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T-8

**Section 205
Reconnaissance Investigation
Thomas Creek, Nevada**

May 1993



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

Section 205
Reconnaissance Investigation
Thomas Creek, Nevada

May 1993

SUMMARY

This Section 205 Reconnaissance Report was prepared in response to a letter dated July 30, 1990, from the Washoe County Department of Comprehensive Planning and the City of Reno, Nevada. The primary objectives of this study were to identify flood and related problems on Thomas Creek, Nevada; formulate measures and alternatives to resolve these problems; and develop an economically feasible plan for further study.

The study area is the watershed of Thomas Creek. It is located about 4 miles southwest of Reno and is one of the tributaries to Steamboat Creek. The watershed is a long, slender shape, approximately 11.5 square miles. The topography of Thomas Creek ranges from a mountainous, deep narrow channel in the upper watershed to a flat valley floor.

The primary water-related problem is flooding due to summer cloudburst storm events. Two recorded historical flood events (1878 and 1963) were caused by summer cloudbursts. These floods resulted in damages to agricultural and commercial structures.

Hydraulic analysis shows that the flood discharge of 685 cubic feet per second (cfs) flow does not meet the minimum 10-year criterion specified in Engineering Regulation (ER) 1105-2-21 for a 10-year flood. However, the discharge of 2,640 cfs for the 100-year event does exceed the criterion in the ER (1,800 cfs). Based on meeting the 100-year discharge flow, and the potential for significant flood damages in the watershed, various measures and alternatives were analyzed. The most effective measures were formulated into alternatives to provide a 100-year level of flood protection. These included nonstructural and structural measures.

The nonstructural measures for individual or group structures include temporary closures, levees, floodwalls, raising structures, and relocating structures. The structural measures include creek clearing, on-stream and off-stream detention basins, channel improvements, and levees. Of the measures analyzed, the nonstructural measures and the detention basin measures were carried forward into plan formulation. The structural measures of channel improvements and levees were not carried forward in the analysis due primarily to the steep terrain.

In the nonstructural alternative, none of the methods favorable benefit-to-cost ratio for all types of structures. The total project first cost for the least costly nonstructural method of individual levees around each structure is \$1,043,000. The average benefit-to-cost ratio is about 0.8.

The structural alternatives did not show a favorable benefit-to-cost ratio. The total first cost for the on-stream and off-stream detention basin alternatives are about \$7.8 million and \$5.1 million, respectively. The annual costs are \$803,000 and \$524,000, respectively. The annual benefits are estimated to be \$193,000 for either alternative. The benefit-to-cost ratios are 0.2 and 0.4, respectively.

It is concluded that further studies for Thomas Creek, Nevada are not warranted at this time.

**SECTION 205
RECONNAISSANCE INVESTIGATION
THOMAS CREEK, NEVADA**

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CHAPTER I - INTRODUCTION

STUDY AUTHORITY

This study was conducted under the authority of Section 205 of the 1948 Flood Control Act, as amended (33 USC 701s). It was initiated in response to a letter dated July 30, 1990, from the Washoe County Department of Comprehensive Planning and the City of Reno, Nevada. (See Appendix.) They requested that the U.S. Army Corps of Engineers (Corps) investigate the potential for a flood control project along Thomas Creek.

STUDY PURPOSE AND SCOPE

This report describes the results of a reconnaissance level evaluation of flood and related water resource problems of the Thomas Creek watershed. The study:

- Identified flood problems in the Thomas Creek watershed.
- Identified potential measures to address the problems.
- Estimated the potential economic feasibility of alternatives to resolve the problems identified.
- Estimated the scope and cost of a potential feasibility study.
- Determined if there is a non-Federal sponsor willing to share in the cost of a potential feasibility study.

PRIOR STUDIES AND REPORTS

Hydrologic Analysis for: Thomas Creek, Dry Creek, and the Boynton Slough, November 1991, by Nimbus Engineers for Federal Emergency Management Agency (FEMA). The study used five rainfall-runoff models based on the Corps HEC-1 computer program to analyze and to establish 100-year discharges at key concentration points along Thomas Creek, Dry Creek, and the Boynton Slough. The results of the analysis will be reviewed by FEMA for possible adoption of the flood plains.

Thomas Creek Detention Basin Study, June 1990, by Kennedy/Jenks/Cilton for Washoe County, Nevada. The study analyzed various flood control alternatives for the lower watershed of Thomas Creek. Their analysis proposed two on-stream detention basins and one off-stream detention basin. They also

proposed full channelization or partial channelization downstream of the detention basin for added protection.

Truckee River, California and Nevada, Hydrology Office Report, February 1980, by Corps, Sacramento District, California. This study analyzed the 100-year discharges for Dry, Thomas, and Evans Creeks using HEC-1 computer modeling with statistical analysis.

Huffaker Hills Storm Drain Relief System Alternative Investigation, December 1986, by SEA Consulting Engineers, Incorporated, for City of Reno, Nevada. This study evaluated the various drainage/hydrology studies relevant to the Thomas Creek watershed. This study recommended that a hydrologic model of the Thomas Creek basin be established using the HEC-1 computer model, cloudburst storm event, SCS Type II rainfall distribution curve, and other parameters for frequencies of 5, 10, 25, 50, and 100 years.

Stormwater Hydrology and Conservation Treatments in Southwest Reno, 1980, by USDA, Soil Conservation Service, for Washoe-Storey Conservation District. This study briefly described the hydrologic and erosion control procedures and methodologies adapted for the study areas of Evans Creek, Dry Creek, Thomas Creek, and White Creek.

Tudor Study, July 1979, by Tudor Engineering for Washoe County and the City of Reno, Nevada. This study used a regional analysis to develop hydrology for Dry Creek and Thomas Creek. The flow discharges of this study were much lower than the Corps' 1980 report and other studies completed by the Corps and the Soil Conservation Service. Objections were raised by these two agencies over the low discharge flows developed in the Tudor study.

Flood Plain Information; Southwest Foothill Streams (Evans, Thomas, and White Creeks and Skyline Wash), 1974, by Corps, Sacramento District, California. This study analyzed the flood plain of the Southwest Foothill Streams (Skyline Wash, Evans, Dry, Thomas, and White Creeks) for the County of Washoe and City of Reno for future development planning.

CHAPTER II - DESCRIPTION OF THE STUDY AREA

LOCATION

Thomas Creek is located about 4 miles southwest of Reno, Nevada. The headwaters originate in the Carson Range of the Toiyabe National Forest. The highest peak is 10,778 feet above sea level on Mount Rose. Other creeks that share the Carson Range with Thomas Creek are Evans Creek, Dry Creek, and White Creek. These four creeks are grouped under the Southwest Foothill Streams and are the tributaries to Steamboat Creek. (See Plate 1.)

The Thomas Creek watershed is approximately 11.5 square miles west of South Virginia Street (U.S. 395) (See Plate 2). Floodflows split in two directions at U.S. 395 and Interstate Highway 580 (I-580). A portion of the flow proceeds north and discharges into Dry Creek and ultimately into Steamboat Creek. The other portion proceeds east on Thomas Creek through Alexander Lake and discharges into Steamboat Creek.

CLIMATE

The climate of the study area is subhumid in the headwaters areas and semiarid on the valley floor. Average annual precipitation over the basin is about 40 inches, with snowpack at higher elevations. The temperatures in the higher elevations vary from winter lows of 10 degrees to summer highs of about 70 degrees. The valley temperatures range from summer highs of about 80 degrees, sometimes exceeding 90 degrees, to winter lows of about 20 degrees. Cloudburst type storms frequently occur in the summer over the drainage basin of the stream.

SEISMICITY & TOPOGRAPHY

The Thomas Creek watershed is in seismic zone 3. This zone designation corresponds to the probability of major damage to structures due to seismic activities. The topography of the upper watershed of Thomas Creek is confined by a deep, narrow channel (See Figure 1). As the creek emerges into the lower valley floor, the channel is shallow. (See Figures 2 and 3). All along the creekbed are obstructions such as trees, shrubs, rocks, dead logs, and sediment from previous floods. Over the last 150 years or so, Thomas Creek has been diverted at various points for irrigation and rangeland purposes (See Figures 4 and 5).



Figure 1. Headwater of the Thomas Creek Watershed Facing Downstream.

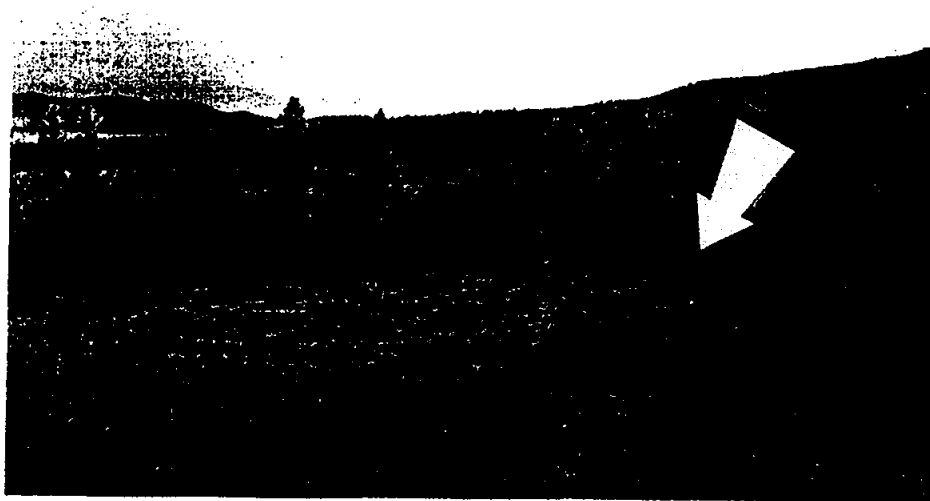


Figure 2. Mid-elevation Tree Line of Thomas Creek.

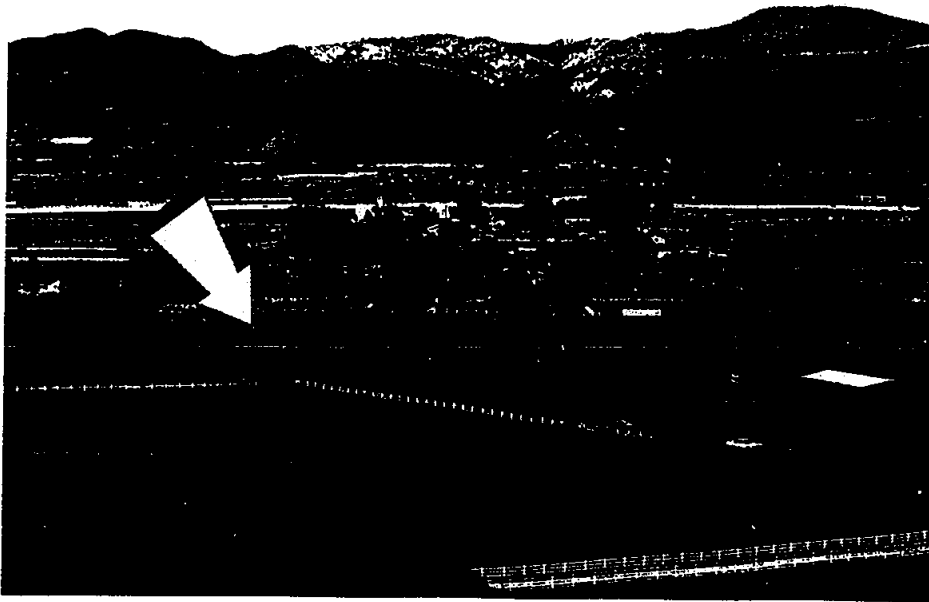


Figure 3. Thomas Creek in the lower reaches of the watershed.

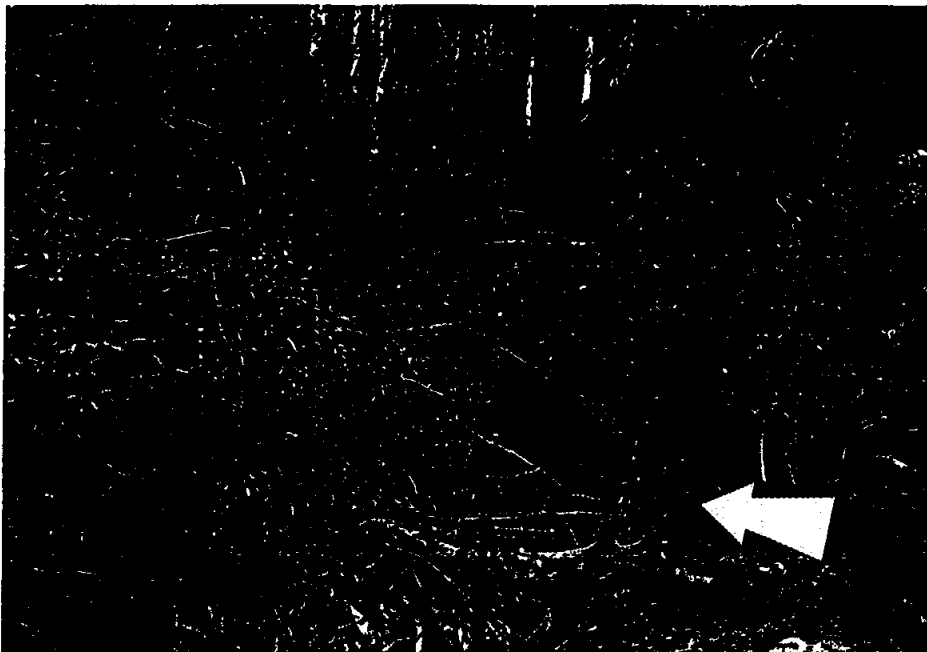


Figure 4. Potential Debris Obstruction in Creekbed.

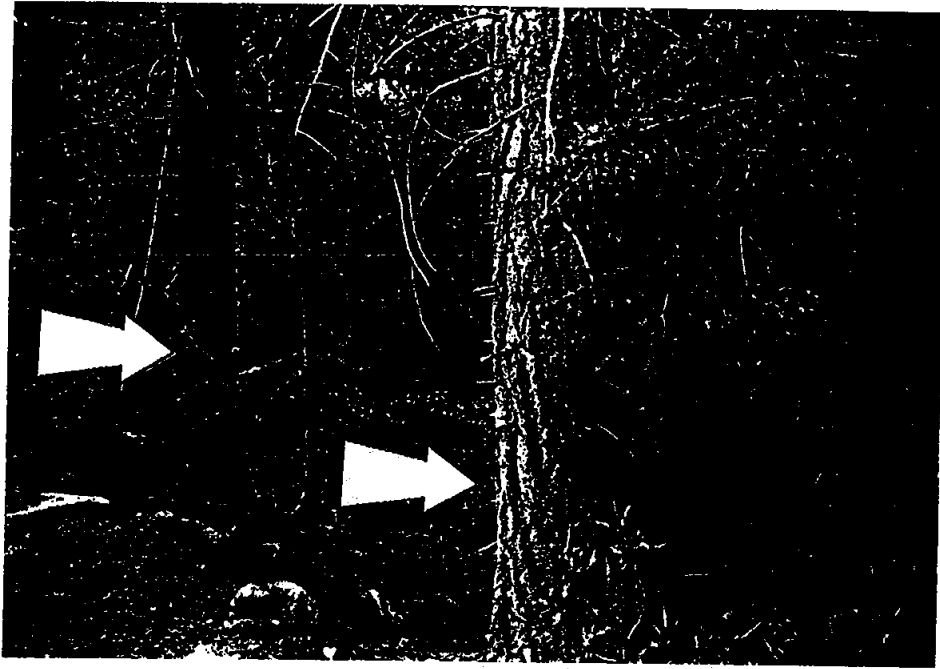


Figure 5. Mature Trees Growing near Creekbed.

VEGETATION

In the upper portion of the watershed (above 6,000 feet), vegetation consists of pine and fir varieties, with an understory of manzanita and snowbrush in the upper elevations, and an understory of sagebrush, mountain mahogany, and grass in the lower elevations. The central portion of this area includes two large meadows with aspen near the creek. Vegetation in the lower Thomas Creek watershed consists of sagebrush, bitterbrush, and cheatgrass. The valley floor areas are mostly improved meadowlands used for pasture and production of hay.

DEVELOPMENT & ECONOMY

The population of the Thomas Creek Watershed is approximately 300 persons. Existing residential and related development within the Thomas Creek watershed is primarily limited to the lower region of the watershed that is below the mountain front. The upper region only contains a few homes. The lower region consists of residential single-story homes, residential two-story homes, multi-structures (duplexes), mobile

homes, storage facilities, and commercial and industrial buildings.

Future development of the Thomas Creek watershed is expected to occur on the east and west sides of South Virginia Street and will consist of primarily residential homes and commercial buildings.

CHAPTER III - FLOOD PROBLEM

HISTORICAL FLOODING

Records of flooding date back to the 1800's. Specific information on past floods in the study area is very limited due to the lack of streamflow records and because its rural and relatively unpopulated nature usually precluded detailed news media reporting of flood events. The Corps 1974 flood plain information report mentioned two particular historical flood events on Thomas Creek. On August 15, 1878, torrential rain (described by the Reno newspaper as a "monster cloudburst") fell for 3 hours on the watersheds southwest of Reno. Thomas Creek became a raging torrent about 200 to 600 feet wide and from 2 to 4 feet deep, and gouged out its channel to bedrock in many locations. Cords of wood awaiting shipment and about one mile of the flume were swept away or covered with mud and debris. Another damaging flood on Thomas Creek was in 1963 and was caused by a severe general rain storm. This flood caused similar damages as the previous flood.

FLOOD TYPES

There are three types of flood events: rain floods, cloudburst floods, and snowmelt floods. Rain floods take place from October through March over a large basin and are characterized by high peak flows, moderate duration, and low runoff. Cloudburst floods are the most dangerous floods. They usually occur during the summer and are characterized by high peak flows of short duration and low volume. Snowmelt floods take place from April through July and have a long duration and large volume.

Cloudburst storms do not concentrate in any one location. This creates unpredictable forecasting of downstream impacts. During a typical rain flood, debris such as rocks, gravel, sand, mud, trees, and manmade structures could obstruct portions of the creek. The floodwater could change course during each storm event due to obstructions in the creek, causing an alluvial fan downstream.

CURRENT HYDROLOGY

Peak flows for various frequency-flow events were used to develop the flood plains of Thomas Creek west of U.S. 395. The peak flows were based on hydrologic studies from the Corps 1980 office report and updated for the FEMA by Nimbus Engineers. Peak values of the hydrographs from the updated analysis were used to

plot the 10-year and 100-year events. The 50-year event was extrapolated from these two points (see Table 1).

**TABLE 1
FLOOD FREQUENCIES AND PEAK DISCHARGE FLOWS OF THOMAS CREEK**

Recurrence Interval (Years)	Peak Discharge (cfs ¹)
10	685
50	1,800
100	2,640

¹ Cubic feet per second.

Engineering Regulation (ER) 1105-2-21 describes the minimum peak-flow requirements for Federal participation in flood projects. It should be noted that the 10-year flow for Thomas Creek measured immediately upstream of Thomas Creek Road is less than the minimum required 800 cubic feet per second (cfs). However, the 100-year flow of 2,640 cfs exceeds the 1,800 cfs requirement in the ER.

According to local officials, flows from Thomas Creek are split in two directions at U.S. 395 and I-580. The channel capacity is limited at these locations because culverts are not adequate to convey flood waters (See Figure 6).

The 100-year floodflow of 2,640 cfs is estimated to split, with about 900 cfs proceeding north and discharging into Dry Creek and ultimately into Steamboat Creek. The remaining flow would proceed east in Thomas Creek through Alexander Lake and discharges into Steamboat Creek.

FLOOD PLAINS

Flood plains were developed for the 10-, 50-, and 100-year events. They are shown on Plate 3. The cross sections used for this flood plain mapping were developed by the FEMA consultant for an updated flood insurance study. The depths of flooding were estimated using normal depth calculation with base data from the FEMA consultant's HEC-2 backwater computer program. The resulting depths of flooding were used in the economic analysis and plan formulation studies.

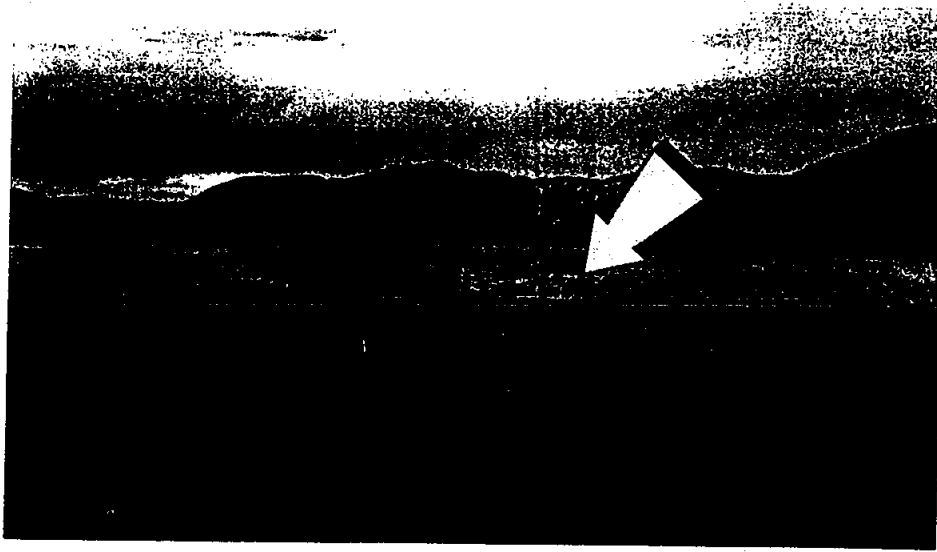


Figure 6. Box Culverts of I-580 at Mays Lane.

FLOOD DAMAGES FOR WITHOUT-PROJECT CONDITION

Flood damages were estimated by determining the relationships between damageable property values and the anticipated depths of flooding. Depths of flooding range from less than half a foot to 2½ feet in the flood plain.

The types of flood damages addressed are those physical damages that are caused by inundation and losses and costs incurred preparing for and fighting floods. These damages include structural and content damages such as inventory, fixtures, and equipment; automobile damages; and emergency costs. Intangible damages, such as loss of life, impairment of health and living conditions, and other impairments that cannot be quantified monetarily, have been excluded from the damage analysis.

Average annual flood damages were estimated for the Thomas Creek watershed on the basis of existing conditions only. No future growth was included in this analysis, which assumed that all future construction will comply with FEMA and the County flood plain ordinance. A 100-year period of analysis (1995 through 2095), 8½ percent interest rate, and October 1992 price levels were assumed for the analysis.

Flood Plain Inventory

There are 85 structures in the 100-year flood plain. The types and number of these structures are shown in Table 2.

TABLE 2
TYPES AND NUMBER OF STRUCTURES IN THE 100-YEAR FLOOD PLAIN

Type of Structure	Number of Structures
Single Family, 1-Story	29
Single Family, 2-Story	12
Multi-Family Unit	4
Mobile Home	10
Commercial	17
Storage Facilities	13
Total	85

The types and locations of structures within the 10-, 50-, and 100-year flood plains were inventoried by using aerial photographs and Geographical Information System mapping supplied by Washoe County. The square footage, type, and value of each structure were estimated during a field visit. The appraisal values of the structures were taken from the real estate property listing. The foundation heights from the ground level were estimated based on a field visit.

Structure values were estimated by the replacement costs less depreciation. The replacement costs and depreciation values were estimated from unit cost data contained in Marshall and Swift Valuation Cost handbooks.

For residential structures (single family, multi-family, and mobile home), content values of 50 percent of structural values were used. For commercial structures, the value of contents percentages were based on information from other studies. For storage facilities, content values of 100 percent of structural values were used.

Total depreciated replacement values of all structures and contents in the 100-year flood plain are shown in Table 3. No content value was estimated for the flood plain areas north of Holcomb Lane because the 100-year overflow is less than half a foot. The first floor elevation is assumed to be greater than half a foot above the ground elevation.

TABLE 3
TOTAL DEPRECIATED REPLACEMENT VALUE
PROPERTY IN 100-YEAR FLOOD PLAIN
(\$1,000)

Type of Structure	Structural Value	Content Value ¹	Total
Single Family, 1-Story	2,367	969	3,336
Single Family, 2-Story	1,354	494	1,848
Multi-Family Unit	351	155	506
Mobile Home	100	50	150
Commercial	7,725	1,993	9,718
Storage Facilities	758	758	1,516
Total	12,655	4,419	17,074

¹ Content value for residential structures reflects 50 percent of structure values for those contents subject to flooding. Content of some structures are not subject to flooding.

Depth-Damage Relationships

Depth-damage relationships describe the damages that occur under different depths of flooding. The 1988 FEMA depth-damage relationships were used for residential structures. The depth-damage relationships developed by the Tennessee Valley Authority for the Department of Housing and Urban Development in December 1969 were used in estimating damages to commercial structures and storage facilities. Damaging depths within the flood plain ranged from 0 feet to 2.5 feet for the 100-year flood event.

Emergency Costs

Emergency costs include losses in addition to physical flood damages. Emergency costs include those costs that would not otherwise be incurred, such as the costs of evacuation and reoccupation of the flood plain, floodfighting and disaster relief, and fire, medical activity, and military patrol.

Damages to Automobiles

Damages to automobiles were based on an estimate of the total number of automobiles in the flood plain. Based on discussions with insurance companies, the total number of automobiles in the flood plain was estimated by multiplying 2 by

the number of structures. It was assumed that 50 percent of the automobiles would be damaged during a flood event. The estimated number of cars, 85, was multiplied by the average value of an automobile, \$10,000, to determine the value of automobiles in the flood plain. The depth-damage relationship derived by the Soil Conservation Service in 1983 for the lower Silver Creek watershed was used to estimate damages to automobiles.

Damage to Roads

Aerial maps of the study area were used to determine the linear feet of dirt and paved roads in the 100-year flood plain. It was assumed that all roads would have at least one foot of flooding and sustain some damage.

Damage-Frequency Relationships

Damage-frequency relationships show the damages associated with a specific frequency of flooding. Damages by flood event for structures and contents under existing conditions are shown in Table 4. The estimated non-damaging flow of 400 cfs has a retain period of 2 years.

TABLE 4
FLOOD DAMAGES UNDER EXISTING CONDITIONS ¹

Damage Category	Flood Plain Damages (\$1,000)		
	10-Year	50-Year	100-Year
Single Family, 1-Story - Structure	111	300	353
Content	92	247	253
Single Family, 2-Story - Structure	32	95	127
Content	18	60	63
Multi-Family Unit - Structure	30	52	57
Content	26	42	42
Mobile Home - Structure	26	44	44
Content	8	13	13
Commercial - Structure	2	47	559
Content	4	111	199
Storage Facilities - Structure	37	66	78
Content	37	66	78
Road Damage	17	36	60
Emergency Costs	110	180	268
Auto Damages	88	143	213
Total Damages	638	1,502	2,407

¹ October 1992 prices.

Average Annual Flood Damages

Average annual without-project damages were those determined for the 100-year flood plain by weighing the estimated damages from varying degrees of flooding by their probability of occurrence. Table 5 shows these damages for the study area.

**TABLE 5
AVERAGE ANNUAL EQUIVALENT DAMAGES FOR WITHOUT-PROJECT
CONDITION IN THE 100-YEAR FLOOD PLAIN ¹**

Damage Category	Average Annual Equivalent Damage (\$1,000)
Single Family, 1-Story - Structure	37
Content	30
Single Family, 2-Story - Structure	12
Content	6
Multi-Family Unit - Structure	8
Content	7
Mobile Home - Structure	7
Content	2
Commercial Structure - Structure	14
Content	9
Storage Facilities - Structure	11
Content	10
Road Damage	6
Emergency Costs	32
Auto Damages	25
Total Damages	216

¹ October 1992 prices, 8 $\frac{1}{2}$ percent interest rate, 100-year project life.

CHAPTER IV - PLAN FORMULATION

Plan formulation consisted of (1) identifying the pertinent criteria used to develop and analyze alternative plans, (2) identifying flood control measures to help reduce flood problems, (3) formulating appropriate measures into alternative plans, and (4) evaluating those alternatives.

PLANNING CRITERIA

Technical Criteria

- Measures and alternatives should be technically sound.
- Measures and alternatives should complement state, county, and other local flood control plans and projects involving study area streams.
- Measures and alternatives should be consistent with provisions of the National Flood Insurance Program.

Economic Criteria

- Benefits and costs should be expressed in comparable terms as completely as possible. Evaluation of alternatives should be based on the same price level, interest rate, and economic life of the project.
- The benefit-to-cost ratio should be one or greater to justify Federal participation in further studies.

Socioeconomic Criteria

- Consideration should be given to the safety, health, and social well-being of the affected community.
- Plans should be workable within the constraints of present and potential governmental structure, function, relationships, and associations in the study area.

MANAGEMENT MEASURES

Various nonstructural and structural measures were identified and initially considered to meet the planning objectives for flood control and related flood problems. Nonstructural measures included flood warning by the local agency, local zoning and building restrictions, temporary closures, levees, floodwalls, raising existing structures, and

relocation. Potential structural measures were creek clearing, upstream detention basins, channel modification, and levees. The following is a summary of the measures.

Measure 1: Nonstructural

The purpose of nonstructural measures is to reduce the threat to public health and safety and flood damages at the point of damage rather than to control the floodwater. Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding; therefore, this measure would have an insignificant impact on overall hydrology.

Flood Warning and Evacuation. - Flood warning consists of the public agencies notifying residents in the flood plain area of an impending flood and to prepare for evacuation. 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 coordinate activities in the three political entities involved, establish communications, disseminate weather and flood information, and request State and Federal assistance when the flood situation so warrants. Formal plans for emergency evacuation of people and property from flood prone areas have not been developed. The Corps responds to requests for flood fighting and rescue work when the emergency is beyond the capabilities of State and local governmental agencies.

Washoe County maintains two alert gauges on the upper reaches of Thomas Creek and White Creek. The gauges relay potential storm information to the National Weather Service (NWS) and the Utility Division of Washoe County. Daily weather forecasts that apply generally to watersheds draining the slopes of Mount Rose are issued by the NWS office in Reno; however, accurate prediction of flood-producing cloudbursts over specific small drainage basins such as those of the Southwest Foothill Streams is not possible and, in any event, would provide little advanced warning of floodflows.

Since a flood warning and evacuation system is already implemented by the County, this measure was not considered further.

Local Zoning and Building Restriction. - Local zoning and building restriction includes flood plain regulations which restrict developments in floodway fringe areas and prohibit construction in designated floodways. Home and business owners are given the option to purchase flood insurance to ensure existing developments against financial losses associated with flooding. Zoning and flood insurance are options for local

governmental implementation, but are not viable Federal flood control options because no National Economic Development benefits are generated.

In March 1988, Washoe County adopted ordinance No. 738 to amend the County's flood plain code by repealing and adding provisions regulating the development of real estate in areas subject to flooding. The amended code required that all new construction be elevated above the FEMA base flood elevation for the minimum year flood protection. Because the County already has the local zoning and building restriction in place, this measure is not considered further.

Temporary Closures. - Dry proofing is defined as a means to seal a structure against floodwaters using floodshields made of aluminum or other light metal alloys. The floodshields would be fitted for attachment to window and door openings to prevent water from entering the structure. These shields may be installed permanently (to slide in place) or temporarily bolted in place for a flood. Floodshields are a good alternative if the building exterior and foundation can be made relatively leakproof and if the outside walls are strong enough to withstand the water pressure. Sump pumps may be added to compensate for seepage. However, use of temporary closures would be limited to commercial structures because FEMA does not accept floodshields for flood insurance for residential structures. This temporary measure was carried forward for further study for commercial structures only.

Ring Levees and Floodwalls. - Ring levees, berms, and floodwalls around individual structures may be appropriate when there is sufficient space for construction. Floodwalls are more appropriate where the lot is small or where flow velocities or wave action may be an additional hazard. Levees and floodwalls would be constructed so that levee tops are 3 feet above the design flood level. Rainfall runoff within the leveed area would be collected in small ditches and directed to a conduit under the ring levee during nonflood periods, to a storage pond within the leveed areas, or to a sump and pumped over the levee during floods. Relandscaping and revegetation of disturbed areas would be included. Floodwalls can be masonry, stone, or concrete walls of various configurations and surface treatments, so long as they are leakproof. Gates can be included to allow for driveways and walks, and sump pumps may be added to compensate for seepage. Floodwalls are usually more expensive than levees or berms. This measure was studied further.

Raising Existing Structures. - Elevating a structure in place, by raising it and placing fill underneath or extending the foundation stemwall, is an option if the building is structurally sound. Stucco buildings and those on concrete slabs are more difficult and expensive to elevate because of cracking problems.

Use of this measure depends on the unique features of the individual structure. Elevating structures was studied further.

Relocation. - Relocating involves moving structures to higher ground or another location not subject to flooding. The same construction considerations apply as in elevating structures. This measure was studied further.

Measure 2: Creek Clearing

Creek clearing would eliminate obstructions to flow and channel the flow away from developed areas. Unobstructed bank full capacity of Thomas Creek is estimated to be about 400 cfs. However, the actual capacity is less than 100 cfs due to obstructions such as trees growing in the creek, debris from previous flood events, soil sediment, and rocks. Without expanding the creek, clearing the creekbed itself would carry about 400 cfs of flood water for about a 5-year flood event. This measure was not considered further because of the relatively minor increase in level of flood protection compared to the high impact on local environmental resources.

Measure 3: Detention Basin

Flood detention storage differs from reservoir storage in that there is no permanent pool for water conservation. The purpose of a detention basin is to temporarily store enough excess floodwater to limit downstream flow to the existing channel capacity. The detention basin would normally be dry and would impound water only during flood events. The detention basin would reduce the peak flow of flash floodwater and reduce the possibility of flood damages. This concept was evaluated for Washoe County in a June 1990 basin study by a private consultant. (See "Prior Studies and Reports" in Chapter 1.) This measure was carried forward for further analysis.

Measure 4: Channels

Channelization consists of clearing and enlarging the existing creek to accommodate the excess floodwater and confining the flow within the channel to reduce adjacent property damages. The 1990 study for Washoe County proposed both a full channelization plan and partial channelization plan for Thomas Creek. The channel concept would carry 400 cfs of floodwater. The channel configuration was 4 feet wide at the bottom, 4 feet deep, and had 2 horizontal to 1 vertical side slopes. The channel identified in the 1990 report was estimated to cost about \$2,300,000 without adjustment for the 1992 price level. If the channel were sized to carry the peak flow (2,640 cfs), the estimated configuration would be 10 feet deep, 20 feet wide, and a minimum of 20,000 feet in length. Due to the high flow velocity as a result of the steep terrain, the channel would

require concrete construction with weirs, baffles, and stilling basins at various locations to change the supercritical flow to subcritical flow. Additional land area, design, construction, and mitigation for environmental impacts of the channel would be economically more expensive, estimated at about \$11 million. Since this would result in an annual cost nearly five times the total average annual damages, this measure was not carried forward.

Measure 5: Levees

Although levees along Thomas Creek could contain some floodflows, they would not be practical. This is because of the relatively steep slope and high flow velocity. Levees are more suited for stream reaches in flatter terrain and not on hillsides. The topography of Thomas Creek would require setback levees with enough land area for the floodwater to meander downstream without approaching super critical flow. The cost of obtaining the required land area through the developed area, mitigation for environmental impacts, and the construction of the levees would be economically prohibitive. As a result, this measure was not carried further.

ALTERNATIVES

The measures carried forward for more detailed development were used to formulate four alternative plans to provide a 100-year level of flood protection. For this reconnaissance study, the Corps assumed that the detention basins designed by the Washoe County consultant would provide 100-year protection. However, the adequacy or accuracy of the proposed designs to meet Corps criteria or standards was not analyzed.

This study uses the 100-year level of protection as a benchmark in the economic analysis to determine if the alternative is considered feasible for Federal participation per ER 1105-2-21. Alternatives that provide between 50- and 100-year would have similar economic costs. Alternatives that provide less than 50-year level protection, although perhaps economically feasible, would likely not have non-Federal support and might not be adequate during larger flood events. Further analysis and detailed data are needed to determine the optimal level of flood protection.

The period of analysis for this study is considered to be 100 years, from 1995 to 2095. The period includes the time required for the project to be implemented. Construction of a project could potentially begin in 1993 (base year) and take 2 years to complete. The actual base year would depend on congressional authorization, funding, and various other factors.

Alternative 1: No Action

Under this alternative, no action would be taken by the Federal Government to reduce flood problems and conditions in the study area. No action means that the without-project condition would continue. Thomas Creek would still only carry about 100 cfs of flood water within the creekbed before spilling over the banks. In addition, neither the State nor local agencies have any current plans to construct flood control measures on Thomas Creek.

Alternative 2: Nonstructural

This alternative includes a combination of the various nonstructural methods believed most applicable to each structure type. The evaluation of the nonstructural alternative was performed using the computer model developed by the Corps. The following methods were analyzed: (1) temporary closures, (2) ring levees or berms, (3) floodwalls, (4) raising existing structures, and (5) structure relocations. Freeboard of 3 feet was assumed for floodproofing, levees, and floodwalls. It was also assumed that there would be sufficient right-of-way for construction of floodwalls and levees.

The nonstructural alternative would have few, if any, adverse effects on environmental, cultural, or fish and wildlife resources. However, construction close to the creekbed could impact riparian vegetative and aquatic habitat important to fish and wildlife, if not properly protected.

Estimated costs for the various nonstructural methods were based on reconnaissance-level design requirements. It was also assumed that each structure would have sufficient associated land on which to implement the nonstructural methods. As a result, no additional land nor any cost associated with land were assumed. It should be understood that some real estate administration costs and relocation assistance would likely be necessary. However, for initial study purposes these costs were assumed to not affect the feasibility of the methods. Total construction cost is represented by a summation of the general costs to implement the nonstructural methods for any economically feasible sites.

The 85 structures within the proposed flood plain were grouped by structural type, including 1-story single family, 2-story single family, multi-family, mobile home, commercial, and storage facility. Each group was subdivided into subgroups based on depth of flooding. For example, the 1-story single family was divided into three subgroups with depths of flooding of 0.5 foot, 1.0 foot, and 2.0 feet. A representative building from each subgroup with each depth was simulated in the computer program

for structural lives of 100 years. The program analyzed each representative building for the different nonstructural methods.

None of the nonstructural methods were economically feasible. The estimated construction cost for the least costly method is \$1,043,000 for the ring levee protecting 41 structures only. The benefit-to-cost ratio is 0.8 to 1.0

Alternative 3: On-Stream Detention Basin with Spillway

The Washoe County designed and evaluated an on-stream detention basin to provide 100-year flood protection for the Thomas Creek watershed. (See Plate 4.) The detention basin would provide about 500 acre-feet of storage capacity. Land requirements would be about 80 acres. The spillway for the on-stream detention basin would carry one-half of the Probable Maximum Flood (PMF). This spillway would be a reinforced concrete lined, rectangular shape with a standard USBR Type II stilling basin. The floodflows would be contained within the spillway structure and be directed downstream, away from the dam embankment. (This spillway would need additional modification to accommodate the full PMF to meet Corps criteria.)

The estimated first and annual costs for this alternative are about \$7.8 million and \$803,000, respectively. These costs were based on information in the Washoe County consultant's report and updated to 1992 price levels.

Alternative 4: Off-Stream Detention Basin with Connecting Channels

The off-stream detention basin would divert the floodwater away from Thomas Creek and also provide about 500 acre-feet of storage. The basin would be configured so that flows would remain in the Thomas Creek canyon rather than being routed through the detention reservoir. Sufficient freeboard on the dam embankment would be provided to accommodate the depth of one-half of the PMF flows at the point of diversion in the creek. The off-stream detention basin would require extensive excavation over a large surface area coupled with a long embankment structure to provide the necessary reservoir volume. The land requirement is about 70 acres. An open channel diversion structure would be constructed in Thomas Creek to divert the 100-year floodflows into the off-stream reservoir. The estimated first and annual costs for this alternative are about \$5.1 million and \$524,000, respectively. These costs were updated similar to Alternative 3. Also, similar to Alternative 3, the spillway would need modification to pass the full PMF to meet Corps criteria.

COMPARISON OF ALTERNATIVES

Table 6 shows the average annual equivalent flood damages, damage reduction and residual damages for the four alternatives by damage category. Alternative 1 (no action) has an annual equivalent without project damage of about \$216,000.

TABLE 6
AVERAGE ANNUAL WITHOUT PROJECT DAMAGE, DAMAGE REDUCTION AND RESIDUAL DAMAGE ¹

Damage Category	Alternative 1 No Action	Alternative 2 Nonstructural		Alternatives 3 & 4 On- and Off-Stream Detention Basins	
	Without Project Damage	Flood Damage Reduction	Residual Damage	Flood Damage Reduction	Residual Damage
Single Family, 1-Story Structure Content	37 30	32 16	5 14	33 28	4 2
Single Family, 2-Story Structure Content	12 6	8 4	4 2	11 5	1 1
Multi-Family Unit Structure Content	8 7	7 4	1 3	7 7	1 0
Mobile Home Structure Content	7 2	0 0	7 2	7 2	0 0
Commercial Structure Structure Content	14 9	4 2	10 7	10 7	4 2
Storage Facilities Structure Content	11 10	4 2	7 8	10 9	1 1
Road Damage	6	0	6	5	1
Emergency Costs	32	0	32	29	3
Auto Damages	25	0	25	23	2
Total	216	83	133	193	23

¹ October 1992 prices, 100-year project life, 8 1/2 percent interest rate.

Alternative 2 (nonstructural) provides an annual equivalent damage reduction (benefit) of about \$83,000. The least costly method in the nonstructural alternative, the ring levees, provides up to a 100-year level of protection for 41 structures only. It would not provide flood protection to the other 44 structures. These 44 structures would be unprotected against any flood events. Alternatives 3 and 4 (on-stream and off-stream

detention basins) provide annual equivalent damage reduction of \$193,000. Both detention basin alternatives provide up to 100-year level of protection for all 85 structures.

The nonstructural alternative would not provide protection against road damages, auto damages, or emergency costs due to evacuation from the structures. The detention basin alternatives would minimize the damages to roads, autos, and emergency costs.

Table 7 shows the economic comparison of the alternatives, including annual costs, benefits, and benefit-to-cost ratios. As shown in the table, none of the alternatives has a benefit-to-cost ratio greater than, or equal to, 1.0. Therefore, none of the alternatives are economically feasible.

**TABLE 7
ECONOMIC COMPARISON OF ALTERNATIVES FOR THOMAS CREEK, NEVADA
(\$1,000)**

Damage Category	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Nonstructural	ALTERNATIVE 3 On-Stream Detention Basin	ALTERNATIVE 4 Off-Stream Detention Basin
FIRST COST				
Land	0	0	230	201
Construction	0	1,043	5,600	3,618
Env Mit & Cult Res	0	0	560	361
Engr Des, Supv, & Admin	0	0 ¹	1,400	904
Total, First Cost	0	1,043	7,790	5,084
INVESTMENT COST				
Interest During Construction ²	0	57	662	432
Total, Investment Cost	0	1100	8,452	5,516
ANNUAL COST				
Interest & Amortization	0	94	718	469
Operation & Maintenance	0	10	85	55
Total	0	104	803	524
ANNUAL BENEFIT	0	83	193	193
BENEFIT-TO-COST RATIO	0	0.8	0.2	0.4

¹ Costs included in construction costs.

² October 1992 prices, 8.5 percent interest rate.

CHAPTER V - CONCLUSIONS

Major conclusions of the reconnaissance study are as follows:

- Residents in the Thomas Creek watershed are at risk from flooding due to cloudburst storms.
- Hydrologic and hydraulic analyses indicate that flows in Thomas Creek do not exceed 800 cfs for the 10-year event but do exceed 1,800 cfs for the 100-year event.
- Channel clearing could reduce flood damages along the creek but would only provide a 5-year level of protection.
- In the nonstructural alternative the methods include temporary closures, levees, floodwalls, raising existing structures, and relocation. An economic analysis of the nonstructural methods indicates that the benefit-to-cost ratio is only 0.8 to 1.0.
- Structural alternatives include on- and off-stream detention basins. An economic analysis of the alternatives indicates that benefit-to-cost ratios are only 0.2 and 0.4, respectively.
- After considering the social and economic effects and engineering feasibility of alternatives, it is concluded that there is not Federal interest in participating in further studies for a flood control project on Thomas Creek, Nevada, at this time.

77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

To Reno

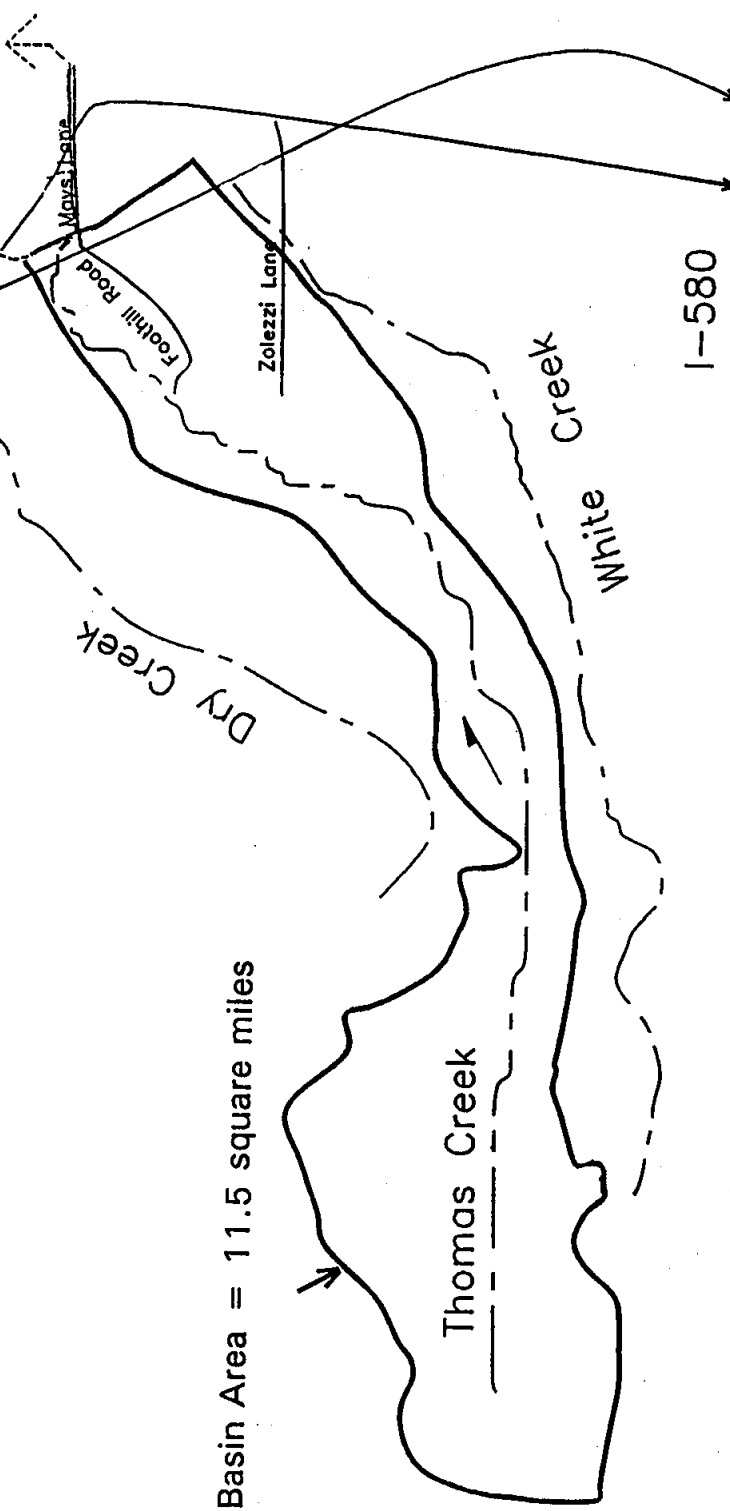
U.S. 395

Flows split for approximately 100-year event and above

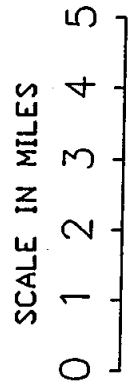
LEGEND

-  Basin Boundary
-  Creeks
-  Roadways

Basin Area = 11.5 square miles



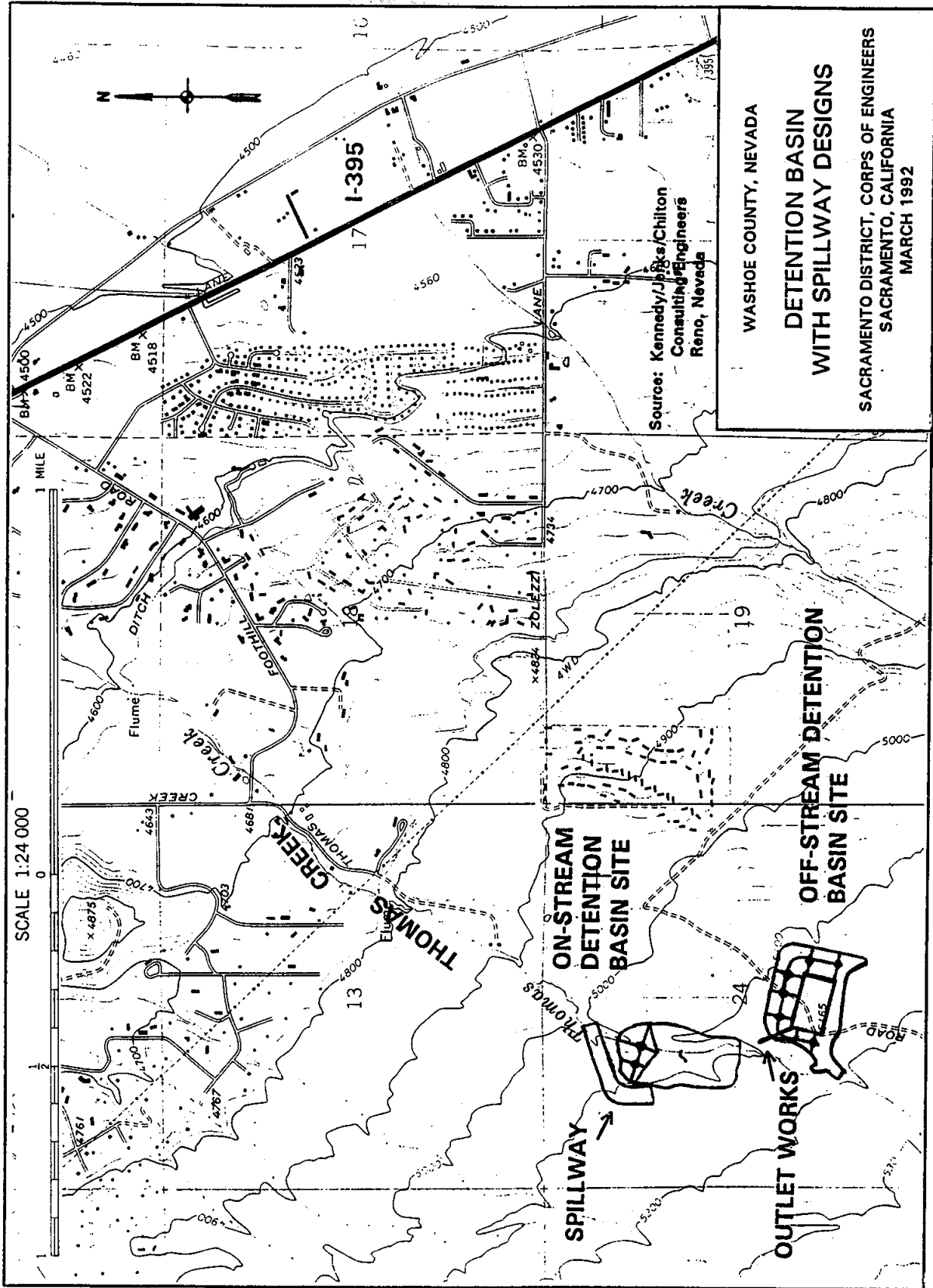
I-580



WASHOE COUNTY, NEVADA

THOMAS CREEK WATERSHED

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA
MARCH 1997



WASHOE COUNTY, NEVADA

**DETENTION BASIN
WITH SPILLWAY DESIGNS**

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA
MARCH 1992

Source: Kennedy/Jeffers/Chilton
Consulting Engineers
Reno, Nevada

APPENDIX

Correspondence

WASHOE COUNTY

"To Protect and To Serve"



WASHOE COUNCIL OF GOVERNMENTS
DEPARTMENT OF COMPREHENSIVE PLANNING
Robert N. Young, Director

241 RIDGE STREET
POST OFFICE BOX 11130
RENO, NEVADA 89520
PHONE (702) 785-4043

July 30, 1990

Colonel Jack A. LeCuyer
U.S. Army Corps of Engineers
Sacramento District
560 Capitol Mall
Sacramento, CA 95815-4790

Subject: Request for Section 205 Project for Thomas Creek

Dear Colonel LeCuyer:

Reno and Washoe County request the Corps of Engineers initiate a Reconnaissance Section 205 Study under the small Projects Authority for those reaches of Thomas Creek within Washoe County and Reno.

Recent mapping by the Federal Emergency Management Agency (FEMA) has placed much of the Thomas Creek area within the 100-year floodplain, resulting in severe impacts on the region. Reno/Washoe County has suffered numerous floods in the recent past in the Thomas Creek Basin. Flooding was experienced in 1980, 1983 and 1986. All three of these floods caused damages in the area and resulted in extensive cleanup efforts by both the city and the county. In addition, Virginia Street/US395 was closed which interrupted commerce and resulted in large losses to the Reno area.

The city, county and state are not able to remedy the problem without Federal assistance. Reno and Washoe County, or both, are potential sponsors. Reno and the county of Washoe understand that if the requested Reconnaissance Study identifies a project which has Federal interest, pursuing a Feasibility Study will require a 50% contribution from the sponsor.

The County has the following information which will provide information for the Reconnaissance Study:

- Flood insurance maps from FEMA
- A Feasibility Study performed by a local consultant
- Land use maps for the area (present and future)
- Historical photographs of the flooded areas

Please contact the Washoe County Flood Control Manager, if you need additional information.

Sincerely,

A handwritten signature in cursive script, appearing to read "Robert N. Young", is written over a large, stylized number "0" or similar mark.

Robert N. Young

RNY:jep

xc: Floyd Vice, Washoe County Public Works
Steve Varela, Reno Engineering

WASHOE COUNTY IS AN EQUAL OPPORTUNITY EMPLOYER

APPENDIX