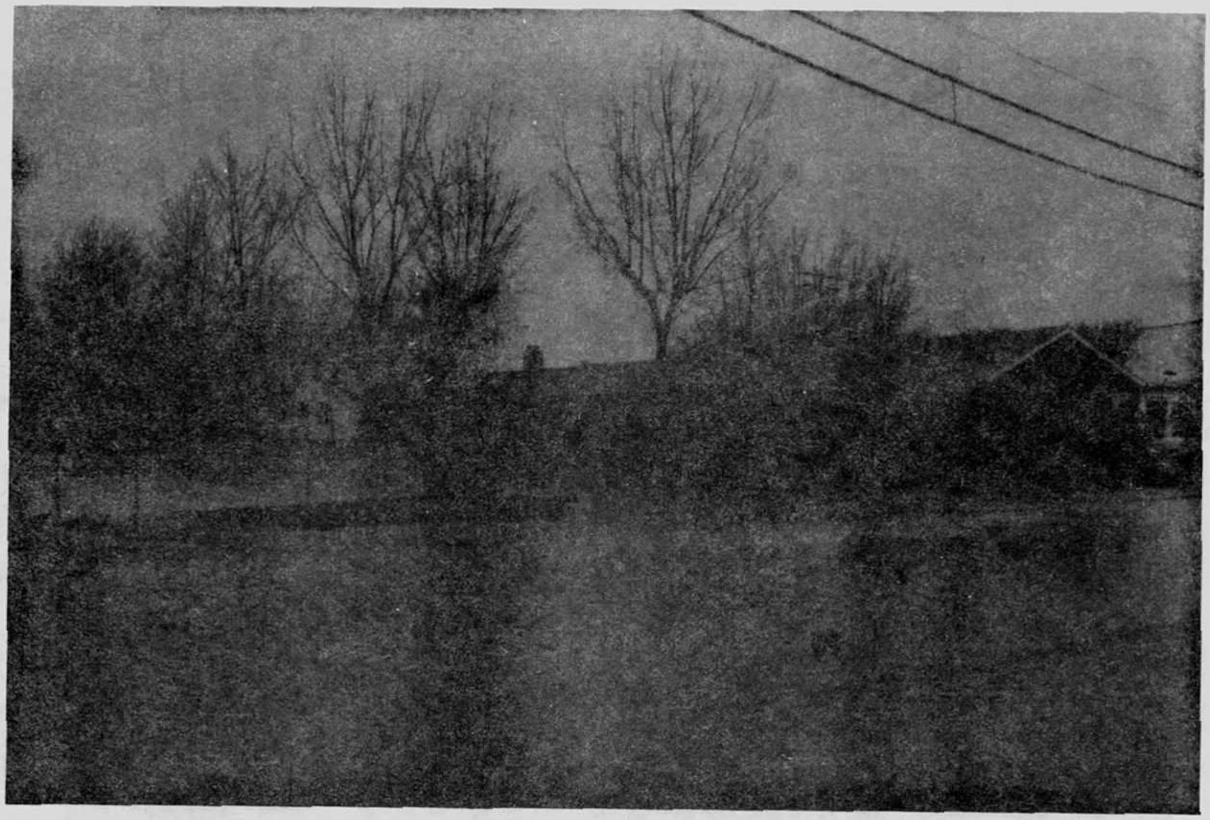


Figure 17. February 1963, a major flooding event in Reno.

Figure 18. Overflow from the Truckee River. Downstream of McCurran Boulevard Bridge, February 1986. (Photo by Nimbus Engineers.)

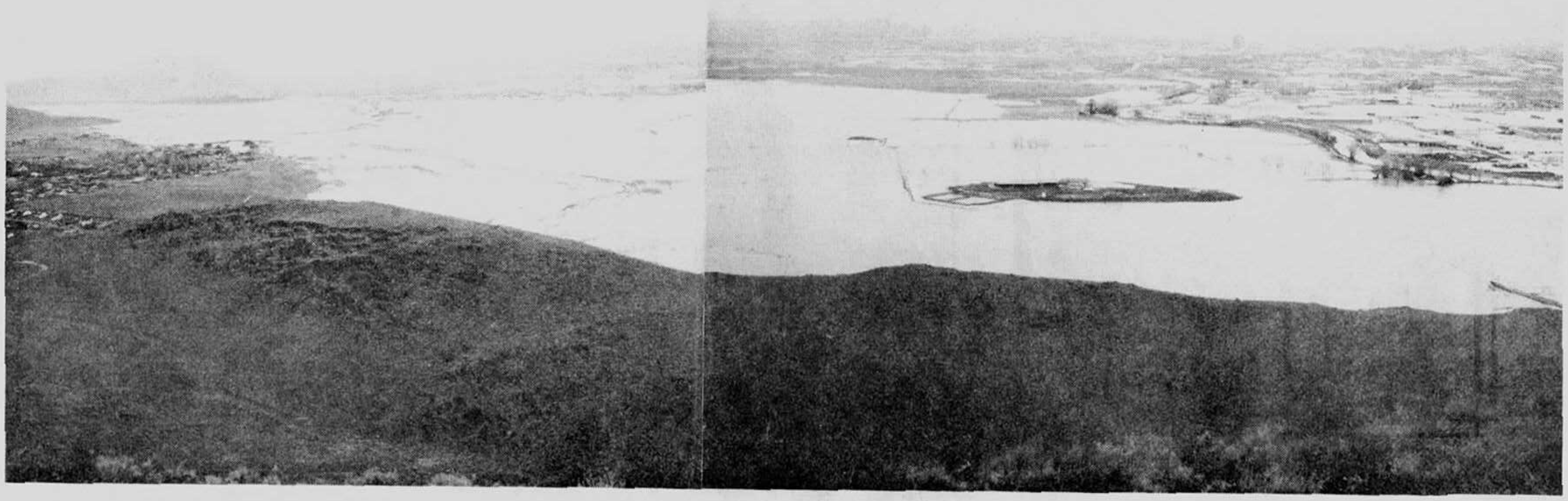


Figure 19. Confluence of the Truckee River and Steamboat Creek. February 1986. (Photo by Nimbus Engineers)

Figure 20. Flooding of sewage treatment plant in Lemmon Valley Playa. February 1986. (Photo by Nimbus Engineers)

## 2.4 Flood Protection Measures

Existing flood protection measures include:

a. Improvement of 7.5 miles of the Truckee River channel by widening, straightening, and steepening the gradient from the Second Street bridge downstream to Vista; and removal of obstructive rock reefs at Vista. This work was done by the COE in 1961. As a result, the bankful capacity of Truckee River through Truckee Meadows is raised to 7,000 cfs (Reference 6).

b. Local interest groups improved the banks of Truckee River through the city, which increased the river channel capacity from 12,000 cfs to 14,000 cfs. The City is responsible for the maintenance of the channel in the vicinity of the city under a contract with the U.S. Department of the Army.

c. The construction of a new channel from Peckham Lane to approximately 0.6 mile upstream, within Washoe County, diverts flows from Dry Creek into Boynton Slough. Between Peckham Lane and Boynton Lane, Boynton Slough has been widened, realigned, and regraded, resulting in a channel which is sufficient to convey floods of a 100-year magnitude.

d. Runoff from the Truckee River drainage area upstream of Reno is regulated by a system of three natural lakes and four reservoirs located on the major tributaries. Three of the four reservoirs (Stampede, Boca, and Prosser) are built and operated by the U.S. Water and Power Resources Service. Martis Creek Reservoir was built by the COE for the primary purpose of flood control.

e. A maximum of 65,000 acre-feet of joint-use space in the four reservoirs is provided for flood control on a seasonal basis. However, they do not provide protection for 100- year flooding. Whenever any part of this space is not required for flood control, it is allocated for other purposes.

f. Prosser Creek Reservoir provides 20,000 acre-feet of joint use flood control space for regulation of Prosser Creek contribution (53.5 square miles) to the Truckee River floods. Similarly, Stampede and Boca Reservoirs together provide 30,000 acre-feet on Little Truckee River (169 square miles). The Martis Creek Reservoir has a gross capacity of 20,400 acre-feet, all of which is initially available for the regulation of floodwater from Martis Creek (39 square miles) subbasin.

g. The operation of the reservoirs for flood control is to be coordinated to limit the flow in Truckee River at Reno, insofar as possible, to a maximum of 6,000 cfs (Reference 8). On the basis of the 65,000-acre-foot flood control space jointly reserved for all the reservoirs, approximately 30 percent of the reserved space will be at Martis Creek, 20 percent at Prosser Creek, and 50 percent at Stampede and Boca Reservoirs together.

h. Some incidental regulation is effected by Donner Lake on Donner Creek and Independence Lake on Independence Creek. Lake Tahoe which is operated under a Federal Court decree issued on September 8, 1944, also provides flood protection by storing water up to a maximum elevation of 6,229.1 feet (USBR datum) (Reference 2). One hundred year flood protection is minimal as lake levels are controlled for recreation purposes.

The SCS has carried out watershed protection projects that include flood detention dams on Peavine Creek. These projects provide flood protection from 100-year flooding to parts of the northwest Reno area.

The National Oceanic and Atmospheric Administration maintains year-round surveillance of weather conditions. Daily forecasts for Reno and vicinity are issued by the Reno office of the National Weather Service, National Oceanic and Atmospheric Administration. The National Weather Service Forecast Center in Sacramento, California, prepares flood forecasts for the Truckee River. These forecasts, along with flood warnings for Truckee Meadows, are released to local news media and law enforcement agencies by the National Weather Service office in Reno. Residents and business establishments in low-lying areas may receive warnings of impending flash floods through law enforcement agencies.

A coordinated plan for flood fighting and other flood emergencies has been developed by Washoe County in cooperation with the Cities of Reno and Sparks. In general, the plan provides that the Directors of Public Works supervise flood emergency operations in their respective jurisdictions, and that the Civil Defense Agency for Washoe County jurisdictions involved, establishes communications, disseminates weather and flood information, and requests State and Federal assistance when the flood situation so warrants.

Formal emergency evacuation plans have not been developed. People in flood-prone areas are asked to evacuate through flood warnings. In the event of flash floods, city and county equipment is used to assist in the evacuation of damaged areas.

There is a local ordinance restricting development along the Truckee River, 150 feet from the center of the channel, along each bank.

## 3.0 ENGINEERING METHODS

For the flooding sources studied in detail 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 which are expected to be equalled 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 flood plain management and for flood insurance premium 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 equalled 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 which equals or exceeds the 100-year flood (1-percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here 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 the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied by detailed methods affecting the community.

For Truckee River the USGS gage (No. 10348000) site in Reno, which is approximately 400 feet downstream from Kietzke Lane bridge, was chosen as the index point for estimating the flood peak-frequency relationship. The peak flow frequency depicted a joint probability of exceedence for the two major types of floods in the Truckee River basin, namely the snowmelt and rain floods. It was derived by statistically combining the frequency curves for the individual events, which were developed separately and were based on the assumption that the two events are independent. The individual frequency curves and other pertinent information were obtained from the reports and files of the COE, Sacramento District (References 2, 6, and 8). Additional information for the flood frequency analyses was extracted from References 7 and 9 through 15.

The flood peak-frequency curve shows the peak discharge-frequency relationships for the present-day upstream watershed condition. In its development, the flood peak attenuation effects of the upstream lakes and reservoirs have been incorporated.

The joint probability curve developed as described above was compared to that of the rain flood probability curve which was the basis for the intermediate regional flood peak value used in developing the Flood Plain Information report for Reno-Sparks-

Truckee Meadows (Reference 2). Although there is an important difference of basic theoretical nature between the two curves, the quantitative difference was insignificant for peak discharges larger than 10,000 cfs. In the range of interest for this Flood Insurance Study 10- to 500-year return period, the difference is under 10 percent. Because of the flatness of the area, the resulting difference in water-surface elevation was evaluated at the Reno gage site and found to be within 0.5 foot. This difference is considered not to be significant by FEMA, therefore; the peak discharge-frequency relationship developed by the COE (Reference 2) was adopted for use in this study.

The peak discharge-frequency relationships for Steamboat Creek and its tributaries (Boynton Slough, and Thomas, Dry, and Evans Creeks) were determined from regional analyses based on 18 moderate-sized, natural drainage basins in the Truckee River and Carson River basins. This method was considered most appropriate to flood insurance rate assessment as it is based on the rate of occurrence of actual observed floods which should sample the net effect of all the diverse characteristics and joint probabilities of the rainfall-snowmelt-runoff relations in both time and space.

Records from the 18 stream-gaging stations containing 306 annual flood peaks obtained from the USGS National Water Data Storage and Retrieval System files (Reference 16) were utilized to establish the peak discharge-frequency relation in accordance with the procedure recommended by the U.S. Water Resources Council (Reference 17). The stations are listed in Table 2. On those tributaries studied within the City of Reno, there are no known stream-gaging stations from which flood discharge-frequency relationships can be directly determined. However, the regional analysis included the stream-gage records from Peavine Creek (No. 347800) and Hunter Creek (No. 347600) located near the west edge of Reno and the gages located on Galena Creek (No. 348900) and upper Steamboat Creek (No. 349300) approximately 7 miles south of Reno. The relationships developed at the gaging stations were transferred to the ungaged study reaches by means of the statistical technique of multiple regression and by mapping of the flood variability (standard deviation). The latter reflected the increased probability of intense thunderstorms along the mountain front west of Reno. With the exception of the airport drainage to Boynton Slough, no adjustment was made for the effects of urbanization, as the major flood-producing areas of these basins are as yet undeveloped.

Peak discharge-drainage area relationships for Steamboat Creek and its tributaries and Truckee River are shown in Table 3.

Table 2. Stations Used for Regional Flood Peak Frequency Analysis

| U.S. Geological Survey Stream Gage No. | Length of Record (Years) | Mean Annual Flood Peak (cfs) | Standard Deviation (Log Units) | Drainage Area (Square Miles) | Mean Annual Precipitation (Inches) | Mean Elevation (Feet) |
|---|---|---|---|---|---|---|
| 310000 | 58 | 940 | 0.288 | 65.60 | 37.0 | 8,000 |
| 310500 | 27 | 45 | 0.384 | 15.00 | 22.0 | 6,400 |
| 336600 | 16 | 830 | 0.234 | 33.10 | 44.0 | 7,600 |
| 336635 | 9 | 8 | 0.273 | 0.64 | 45.0 | 6,800 |
| 336660 | 16 | 520 | 0.355 | 11.20 | 69.0 | 7,000 |
| 336693 | 10 | 20 | 0.361 | 1.69 | 30.0 | 8,000 |
| 336700 | 6 | 35 | 0.348 | 7.00 | 30.0 | 7,800 |
| 336780 | 16 | 150 | 0.288 | 36.70 | 33.0 | 7,800 |
| 339400 | 12 | 380 | 0.349 | 40.00 | 29.5 | 6,400 |
| 339900 | 13 | 115 | 0.408 | 7.47 | 36.0 | 6,400 |
| 340500 | 20 | 1,020 | 0.366 | 53.60 | 37.0 | 6,200 |
| 342000 | 26 | 1,030 | 0.426 | 36.60 | 36.0 | 7,200 |
| 343500 | 23 | 120 | 0.405 | 10.80 | 31.0 | 7,000 |
| 347600 | 12 | 45 | 0.465 | 11.50 | 18.0 | 7,800 |
| 347800 | 9 | 8 | 0.372 | 2.34 | 12.0 | 5,800 |
| 348900 | 15 | 180 | 0.633 | 8.50 | 31.0 | 8,200 |
| 349300 | 14 | 180 | 0.424 | 39.00 | 18.0 | 5,800 |
| 349700 | 5 | 30 | 0.231 | 8.02 | 31.0 | 8,000 |

The floodflows for Steamboat Creek and its tributaries were compared with flows obtained using USGS methods (Reference 18) and those listed in the COE Flood Plain Information reports (References 19 and 20). The tabulated values are somewhat higher than the USGS values, but for smaller drainages, they are substantially lower than those estimated by the COE. These discrepancies are believed to be due to the differences in methods, assumptions, and data used, and have not been reconciled.

The 1987 restudy was limited to hydrologic and hydraulic studies of the 100-year floods; those events with a 1-percent chance of being equalled or exceeded in any given year.

The hydrologic analysis used to determine the lake levels for the four playas in Lemmon Valley was done using the COE HEC-1 computer program. This hydrologic model was calibrated using rainfall and runoff collected during and after the February 1986 flooding event.

The watershed parameters used in the HEC-1 model were determined from 7.5-minute USGS topographic quandrangle maps of the area. Soil properties were determined from SCS soil surveys for Washoe County. Statistical rainfall information from the National Oceanic and Atmospheric Administration Atlas 2 and National Weather Service Technical Paper No. 49 were considered to be inappropriate references for the study area based upon observed rainfall patterns of past major storm events such as those that occurred in 1955, 1963, and 1986. Technical coordination between the study contractor (Nimbus Engineers), the National Weather Service and Washoe County Department of Comprehensive Planning was done to determine the appropriate rainfall patterns and distributions to be used. Additional references used included statistical rainfall information by the California Department of Water Resources and volunteer rain gage information from 3 sites in the study area. The final analysis used was also reviewed by the SCS, COE, USGS, National Weather Service, and local agencies.

### 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

For the most part, flood elevations were determined by the Standard Step method of backwater profile computation using the COE HEC-2 computer program (Reference 21). A separate program was developed to handle the hydraulics at small culvert crossings for flow conditions ranging from inlet control free surface flow to totally submerged weir flow condition over the road crossings.

Table 3. Summary of Discharges

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (cfs) 10-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|
| Truckee River | | | | | |
| At Vista | 1,429 | 5,000 | 15,000 | 20,500 | 32,000 |
| At Reno | 1,067 | 5,000 | 12,000 | 18,000 | 38,500 |
| Steamboat Creek | | | | | |
| At Confluence With Truckee River | 154 | 1,850 | 4,800 | 7,000 | 15,700 |
| Below Confluence With Boynton Slough | 148 | 1,770 | 4,600 | 6,650 | 15,100 |
| Above Confluence With Boynton Slough | 112 | 1,350 | 3,450 | 5,000 | 11,300 |
| Boynton Slough | | | | | |
| At Boynton Lane | 27.5 | 400 | 1,260 | 1,980 | 5,300 |
| At Confluence With Steamboat Creek | 31 | 450 | 1,430 | 2,200 | 6,100 |
| Dry Creek | | | | | |
| Below Evans Creek | 25.5 | 380 | 1,200 | 1,880 | 5,100 |
| At South Virginia Street | 14 | 200 | 640 | 1,000 | 2,700 |
| Evans Creek | | | | | |
| At South Virginia Street | 11 | 200 | 620 | 980 | 2,650 |
| Thomas Creek | | | | | |
| Below Highway 395 | 11.3 | 290 | 921 | 1,451 | 3,918 |

The hydraulic principles and the solution methods used in the latter program are those developed by the U.S. Bureau of Public Roads (References 22 and 23), expanded to incorporate weir flow conditions over road crossings. This program was written by Tudor Engineering Company for use on an HP-9830A computer. Hand calculations were made for special cases as required.

Necessary data were obtained from several sources. The cross sections of the Truckee River used for backwater analyses were those surveyed for the Flood Plain Project of the City of Reno (Reference 24). A moderate amount of modification was made to make the cross sections hydraulically compatible to flow conditions. Cross sections of Steamboat Creek and its tributaries included in the study were prepared specifically for this study. The cross sections were located with the help of aerial photographs and existing topographic maps and later confirmed by field inspection (Reference 25). Dimensions of bridges, culverts, and other hydraulic structures were obtained by field measurements. Cross section geometries and bridge and culvert data for the channelized Boynton Slough between the downstream crossing of McCarren Boulevard and the diversion point from Dry Creek were obtained from as-built plans furnished by the City (References 26, 27, 28, 29 and 30).

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 is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficient values for the Truckee River were determined using historic flood data and field inspection of the flood- plain. Flow rating curves at Reno and Vista gage sites were obtained from the USGS. The data for the December 1964 flood at Vista were used for the calibration of the hydraulic parameters in the vicinity of the Vista gage. The data at Vista gage from the flood of February 1963 could not be used for calibration due to apparent uncertainty about the flow estimate. Based on the slope-area measurements made after the flood, the USGS estimated a peak flow of 18,900 cfs. The COE considers this to be too high for the reported high-water levels. This conclusion was based on backwater analysis using surveyed overbank sections and projected channel grades for the Vista reef modification work completed in 1961. This matter was investigated by Tudor Engineering Company because correct evaluation of the water- and energy-surface elevations in the vicinity of the Vista gage is essential to the determination of the flood-surface elevations in Truckee Meadows.

The raw data and the analyses of both approaches were reviewed and additional channel surveys were conducted for backwater analysis. The expansion and contraction coefficients used by the COE were considered highly conservative values. The 1964 flood level at

Vista gage was matched using channel roughness coefficient "n" = 0.028, a reasonable value based on actual wading of the river channel. Furthermore, the high-water level on the outside of the gage well of 17.11 feet (4385.70 feet elevation) was considered a better representative of the actual water surface during the passage of the peak than the lower water surface observed inside the well. Based on the foregoing, the peak flow was estimated to be approximately 17,900 cfs, i.e., 1,000 cfs (6 percent) lower than the revised USGS estimate of 18,900 cfs. Conversely, the water-surface elevation for 18,900 cfs would have been 4386.25 feet, 0.55 foot higher than was reported.

Surveyed elevations of observed high-water marks of the February 1963 flood in the Truckee Meadows area (Reference 31) were used for calibration in developing the relationship between the flood water-surface elevation in Truckee Meadows, sometimes referred to as the Vista Lake, and the outflow rate at Vista gage. In the downtown Reno reach, elevations of high-water marks of the 1950 and 1955 floods along with judgment based on field inspection of the current conditions were used in determining hydraulic parameters such as Manning's roughness coefficients and coefficients of contraction and expansion. The channel roughness coefficient values used for the Truckee River between Lawton and Vista ranged from 0.025 to 0.040 for the channel and from 0.040 to 0.060 for the overbank areas.

Roughness and loss factors used in the hydraulic analyses of Steamboat Creek and its tributaries were chosen by engineering judgment based on field inspection of the streams and their floodplains. The values used ranged from 0.027 to 0.030 for the channels and 0.032 to 0.045 for the overbank areas.

Starting water-surface elevations for the Truckee River were obtained from the Truckee River rating curve at Vista gage (No. 343500) furnished by the USGS and extended by backwater calculation for discharge values larger than 10,300 cfs (the December 1964 flood peak).

Starting water-surface elevations for Steamboat Creek and its tributaries were obtained by using normal-depth calculations and the HEC-2 computer program (Reference 21).

For Boynton Slough, upstream of Boynton Lane, the 100-year flood is entirely contained within the channel banks; therefore, no flood elevations are shown.

Cross section data for the 1987 restudy for the Truckee River and Steamboat Creek were obtained using photogrammetric mehtods by Great Basin Aerial Surveys utilizing aerial photographs dated December 1, 1986 (Reference 32).

Additional information concerning the Truckee River channel invert was obtained from site surveys performed in June 1987 by Nimbus Engineers.

The HEC-2 computer program was used to develop a model of North Truckee Drain for the 1987 restudy. Model parameters and topographic information were taken from construction drawings for the recent improvements performed on North Truckee Drain.

High water marks from the flood of 1986 were used to calibrate roughness values. This yielded similar channel roughness values as obtained in previous studies. Overbank roughness has increased primarily due to additional obstructions within the floodplain.

Bridge information for the Truckee River crossings was obtained from construction plans and site visits by Nimbus Engineers.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

Evans, Thomas, and Dry Creeks cause alluvial fan type flooding and shallow flooding in southeast Reno. The elevations of the 100-year flood were developed from alluvial fan analyses, normal- depth calculations, and topographic maps (Reference 32).

All elevations are referenced to the National Geodetic Vertical Datum of 1929. Elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for the Truckee River were based on unobstructed flow. This was because the City cleans and maintains the channel under a contract with the COE. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

## 4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program (NFIP) encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study includes a floodplain boundary map designed to assist communities in developing sound floodplain management measures.

### 4.1 Floodplain Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of floodplain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at scales of 1:1,200, contour interval 2 feet; 1:4,800, contour interval 2 feet; 1:4,800, contour interval 5 feet, and 1:2,400, contour interval 5 feet (References 24, 25, 32, and 33, respectively). Where applicable, as-built plans were used to supplement floodplain boundary delineations (References 26, 27, 28, 29, 31, and 35).

For stream channels designated as "Zone A Contained in Channel," the 100-year floodplain boundaries were based on existing channel alignment and right-of-way.

Approximate floodplain boundaries in some portions of the study area were taken from FEMA Flood Hazard Boundary Maps for the City of Reno and Washoe County (References 35 and 36. Approximate boundaries were also taken from USGS Flood Prone Area Maps, at a scale of 1:24,000, with a contour interval of 20 feet (Reference 38).

Floodplain boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). 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 and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

### 4.2 Floodways

Encroachment on floodplains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, 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, the concept of 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 flood 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 in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum FEMA standards limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

Floodway delineation is considered inappropriate on that segment of the Truckee River floodplain beginning opposite Del Curto Drive and Sumac Street to Locust Street, as the floodplain is already fully developed. It should also be underscored that any further development within the "Base Floodplain" will adversely affect its boundaries.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the floodplain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 4).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year floodplain are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus 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 21.

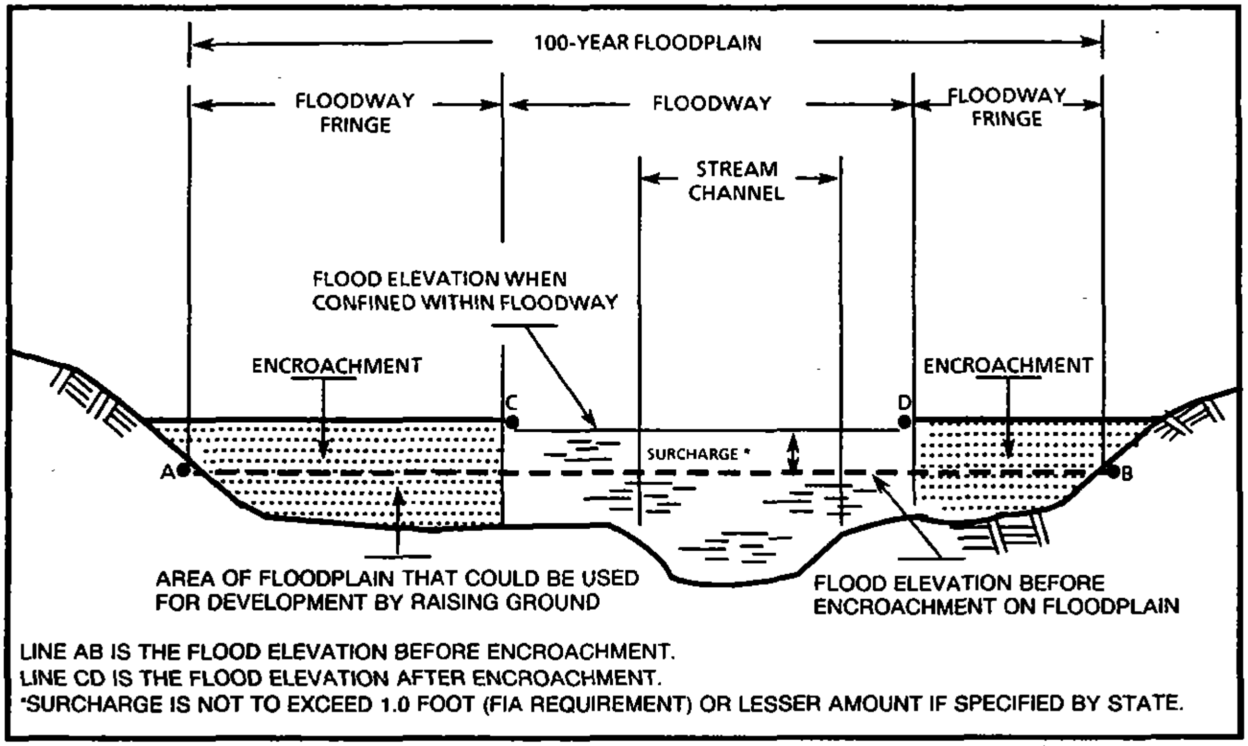



Figure 21. Floodway Schematic

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION (FEET NGVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE[3] |
| Truckee River | | | | | | | | |
| BO | 19,950[1] | 669/244[4] | 3897 | 4.6 | 4,400.6 | 4,400.6 | 4,401.0 | 0.4 |
| BP | 22,160[1] | 805/340[4] | 2967 | 6.1 | 4,403.0 | 4,403.0 | 4,404.0 | 1.0 |
| BQ | 24,140[1] | 530/305[4] | 3031 | 5.9 | 4,407.1 | 4,407.1 | 4,407.8 | 0.7 |
| BR | 25,430[1] | 196/86[4] | 1570 | 10.8 | 4,409.7 | 4,409.7 | 4,410.4 | 0.7 |
| BS | 26,125[1] | 186/76[4] | 1474 | 11.5 | 4,411.8 | 4,411.8 | 4,412.1 | 0.3 |
| BT | 27,210[1] | 376/226[4] | 1595 | 10.6 | 4,416.1 | 4,416.1 | 4,416.1 | 0.0 |
| BU | 28,520[1] | 196/106[4] | 1201 | 14.1 | 4,421.2 | 4,421.2 | 4,421.2 | 0.0 |
| BV | 30,575[1] | 199/74[4] | 1979 | 9.1 | 4,429.7 | 4,429.7 | 4,430.0 | 0.3 |
| BW | 31,400[1] | 236/96[4] | 2009 | 9.0 | 4,433.0 | 4,433.0 | 4,433.0 | 0.0 |
| BX | 31,675[1] | 232/82[4] | 1598 | 11.3 | 4,433.3 | 4,433.3 | 4,433.3 | 0.0 |
| BY | 32,295[1] | 474/234[4] | 1793 | 10.0 | 4,438.1 | 4,438.1 | 4,438.1 | 0.0 |
| BZ | 50.493[2] | 189 | 2237 | 8.0 | 4,445.1 | 4,445.1 | 4,446.0 | 0.9 |
| CA | 50.557[2] | 185 | 1682 | 10.7 | 4,445.4 | 4,445.4 | 4,445.4 | 0.0 |
| CB | 50.646[2] | 150 | 1900 | 9.5 | 4,447.5 | 4,447.5 | 4,448.4 | 0.9 |
| CC | 50.813[2] | 280 | 2729 | 6.6 | 4,453.9 | 4,453.9 | 4,453.9 | 0.0 |
| CD | 50.900[2] | 157 | 1566 | 11.5 | 4,453.9 | 4,453.9 | 4,453.9 | 0.0 |
| CE | 51.049[2] | 136 | 1201 | 15.0 | 4,457.5 | 4,457.5 | 4,457.5 | 0.0 |
| CF | 51.180[2] | 153 | 1227 | 14.7 | 4,463.8 | 4,463.8 | 4,463.8 | 0.0 |
| CG | 51.327[2] | 135 | 1373 | 13.1 | 4,469.8 | 4,469.8 | 4,469.8 | 0.0 |
| *CH-DD*[3] | | | | | | | | |

[1]Feet Above Southern Pacific Railroad [2]Miles Above Pyramid Lake [3]Floodway Not Computed
[4]Total width/width within corporate limits

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF RENO, NV (WASHOE CO.)**

# FLOODWAY DATA

## TRUCKEE 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[3] |
| Truckee River (Cont'd) | | | | | | | | |
| DE | 54.868 | 161/40[2] | 1601 | 11.2 | 4,560.8 | 4,560.8 | 4,560.8 | 0.0 |
| DF | 54.961 | 188/70[2] | 1824 | 9.9 | 4,562.8 | 4,562.8 | 4,563.3 | 0.5 |
| DG | 55.220 | 142/110[2] | 1376 | 13.1 | 4,568.3 | 4,468.3 | 4,568.4 | 0.1 |
| DH | 55.330 | 216/100[2] | 1874 | 9.6 | 4,572.0 | 4,572.0 | 4,572.6 | 0.6 |
| DI | 55.832 | 135[3] | 1387 | 13.0 | 4,584.0 | 4,584.0 | 4,584.2 | 0.2 |
| DJ | 56.436 | 215[3] | 2047 | 8.8 | 4,604.4 | 4,604.4 | 4,604.7 | 0.3 |
| DK | 56.815 | 198/20[2] | 1501 | 12.0 | 4,610.7 | 4,610.7 | 4,610.7 | 0.0 |
| DL | 56.908 | 180/65[2] | 1575 | 11.0 | 4,613.9 | 4,613.9 | 4,614.0 | 0.1 |
| DM | 56.940 | 149/55[2] | 1474 | 12.4 | 4,614.1 | 4,614.1 | 4,614.6 | 0.5 |

[1]Miles Above Pyramid Lake [2]Width/Width with corporate limits
[3]Floodway lies entirely outside corporate limits

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

TABLE 4

**FLOODWAY DATA**

**TRUCKEE 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 |
| Steamboat Creek | | | | | | | | |
| A | 730 | 645[2] | 1476 | 4.7 | 4391.7[3] | 4386.2 | 4386.2 | 0.0 |
| B | 3,860 | 1997[2] | 5906 | 1.2 | 4391.7[3] | 4388.3 | 4388.5 | 0.2 |
| C | 4,135 | 1021[2] | 5615 | 1.2 | 4391.7[3] | 4388.5 | 4388.7 | 0.2 |
| D | 12,655 | 1310[2] | 2851 | 2.3 | 4391.7[3] | 4389.2 | 4390.2 | 1.0 |
| E | 13,257 | 1800 | 5728 | 1.2 | 4391.7[3] | 4391.2 | 4391.4 | 0.2 |
| F | 15,557 | 1670 | 8512 | 0.6 | 4391.7[3] | 4391.2 | 4391.4 | 0.2 |
| G | 16,957 | 1230 | 9448 | 0.5 | 4391.7[3] | 4391.2 | 4391.5 | 0.3 |
| H | 20,157 | 735 | 2799 | 1.8 | 4391.7 | 4391.3 | 4391.8 | 0.5 |
| I | 28,316 | 331[2] | 1215 | 3.9 | 4417.6 | 4417.6 | 4418.6 | 1.0 |
| J | 31,416 | 72[2] | 367 | 12.9 | 4428.3 | 4428.3 | 4428.3 | 0.0 |
| Dry Creek | | | | | | | | |
| A | 17,811[4] | 149/110[5] | 169 | 5.9 | 4481.6 | 4481.6 | 4481.6 | 0.0 |

1Feet above confluence with Truckee River
2Floodway lies entirely outside corporate limits
3Based on Truckee River backwater effects
4Feet above Boynton Lane
5Width/Width within corporate limits

TABLE

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV (WASHOE CO.)

# FLOODWAY DATA

## STEAMBOAT CREEK - DRY CREEK

## 5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source studied by detailed methods affecting Reno.

### 5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-Year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the flooding sources of Reno are shown on the Flood Profiles (Exhibit 1) and summarized in Table 5.

For channels designated "Zone A Contained in Channel," no profiles or reach determinations were made. Reach determinations which were made for insurance purposes would have no relevance in a defined channel.

### 5.2 Flood Hazard Factors

The FHF is the FEMA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

FHFs are derived from reach determinations; therefore, they do not apply on the downstream portion of Dry Creek and for Boynton Slough, in Reno.

| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION (FEET NGVD)[3] |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| Truckee River | | | | | | | |
| Reach 1 | 1451, 1453, 1454 | -4.6 | -1.2 | 0.8 | 045 | A9 | Varies - See Map |
| Reach 2 | 1432, 1451 | -6.2 | -2.4 | 2.5 | 060 | A12 | Varies - See Map |
| Reach 3 | 1432 | -10.4 | -5.9 | 7.7 | 100 | A20 | Varies - See Map |
| Reach 4 | 1432 | -6.3 | -2.7 | 6.7 | 065 | A13 | Varies - See Map |
| Reach 5 | 1429, 1431, 1432, 1433 | -5.6 | -2.1 | 4.5 | 055 | A11 | Varies - See Map |
| Steamboat Creek | | | | | | | |
| Reach 1 | 1453, 1454 | -4.0 | -1.0 | 2.1 | 045 | A9 | Varies - See Map |
| Reach 2 | 1461, 1462 | -2.1 | -0.8 | 1.5 | 020 | A4 | Varies - See Map |
| Dry Creek | | | | | | | |
| Reach 1 | 1442, 1444 | -1.6 | -1.0 | 1.5 | 015 | A3 | Varies - See Map |
| Shallow Flooding | 1461 | N/A | N/A | N/A | N/A | AH | Varies - See Map |
| Boynton Slough | 1453 | -3.1 | -1.2 | 1.6 | 030 | A6 | Varies - See Map |
| Evans Creek | | | | | | | |
| Shallow Flooding | 1442 | N/A | N/A | N/A | N/A | A0 | Depth ¼ Velocity 5 |
| Shallow Flooding | 1442 | N/A | N/A | N/A | N/A | A0 | Depth ¼ Velocity 4 |
| Shallow Flooding | 1442 | N/A | N/A | N/A | N/A | A0 | Depth ¼ Velocity 3 |
| Thomas Creek | | | | | | | |
| Shallow Flooding | 1444, 1465 | N/A | N/A | N/A | N/A | A0 | Depth 1 |

[1] Flood Insurance Rate Map Panel [2] Weighted Average [3] Rounded to Nearest Foot

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE COUNTY)

# FLOOD INSURANCE ZONE DATA

TRUCKEE RIVER-STEAMBOAT CREEK-DRY CREEK-BOYNTON SLOUGH
EVANS CREEK-THOMAS CREEK

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of Reno was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

| | |
|---|---|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined. |
| Zone AO: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet and depths are shown; or, areas of 100-year alluvial fan flooding with depths and velocities shown, but no FHFs determined. |
| Zone AH: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined. |
| Zones A1-A30: | Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year floodplain that are protected from the 100-year flood by a dike, levee, or other water control structure; also areas subject to certain types of 100- year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding. |

In this study, channels studied by detailed methods in which the flood hazard is within the channel, have been designated Zone A.

Alluvial fan flood hazard areas on Evans and Thomas Creeks are shown on the Flood Insurance Rate Map (published separately) as

Zone AO, with average depths and velocities of flow given. In these areas, depths of the 100-year flood well exceed 3 feet. Development on alluvial fans is subject to a more severe type of flood hazard than would normally be encountered in Zone AO due to high velocities and the unpredictability of the location of the stream channel across the width of the fan.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied by detailed methods in the community are summarized in Table 5.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Reno is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

## 6.0 OTHER STUDIES

Flooding has always been a major problem in the Reno area and has generated numerous studies and reports. One is a Flood Plain Information report for Reno, Sparks, and Truckee Meadows (Reference 2) published by the COE in October 1970. The main product of this study is the estimated level and extent of flooding in the Reno-Sparks-Truckee Meadows area if an Intermediate Regional Flood or a Standard Project Flood were to occur. An Intermediate Regional Flood on the Truckee River is by definition equal to a 100-year flood. The Standard Project Flood is defined as follows (Reference 2):

> The Standard Project Flood on the Truckee River is that which can be expected from a standard project rainstorm (the storm that would result from the most severe combination of meteorological conditions considered reasonably characteristic of the geographical region) centered over the drainage basin, taking into account reduction of runoff through infiltration, surface ponding, and other factors.

Average recurrence interval is not attached to the Standard Project Flood, although a routing study conducted to assess the effect of all the upstream reservoirs on major floods (Reference 6) shows its peak at Reno to be equivalent to a 450-year flood.

A comparison of the results of the Flood Plain Information report with those of the current Flood Insurance Study, shows significant differences in the water-surface profiles. The 100-year flood profile in the Flood Plain Information report is higher than that of the present study by approximately 1.3 feet in Truckee Meadows (otherwise known as Vista Lake) and by up to 5 feet in the upstream reach of this study, between Mayberry Drive Bridge and Warren Ranch Bridge. The Flood Plain Information profile is lower in the reaches from Mayberry Bridge to Idlewild Park (2 to 6 feet) and from Wells Avenue Bridge to South Rock Bridge (2 to 4 feet). It alternates in the downtown Reno area.

The most important reason for the differences was found to be the variance in the quality of the cross section data used. This conclusion was based on the differences between the river channel thalweg profiles and the differences between water-surface profiles of the two studies. The thalweg profile in the Flood Plain Information report is up to 5 feet higher than that of the Flood Insurance Study in Truckee Meadows and in the upstream reach from Mayberry Drive Bridge to Warren Ranch Bridge; it is lower by approximately the same amount from Mayberry Drive Bridge to Idlewild Park, and alternates in the downtown area. The differences in the water-surface profiles are nearly identical to those of the thalweg. In the reach between Wells Avenue and South Rock Boulevard, the difference in thalweg and water-surface profile is as significant as elsewhere; and the influence of the three diversion dams is pronounced on the Flood Insurance Study profile and absent on the Flood Plain Information profile. The last observation may be an indication to possible variance in the assumptions made in the two studies about the integrity of the dams during floods.

The deduction that the differences in the water-surface profiles were primarily due to differences in input data was corroborated by comparison of results of recent COE studies using similar cross section data. The water-surface profiles in this Flood Insurance Study match the COE profiles at the upstream-end region of the Flood Insurance Study where the COE study from Lawton to Lake Tahoe begins. A 100-year flood profile prepared by the COE in February 1977 for the downtown Reno area, from the Reno gage to approximately 1 mile upstream of Booth Street bridge, agrees well with the Flood Insurance Study profile. Here again the backwater effect of the power diversion dam at the west edge of town is modeled in the Flood Insurance Study and is significant, but it is omitted by the COE model.

Based on the foregoing, the 100-year water-surface profile in the Flood Plain Information report should be superseded by that presented in this study.

Floodplain Information reports were also published by the COE for the nearby communities of Steamboat and Pleasant Valleys in June 1972 (Reference 19) and for the area affected by the southwest foothill streams, namely Evans, Thomas, and Whites Creeks and Skyline Wash in June 1974 (Reference 20). The COE has also published a master report (Reference 6) on the regulation of the system of reservoirs and lakes in the Truckee River basin for flood control purposes.

The SCS has conducted a Type IV river basin survey for the Central Lahontan Basin. It has published Watershed Investigation Reports for Galena Creek, Sun Valley, southwest Reno watershed, Evans Creek (Block N), and on Peavine Creek watershed improvement works (References 39 through 44).

A feasibility study of flood control in Hidden Valley was completed by SEA Incorporated of Sparks, Nevada, in 1971 (Reference 45).

A Flood Insurance Study is being conducted for the City of Sparks, which borders the City of Reno on the northeast, and for adjacent unincorporated areas of Washoe County (References 46 and 47). These studies will be in agreement with this Flood Insurance Study.

A study for the flood protection of Truckee Meadows was conducted by the COE (Reference 48).

This study supersedes the previous Flood Hazard Boundary Map for the City of Reno, Nevada (Reference 35).

This study is authoritative for the purposes of the NFIP data presented herein either supersede or are compatible with all previous determinations.

The Sacramento District of the COE prepared a flood control feasibility study and environmental impact statement for a flood control project on the Truckee River. This February 1985 report describes a flood control project that includes levees, dikes and detention basins for the Truckee River.

## 7.0 LOCATION OF DATA

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

## 8.0 BIBLIOGRAPHY AND REFERENCES


1. U.S. Department of Agriculture, Forest Service, Water and Related Land Resources, Flood Chronology, Truckee River Subbasin 1861-1976, Victor Goodwin, Carson City, Nevada, April 1977.

2. U.S. Department of the Army, Corps of Engineers, Sacramento District, Flood Plain Information, Truckee River, Reno-Sparks-Truckee Meadows, Nevada, October 1970.

3. The Regional Planning Commission, Reno, Sparks, and Washoe County, Growth in Washoe County 1870-1975, March 1976.

4. Nevada Bureau of Mines and Geology, McKay School of Mines, University of Nevada, Special Publication 2, Nevada's Weather and Climate, John Houghton, Reno, Nevada, 1975.

5. Boardman, H.P., Emeritus Professor, Truckee River Floods and High Water Years, June 1952.

6. U.S. Department of the Army, Corps of Engineers, Sacramento District, Master Report on Reservoir Regulation for Flood Control, Truckee River Reservoirs, Nevada and California, December 1971.

7. U.S. Department of the Interior, Geological Survey, Water-Supply Paper, 1830-A, Floods of January-February 1963, in California and Nevada, 1966.

8. U.S. Department of the Army, Corps of Engineers, Sacramento District, Hydrology: Martis Creek, Truckee River Tributaries, California and Nevada, Design Memorandum 1 (as amended), Martis Creek Project, November 1964.

9. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1734, Compilation of Records of Surface Waters of the United States October 1950 to September 1960, Part 10, The Great Basin, 1963.

10. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1927, Compilation of Records of Surface Waters of the United States, 1961-1965, 1970.

11. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 2127, Compilation of Records of Surface Waters of the United States, 1966-1970, 1974.

12. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1684, Magnitude and Frequency of Floods in the United States, Part 10, The Great Basin, 1966.

13. U.S. Department of the Interior, Geological Survey, Water-Supply Paper, Water Data Report, Water Resources Data for Nevada Water Years, 1970-1978.

14. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Precipitation-Frequency Atlas of the Western United States, Atlas 2, Volume VII-Nevada, 1973.

15. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Precipitation Frequency Atlas of the Western United States, Atlas 2, Volume XI-California, 1973.

16. U.S. Department of the Interior, Geological Survey, National Water Data Storage and Retrieval System (WATSTORE), December 20, 1976.

17. U.S. Water Resources Council, Hydrology Committee, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, March 1976.

18. State of Nevada Highway Department, Hydrologic Report 3, Estimating Peak Discharges for Small Drainages in Nevada According to Basin Areas Within Elevation Zones, Donald O. Moore, 1976.

19. U.S. Department of the Army, Corps of Engineers, Sacramento District, Flood Plain Information, Steamboat and Pleasant Valleys, Nevada, Steamboat Creek and Tributaries, June 1972.

20. U.S. Department of the Army, Corps of Engineers, Sacramento District, Flood Plain Information, Southwest Foothill Streams, Evans, Thomas, and Whites Creek, and Skyline Wash, Reno, Nevada, June 1974.

21. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water-Surface Profiles, Davis, California, December 1968.

22. U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Engineering Circular 5, Hydraulic Charts for the Selection of Highway Culverts, December 1965.

23. U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular 13, Hydraulic Design of Improved Inlets for Culverts, August 1972.

24. Spink Corporation, Truckee River Maps, Scale 1:1,200, Contour Interval: 2 feet, Reno, Nevada, 1975.

25. Towill Inc. of San Francisco, Contour Maps, Scale 1:4,800, Contour Interval 2 feet: Truckee River, Steamboat Creek and Tributaries, Reno, Nevada.

26. SEA Engineers/Planners Incorporated, Reno Freeport Aircenter Unit No. 1, Sparks, Nevada, June 1978.

27. SEA Engineers/Planners Incorporated, Reno Aircenter Airport Access, Sparks, Nevada, April 1982.

28. SEA Engineers/Planners Incorporated, McCarran Boulevard, Southeast Quadrant, Mira Loma Drive to Mill Street, Sparks, Nevada, January 1981.

29. SEA Engineers/Planners Incorporated, McCarran Boulevard, Southeast Quadrant, Longley Lane to Mira Loma Drive, Sparks, Nevada, March 1980.

30. SEA Engineers/Planners Incorporated, Dry Creek Rerouting, Capurro Ranch, Sparks, Nevada, August 1978.

31. City of Reno, Department of Engineering, An Addendum Report on Storm Drainage, Supplement to the Storm Drainage Section of the Master Plan Report on Storm Drainage and Sanitary Sewerage, of October 1957, August 1963.

32. Nimbus Engineers, Aerial Photographs, Washoe County, City of Reno, City of Sparks, Nevada, Scale 1:6,000, July 1987 (Aerial Photographs Flown December 1, 1986 by Great Basin Aerial Surveys).

33. Nevada State Highway Department, Topographic Maps, Scale 1:4,000, Contour Interval 5 feet: September 1966.

34. Pugh-Nolte, Contour Map, Truckee River, Reno, Nevada, Scale 1:2,400, Contour Interval 5 feet: 1969.

35. SEA Engineers/Planners Incorporated, Donner Springs Subdivision, Unit Nos. 3-A, 3-B (1976), Unit Nos. 4, 5, 6 (1977) Sparks, Nevada.

36. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Reno, Nevada, Scale 1:12,000, April 1977.

37. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Washoe County, Nevada, Unincorporated Areas, Scale 1:24,000, February 1978.

38. U.S. Department of the Interior, Geological Survey, Flood Prone Area Maps, Scale 1:24,000, Contour Interval 20 feet: Reno N.E., Nevada; Reno N.W., Nevada.

39. U.S. Department of Agriculture, Soil Conservation Service, Galena Creek Watershed Investigation Report, Central Lahontan Basin, Truckee River Subbasin, Washoe County, Nevada, November 1972.

40. U.S. Department of Agriculture, Soil Conservation Service, Sun Valley Watershed Investigation Report, Central Lahontan Basin, Truckee River Basin, Washoe County, Nevada, 1971.

41. U.S. Department of Agriculture, Soil Conservation Service, Southwest Reno Watershed Investigation Report, Central Lahontan Basin, Truckee River Subbasin, Washoe County, Nevada, November 1972.

42. U.S. Department of Agriculture, Soil Conservation Service, Watershed Work Plan, Evans Creek (Block N), Washoe County, Nevada, March 1958.

43. U.S. Department of Agriculture, Soil Conservation Service, Watershed Work Plan, Peavine Mountain Watershed, City of Reno, Washoe County, Nevada, March 1958.

44. U.S. Department of Agriculture, Soil Conservation Service, Project Reevaluation, Peavine Watershed Project, Reno, Washoe County, Nevada, December 1976.

45. SEA Engineers/Planners Incorporated, Feasibility Study of Flood Control in Hidden Valley, Washoe County, Nevada, Sparks, Nevada, January 1971.

46. Federal Emergency Management Agency, Flood Insurance Study, City of Sparks, Nevada, 1983.

47. Federal Emergency Management Agency, Flood Insurance Study, Washoe County, Nevada (Unincorporated Areas), unpublished.

48. U.S. Department of the Army, Corps of Engineers, Sacramento District, Plan of Study, Truckee Meadows Investigation, Nevada, July 1977.

Boyle Engineering Corporation, Revisions to; Addendum to the Flood Insurance Study for Washoe County, Nevada Unincorporated Areas of February 1, 1984, June 1987.

State of California, Department of Water Resources, Division of Planning, Rainfall Depth-Duration-Frequency for California, Revised November 1982.

Crowe, Leonard E., Jr., Storm Amounts Recorded During the February 1986 Flooding, Washoe County Department of Comprehensive Planning, Memo dated April 3, 1986.

Great Basin Aerial Survey Co., Truckee River, Steamboat Creek, and North Truckee Drain Photos, Scale 1:9,600, December 1, 1986.

Great Basin Aerial Surveys, Spot Elevations for Lemmon Valley Playas, Scale 1"=400', June 1987.

State of Nevada, Department of Conservation and Natural Resources, Division of Water Resources, Water Resources - Reconnaissance Series Report 57, A Brief Water-Resources Appraisal of the Truckee River Basin, Western Nevada, 1973.

Nimbus Engineers, Technical Appeal to the Washoe County FIS, Hydrologic Evaluation of Spanish Springs Area, Washoe County, Nevada, October 1986, Revised December 1986.

Nimbus Engineers, Steamboat Creek, Application for Letter of Map Revision for City of Reno, Nevada and Washoe County, Nevada, July 1986.

Nimbus Engineers, Hydrologic Analysis of Silver Lake and Lemmon Valley Playas, Revised December 1987.

Winzler and Kelly Consulting Engineers, Reno Drainage Study, Preliminary Report: Analysis of Drainage Deficiency Areas Within the City Limits, December 1984.

Schaaf & Wheeler, Consulting Engineers, Hydrology Report for Silver Lake in Reno, Nevada, March 18, 1985.

Reimer and Associates, Request for a Letter of Map Amendment for North Reno, Business Park, Reno, Nevada, July, 1985.

Harrill, James R., Evaluation of the Water Resources of Lemmon Valley, Washoe County, Nevada, with Emphasis on Effects of Groundwater Development to 1971, U.S. Geological Survey and the

State of Nevada, Department of Conservation and Natural Resources, Division of Water Resources, Bulletin No. 42, 1973.

Cochran, G.F., M.W. Dale, and D.W. Kemp, Peavine Mountain Water Harvest: Preliminary Feasibility Report, Water Resources Center, Desert Research Institute, University of Nevada, 1984.

Cochran, Gilbert F., Silver Lake 100 yr - 24 hr Storm Volume and Flood Elevations, Letter report to Mr. John P. Hine, Vice President of Hanson Engineers, Inc., 1984.

City of Reno, Department of Public Works, Engineering Division, Public Works Design Manual, July 1, 1985.

EGH and Associates, Consulting Engineers and Planners, Grading and Drainage Plan for Warehouse Market - McCarran and Mira Loma, August 27, 1984.

Fuller, Robert L., Topographic Map of the Jones Ranch, Scale 1" = 100', Contour Interval of 1', April 1978.

Pillsbury, William E., Consulting Engineers, Foxfire Village Grading Plan, May 11, 1978.

Pyramid Engineers and Land Surveyors, North Reno Business Center, Moya Boulevard Improvements, "As Built" plans dated February 1987.

SEA Incorporated, Tahoe/Pyramid Link Alignment Study, October 1983.

The Spink Corporation, Record of Survey of the Truckee River, from the California-Nevada State Line to Vista, 1978.

The Spink Corporation, Lear Reno, Reno/Stead Development Company, Topographic Base Maps, date unknown, from photos dated August 1968.

Simons, Li and Associates, Engineering Analysis of Fluvial Systems, 1982.

U.S. Department of Agriculture, Soil Conservation Service, SCS National Engineering Handbook, Section 4, Hydrology, August 1972.

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Washoe County, Nevada, South Part, August 1983.

U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

U.S. Department of the Army, Corps of Engineers, Sacramento District, Truckee Meadows (Reno - Sparks Metropolitan Area) Nevada, Feasibility Study and Environmental Impact Statement, February 1985.

U.S. Department of the Army. Corps of Engineers, Sacramento District, Floodplain Information, Steamboat Creek and Tributaries, July 13, 1981.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L2010, HEC-1, Flood Hydrograph Package, January 1985.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Training Document No. 5, Floodway Determination Using Computer Program HEC-2, May 1974.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Workshop, Los Angeles District, Nov-Dec, 1981.

U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Hydrologic Engineering Methods for Water Resources Development, Volume 6, Water Surface Profiles, July 1975.

U.S. Department of Commerce, National Weather Service, Two to Ten-Day Precipitation for Return Periods of 2 to 100 years in the Contiguous United States, Technical Paper No. 49, 1964.

U.S. Department of Transportation, Federal Highway Administration, Hydraulic Design Series, No. 1, Hydraulics of Bridge Waterways, March 1978.

U.S. Geological Survey, Discharge Characteristics of Embankment-Shaped Weirs, USGS Water-Supply Paper 1617-A, 1964.

U.S. Geological Survey, Roughness Characteristics of Natural Channels, USGS Water Supply Paper 1849, 1967.

## 9.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at Engineering Division, City of Reno, 450 St. Clair Street, Reno, Nevada.

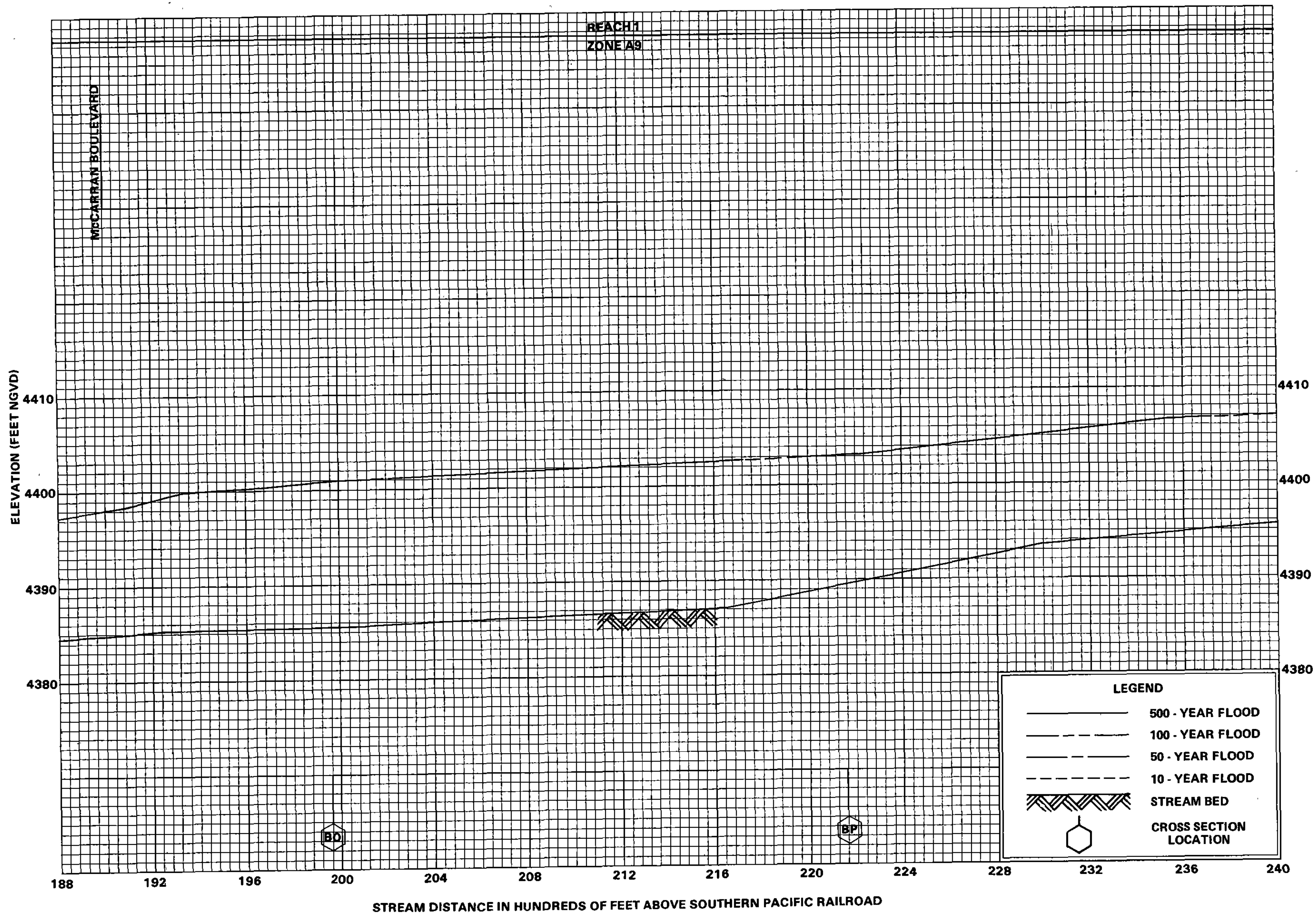
### 9.1 First Revision

This study was revised May 17, 1988, to modify the floodway, base flood elevations, and floodplain delineations along a reach of Steamboat Creek from Pembroke Drive to a point approximately 8,500 feet upstream. The information for this revision was obtained from a reanalysis of Steamboat Creek prepared by Nimbus Engineers, Sparks, Nevada. The base flood elevations along Boynton Slough have also been revised as a result of the modifications to

Steamboat Creek. These revisions are shown on the revised Flood Insurance Rate Map, Flood Boundary and Floodway Map, Floodway Data Table and Profiles for the City of Reno, Nevada. The corporate limits for the City of Reno have also been revised to reflect annexations from the unincorporated areas of Washoe County, Nevada. These annexations placed a reach of Steamboat Creek within the City of Reno. The floodway delineations, base flood elevations, and floodplain boundaries presented in the Flood Insurance Study for Washoe County, Nevada, are in exact agreement with those presented in this study.

9.2 Second Revision

A second revision involving the Truckee River, Steamboat Creek, and Lemmon Valley Playas was completed by Nimbus Engineers in December 1987 and has been included in the main body of this report.



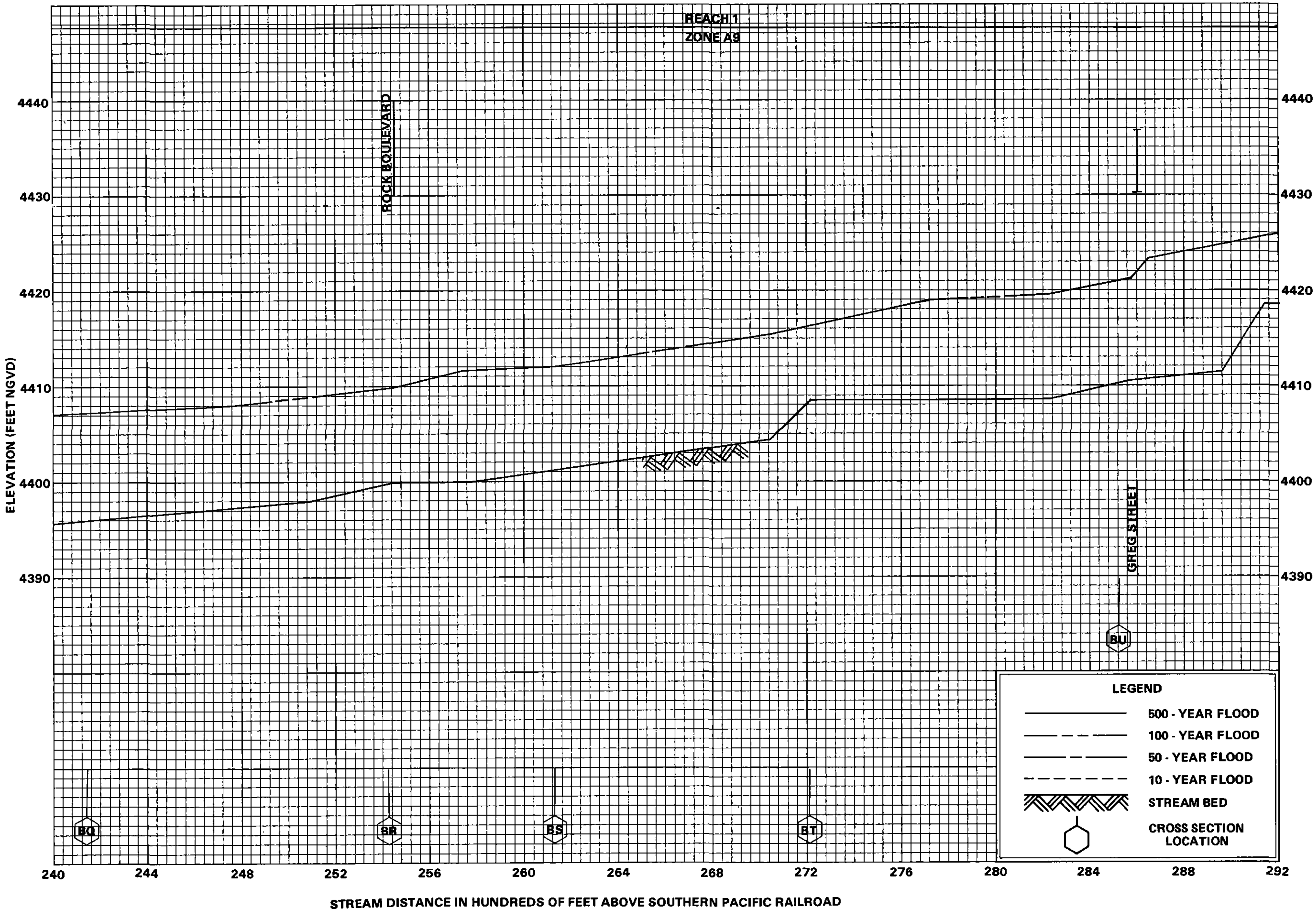

FLOOD PROFILES

TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

01P




FLOOD PROFILES

TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV (WASHOE CO.)

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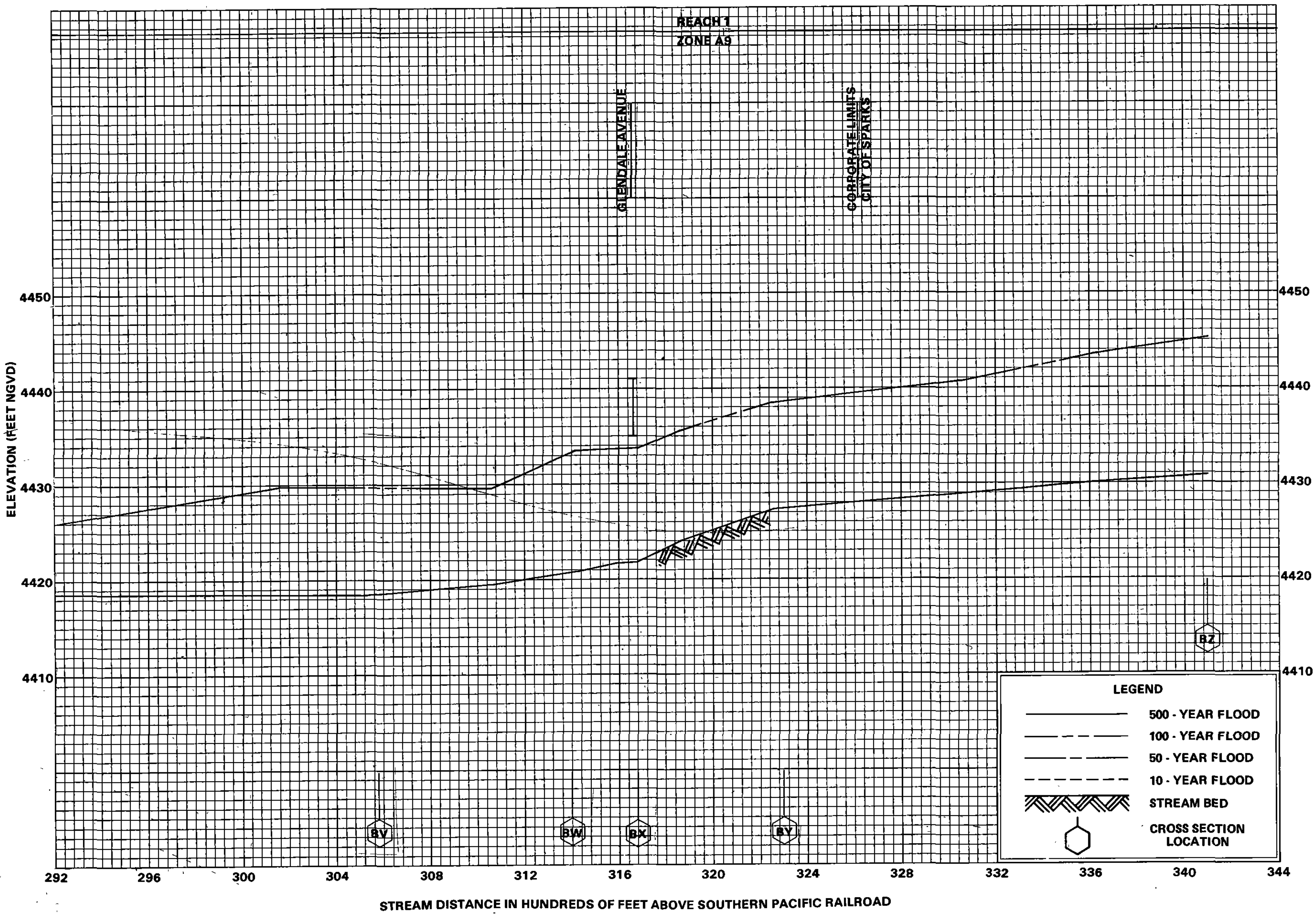


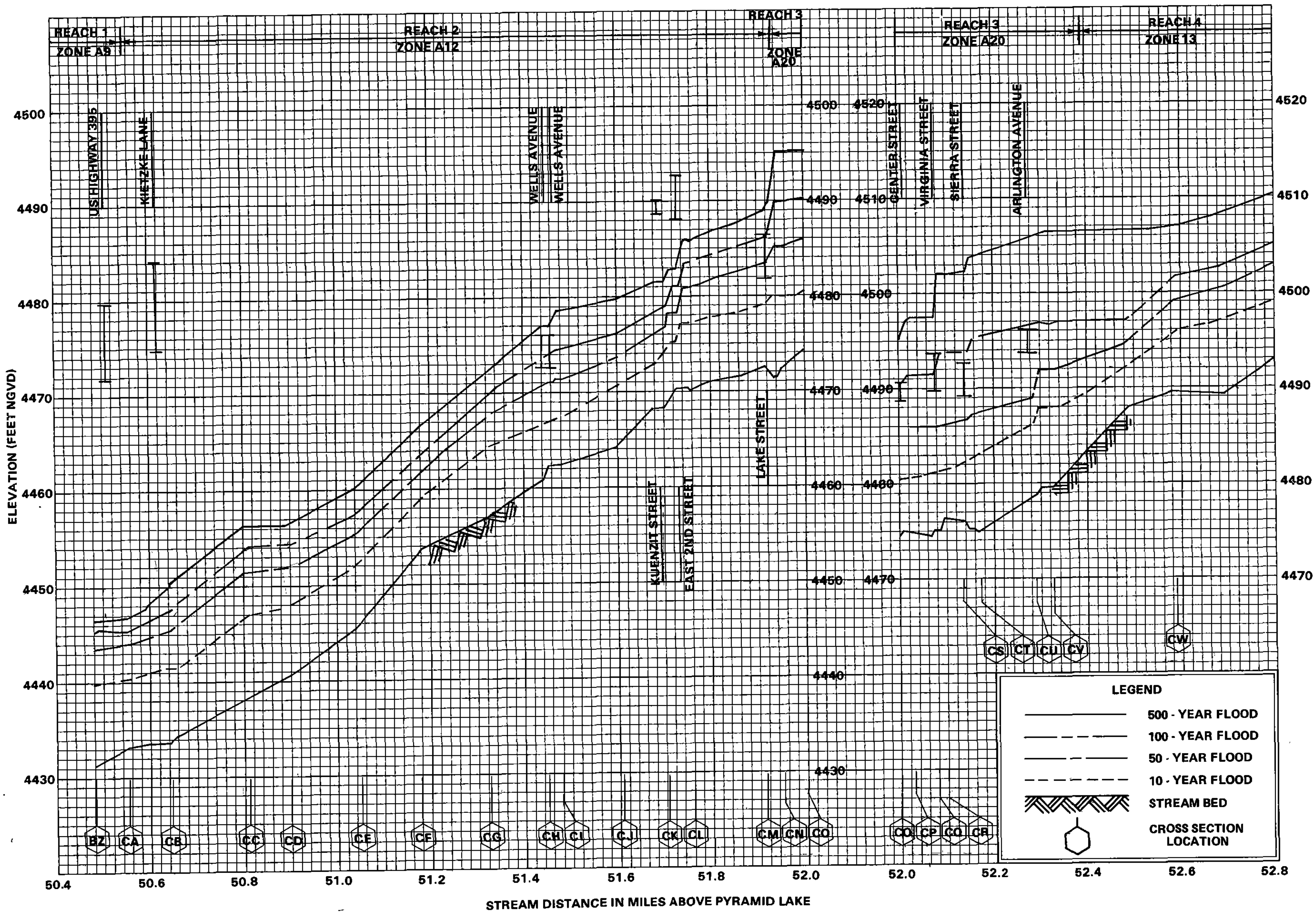

FLOOD PROFILES

TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

03P



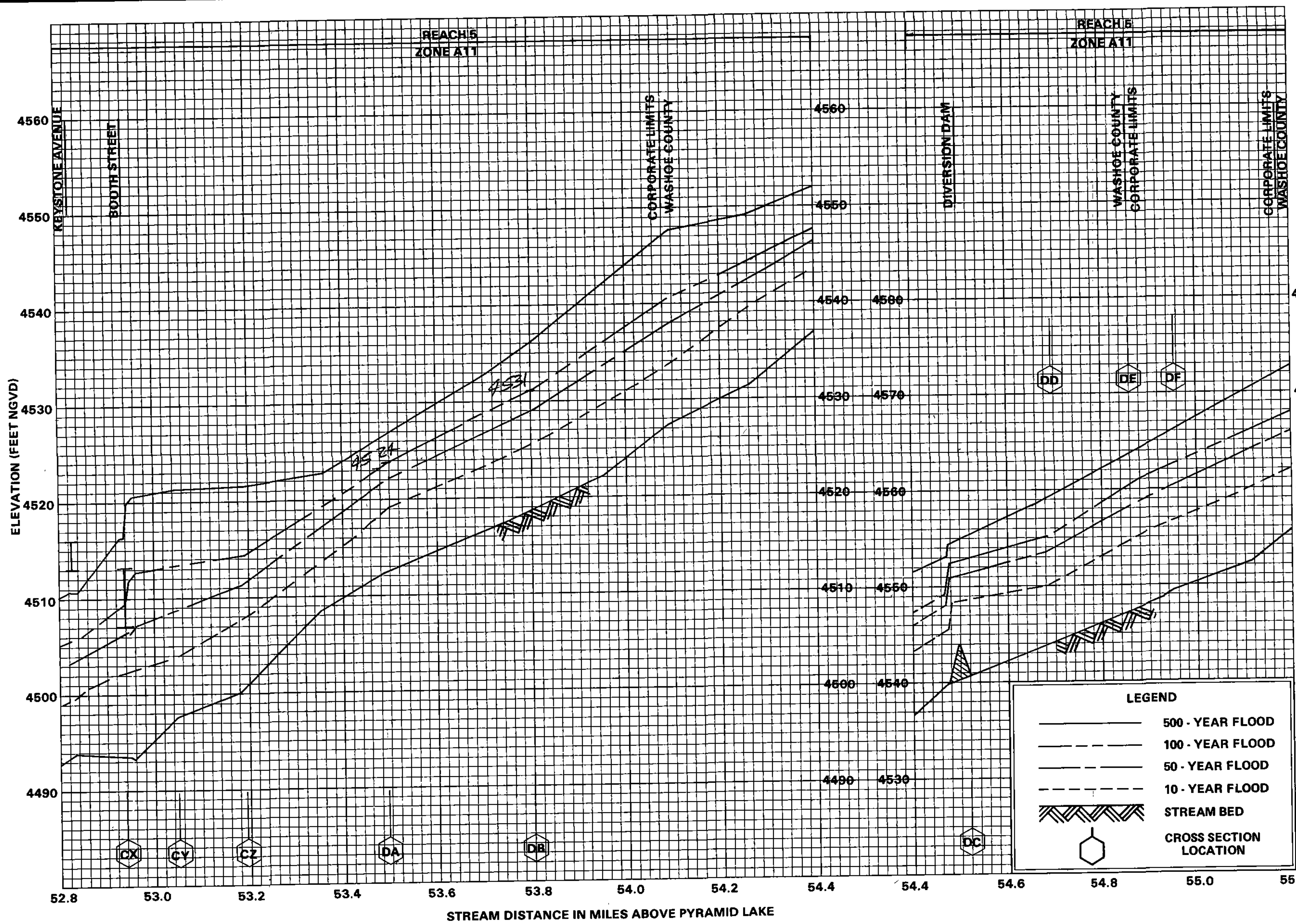

FLOOD PROFILES

TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

04P



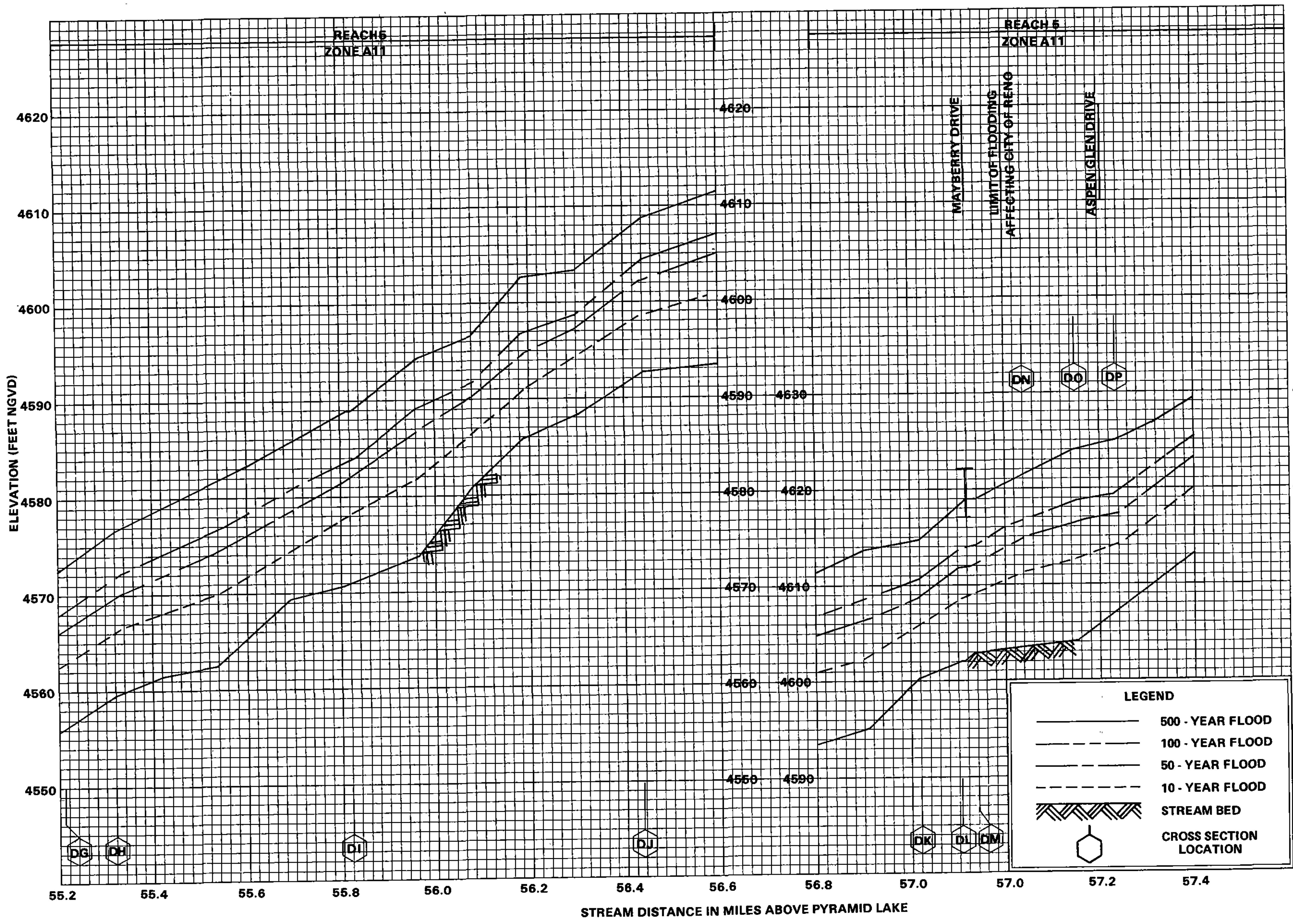

# FLOOD PROFILES

## TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF RENO, NV**
(WASHOE CO.)

05P

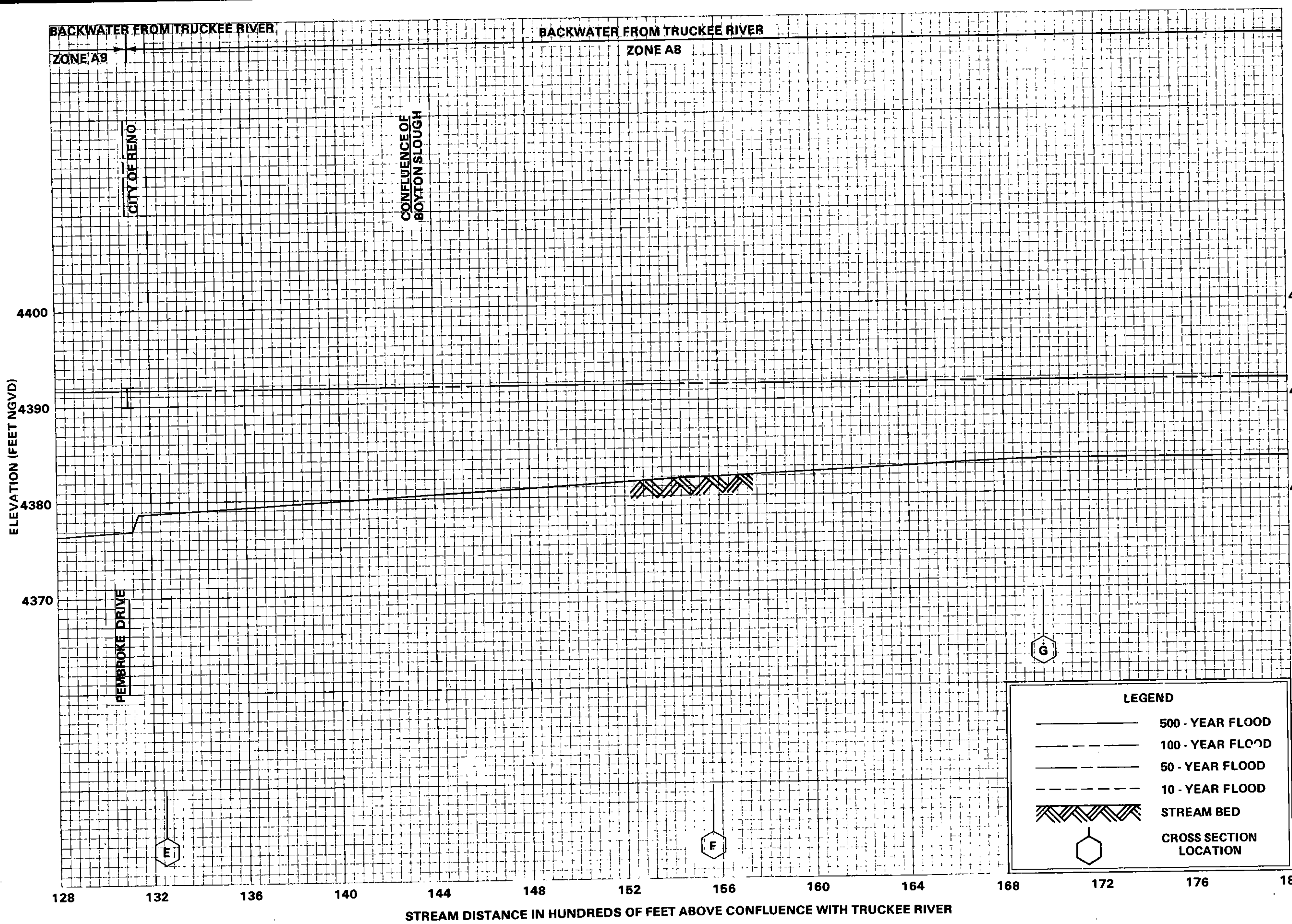



FLOOD PROFILES

TRUCKEE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV (WASHOE CO.)

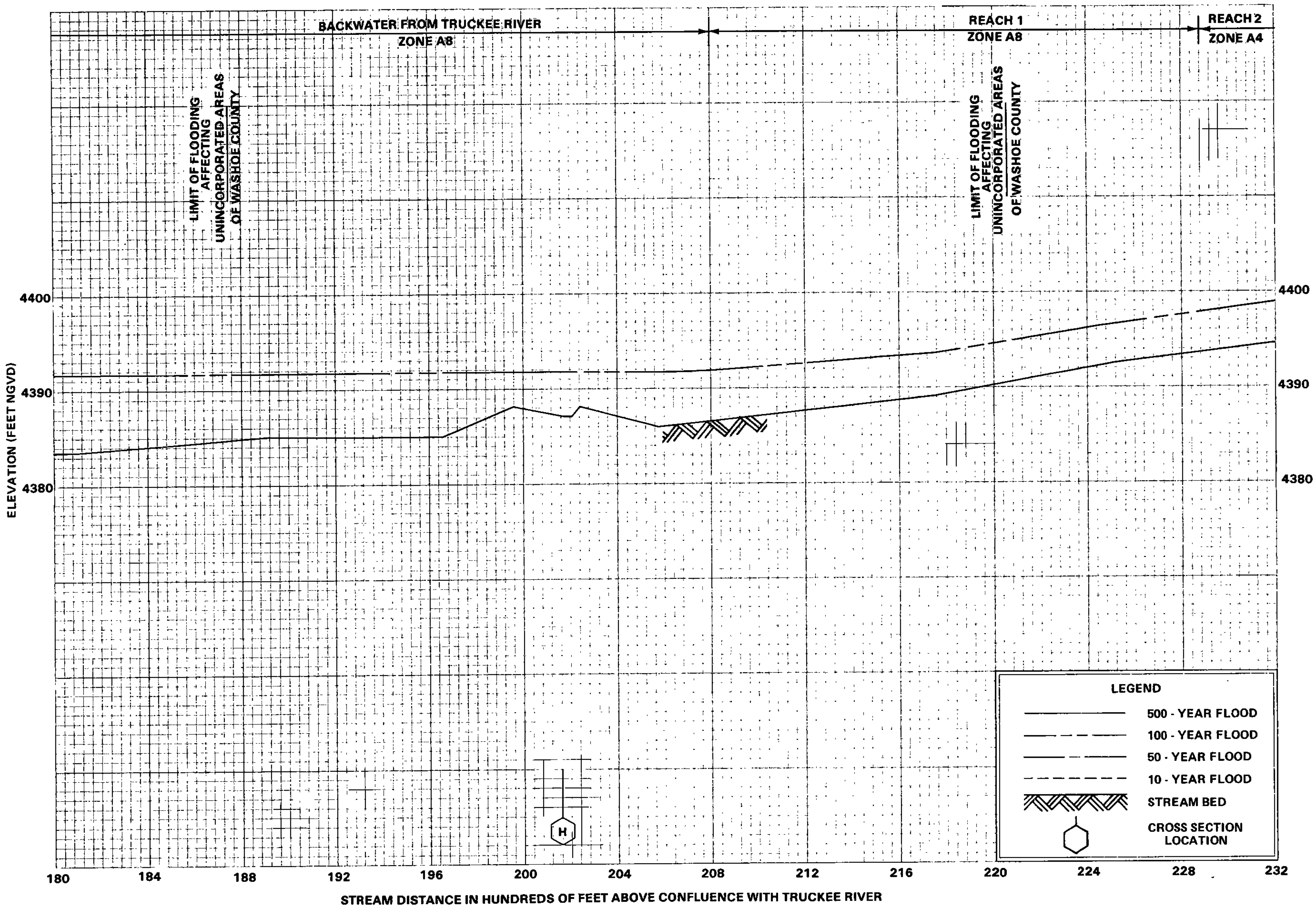



FLOOD PROFILES

STEAMBOAT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)



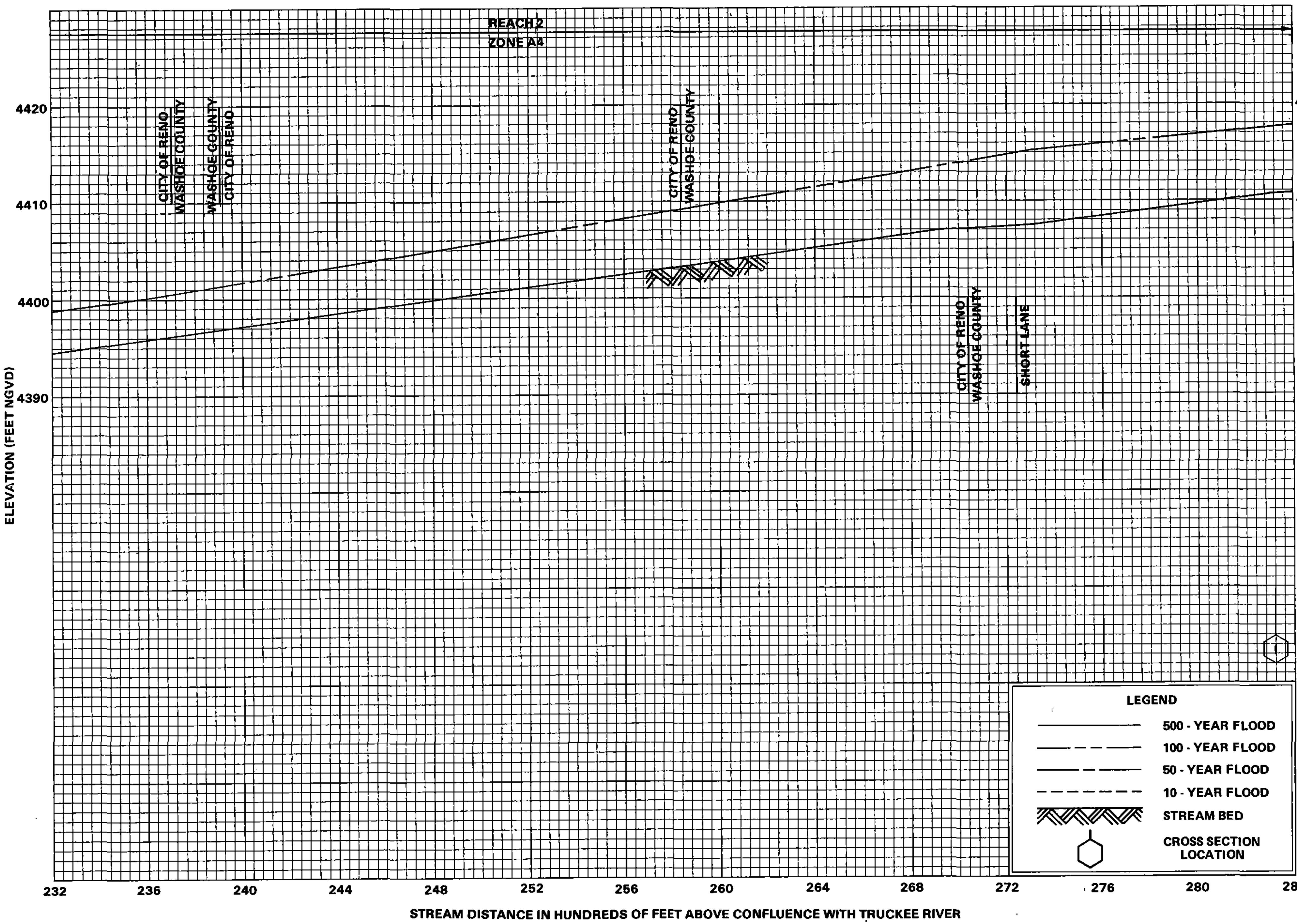

FLOOD PROFILES

STEAMBOAT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

08P



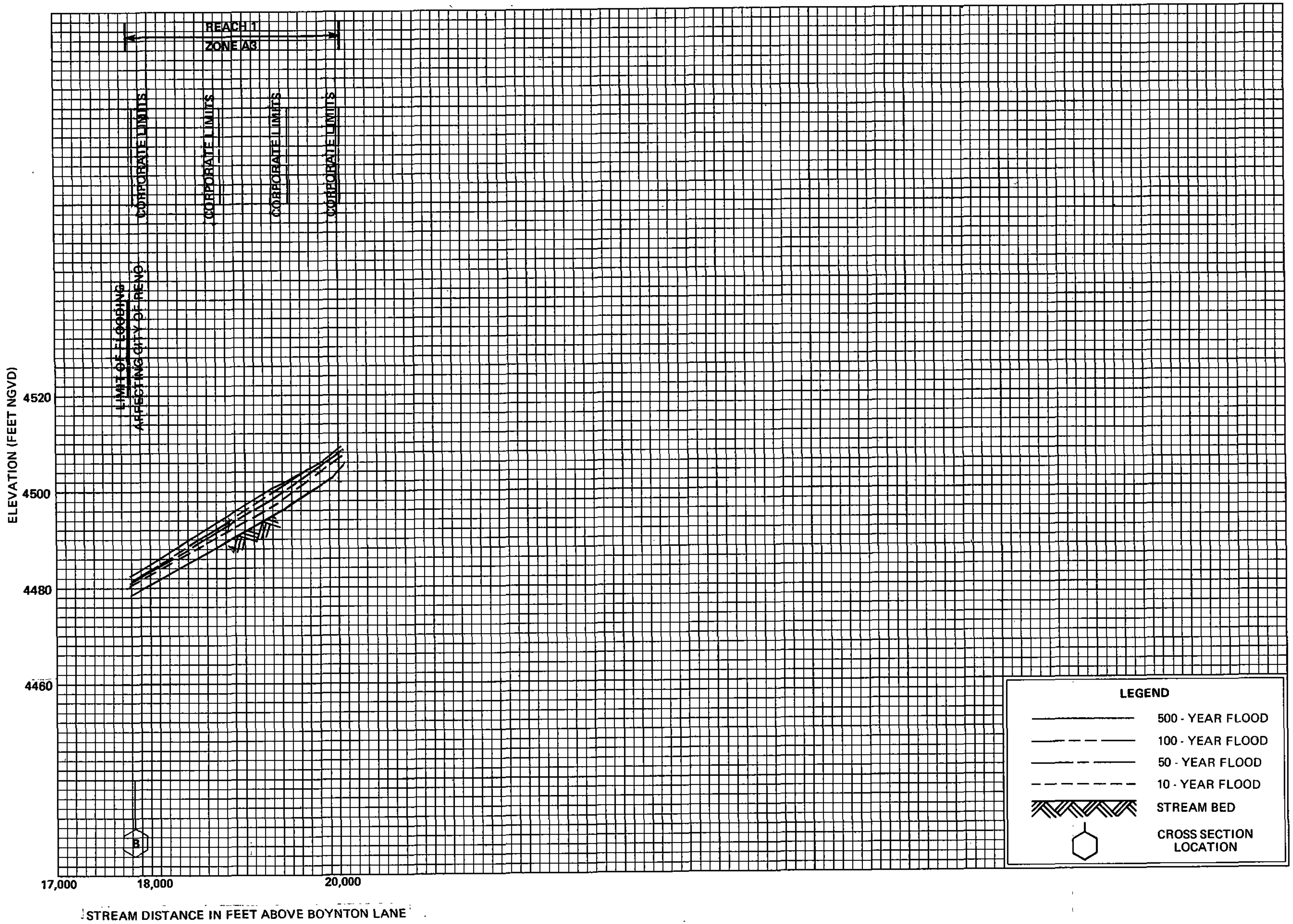

FLOOD PROFILES

STEAMBOAT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

09P



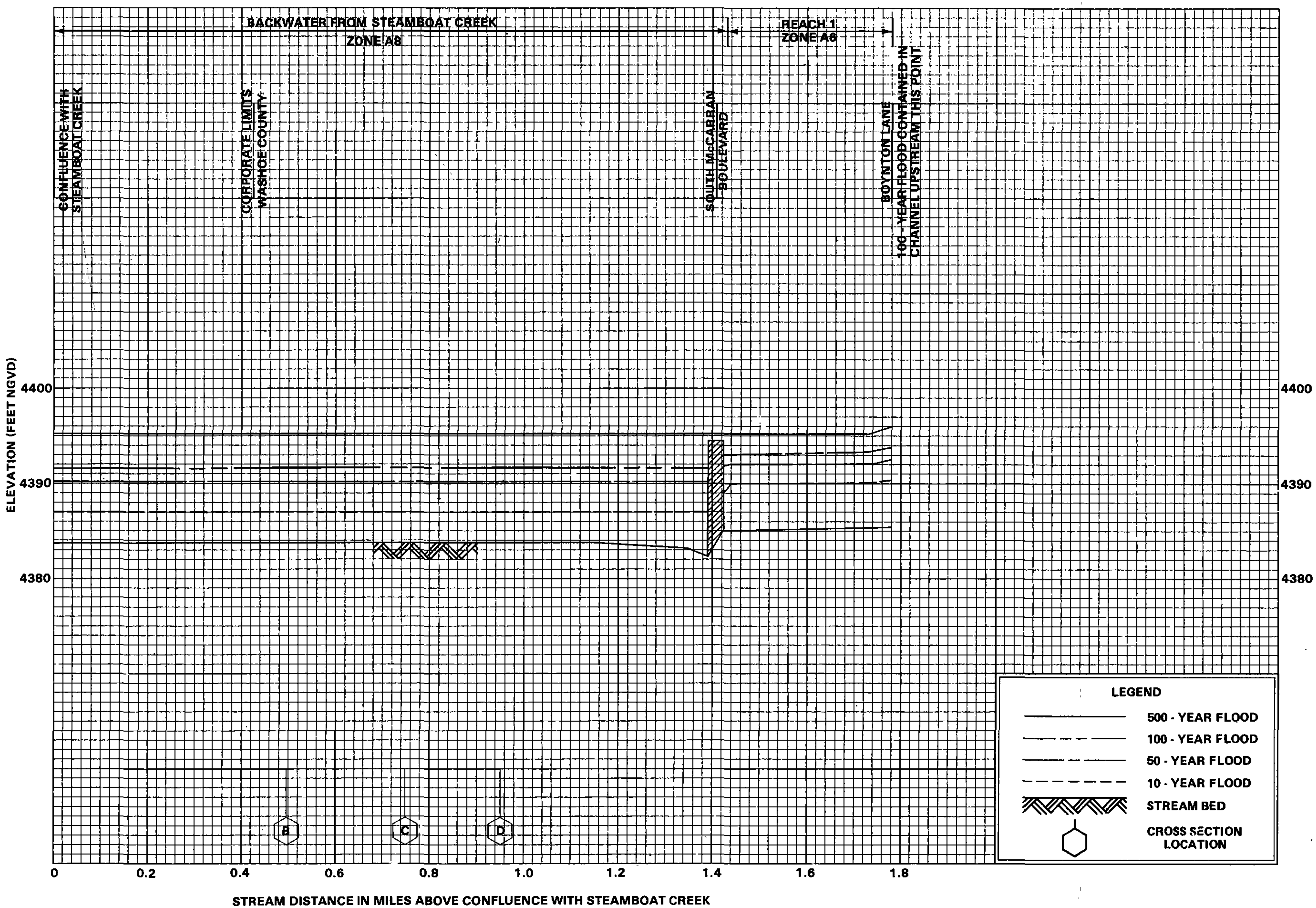

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

FLOOD PROFILES

DRY CREEK

10P




FLOOD PROFILES

BOYNTON SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF RENO, NV
(WASHOE CO.)

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