FEASIBILITY STUDY

HUFFAKER DETENTION FACILITY

near the City of Reno,
Washoe County, Nevada

FINAL DRAFT 2/28/90

Prepared for:

Washoe County Public Works
1001 E. 9th Street
Reno, Nevada 89512

In cooperation with:

City of Reno Engineering
450 Sinclair Street
Reno, Nevada 89502

FEBRUARY 1990
NIMBUS JOB #8909

Nimbus Engineers
3710 Grant Dr., Suite D · Reno, NV 89509
Mail: P.O. Box 10220 · Reno, NV 89510
(702) 689-8630

HUFFAKER HILLS DETENTION BASIN FEASIBILITY STUDY

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INTRODUCTION

In February 1986, the Truckee Meadows area suffered one of the largest floods of recent record. During the flooding the residents of Hidden Valley, an unincorporated subdivision within Washoe County and directly adjacent to the City of Reno, were isolated for an extended period of time. As a result of that flooding and the associated isolation of the area, Washoe County undertook a study of alternatives to provide all weather access to the area.

The study was performed by Nimbus Engineers in 1987. Numerous system modifications and combinations of those modifications were evaluated. Pembroke Drive, which is presently the only access to the area was the focus of the study. The present bridge on Pembroke was inadequate to convey the flows of Steamboat Creek beneath the roadway during the 1986 event and overtopping of the roadway occurred over a considerable length. During the evaluation of the roadway and structure, it was confirmed that not only was the structure inadequate to convey high flows in Steamboat Creek, but that the roadway would be inundated during a 100-year event on the Truckee River.

The most effective alternative identified in the study, and the only one which would provide access during major flow events was to utilize an alternative alignment at the extension of Mira Loma Drive and detain flows at the Huffaker Narrows in order to lower the peak flows on Steamboat Creek. The Mira Loma alignment lies beyond the limit of the Truckee River flooding, thus making it possible to only address one source of inundation (Steamboat Creek). The detention site which is the subject of this study lies upstream of the proposed Mira Loma crossing of Steamboat Creek at a site known as the Huffaker Narrows.

PURPOSE

Washoe County, the City of Reno and Dermody Properties have cooperated to fund this study, and the contract was administered by Washoe County. The study was undertaken in order to examine the feasibility of construction of a detention dam at the site identified in the earlier study. A location map is included as Figure 1 and the Dam Site is shown on Figure 2. Also included for reference is an ownership map of the immediate area of the dam; this is Figure 3.

The focus of this study was the development of detailed hydrology for the 109 square mile watershed that is tributary to the dam site. This analysis was performed in order to determine the height and type of structure that would achieve the most benefit and require the least amount of acreage. Also included was a geotechnical investigation of the proposed dam site which was prepared by Harding Lawson and Associates, along with recommendations for the type of dam to be constructed and the possible placement of a spillway. The complete report is included in the appendix.

Other aspects of the study included a preliminary assessment of alternative configurations for the dam itself and the proposed flood pool, and evaluation of the benefits of the facility and an investigation of possible delivery systems for Thomas Creek. Earlier studies by SEA Engineers and others, as well as the current Flood Insurance Restudy for Thomas Creek have determined that presently it breaks out of its channel during moderate flows and during high flows, approximately forty per cent (1000 cfs out of the 100 year flow of 2500 cfs) of the flow will affect a developed portion of the City of Reno.

During the course of the study, continuing coordination efforts with the Corps of Engineers Design Team and Hydrology Staff were an integral part of the technical analysis. This coordination was important to assure that the project could be incorporated into the Corp's Truckee Meadows Project and that the technical data used was compatible.

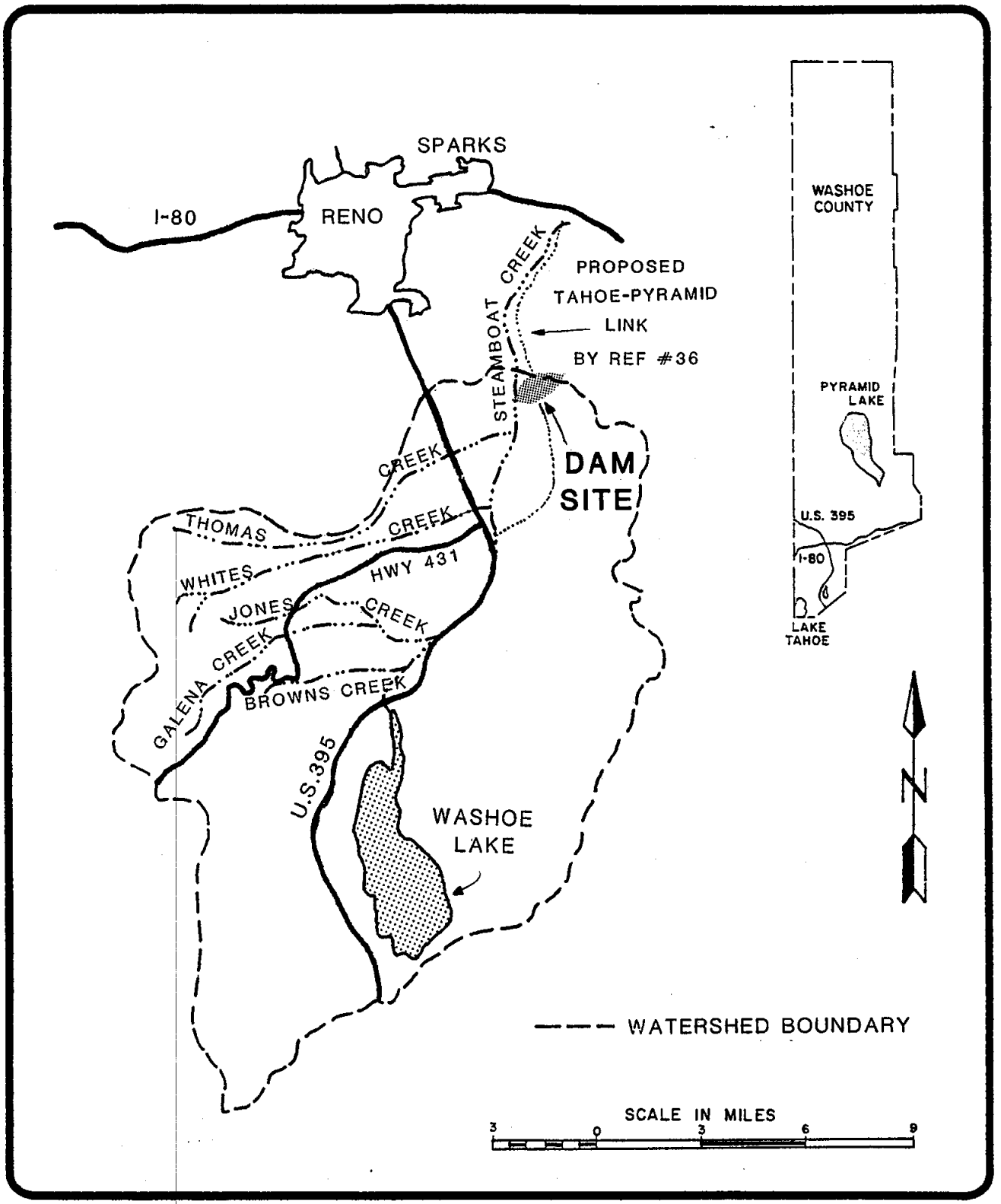

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FIGURE 1

VICINITY MAP

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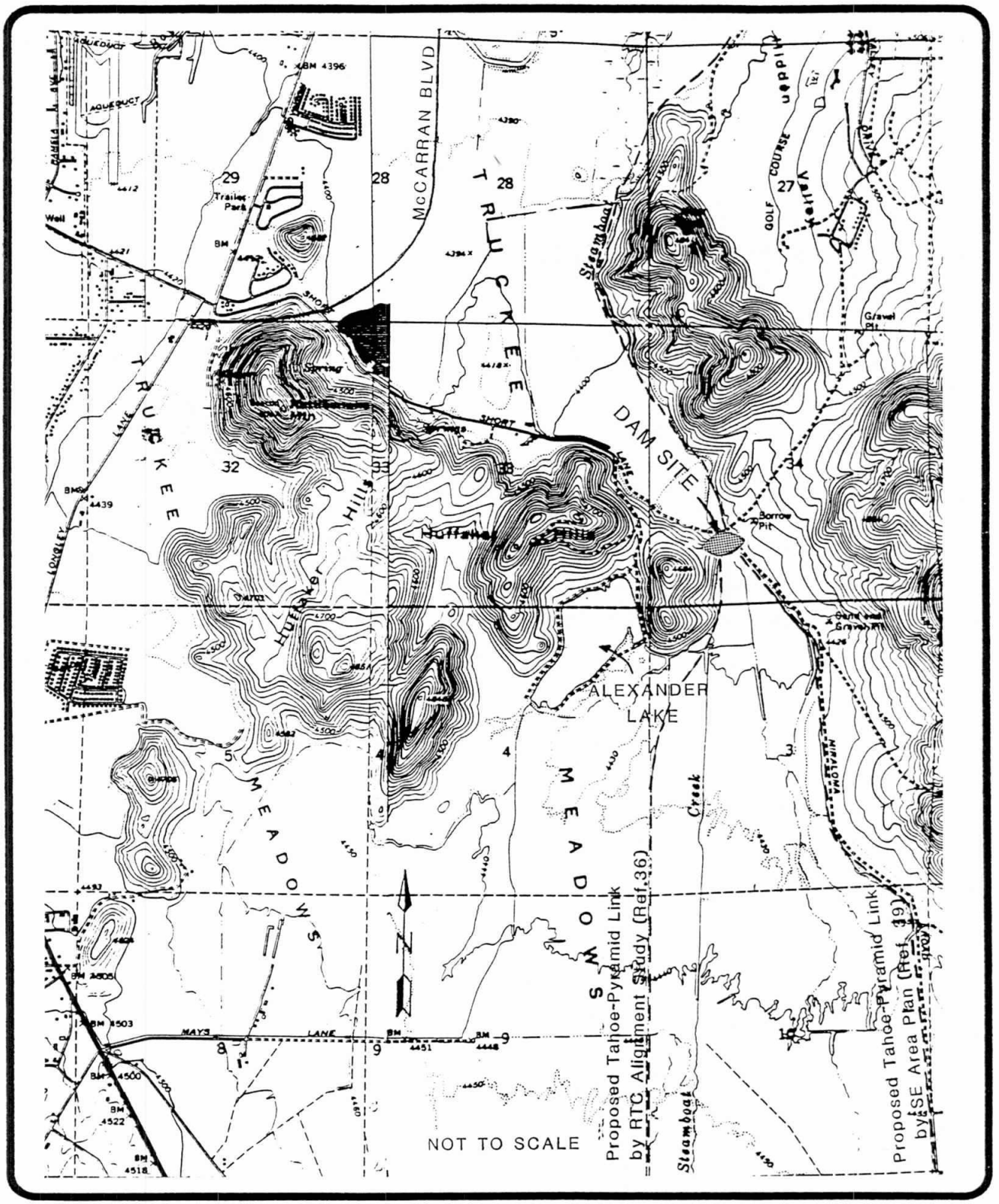

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FIGURE 2

LOCATION MAP

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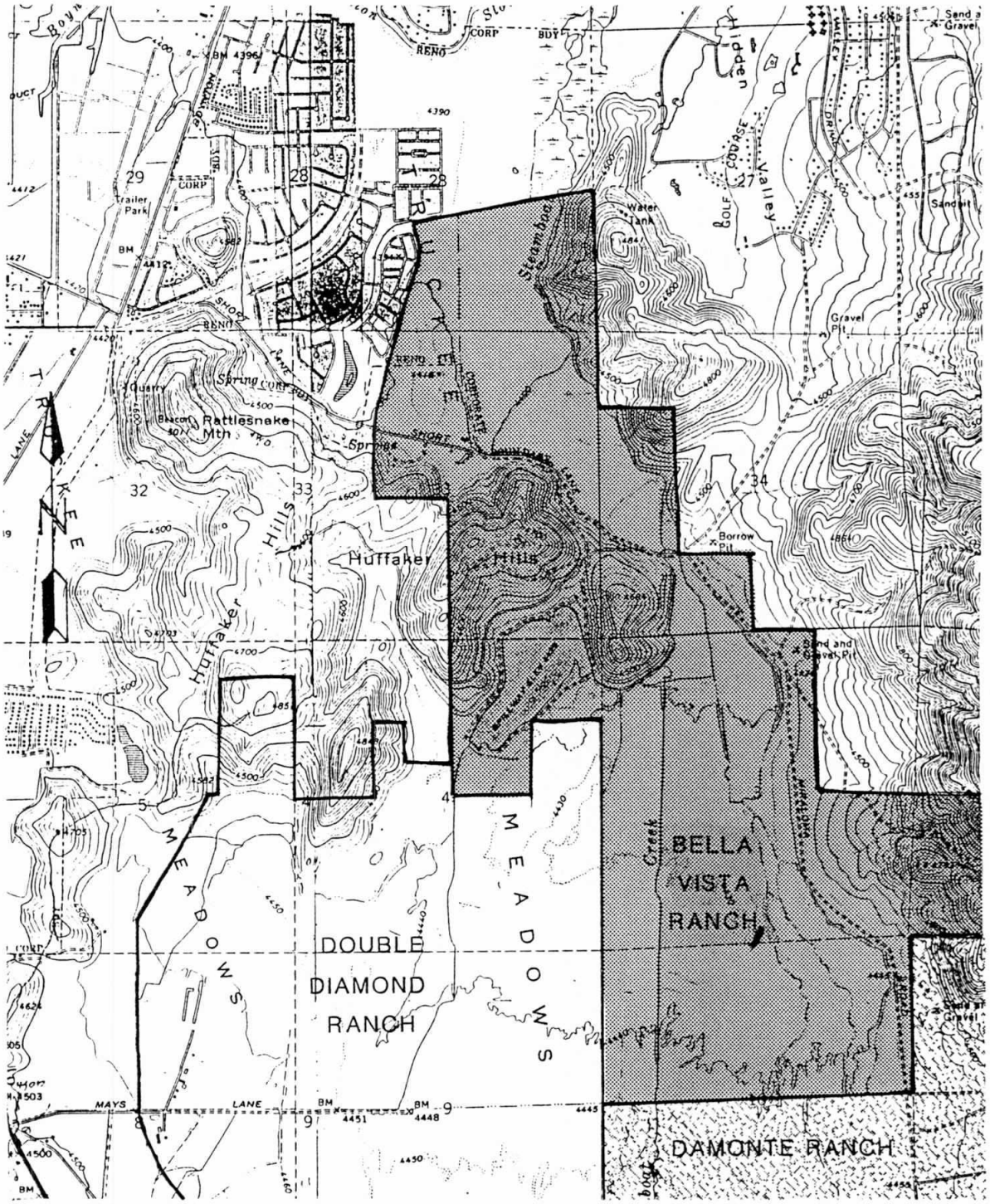

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FIGURE 3

PROPERTY OWNERSHIP MAP

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HYDROLOGIC EVALUATION

Numerous hydrologic investigations of the Steamboat Creek Watershed have been performed by federal agencies; the results of these studies are presented in tabular form in Table No. 1. The Corps of Engineers developed two Floodplain Information Reports, one in 1972 (Ref. 25) which dealt primarily with flooding in the Pleasant Valley area and developed peak flows for Steamboat Creek, Galena Creek and Bailey Canyon and a second in 1974 (Ref. 26) which developed peak flows for Thomas, Whites, Evans and Dry Creeks. As part of the proposed Truckee Meadows project, the Corps of Engineers prepared a comprehensive hydrology study of the entire Washoe County area (Ref. 20).

The Soil Conservation Service has prepared a series of reports on flows from streams in the southwest Reno area. The most recent of these was written in February 1980 and was prepared to present runoff values for a number of watersheds and to examine stormwater management requirements and erosion potential (Ref. 27). The Federal Emergency Management Agency performed a Flood Insurance Study which was published in 1984 (Ref.5). Peak discharges were developed for the areas of interest by using a regional regression method.

The hydrologic evaluation for the Huffaker Narrows detention dam site was performed using the Corps of Engineers Computer Model HEC-1. This model incorporates a number of options for watershed evaluation to determine runoff quantities and peak flows. The values developed for this study were calculated using the 10, 25 and 100 year 24 hour rainfall from the NOAA Atlas, the SCS Curve number method for determining excess rainfall, the Upland method and Manning's equation to determine time of concentration, and the Muskingum and Modified Puls Methods for routing of hydrographs. The watershed areas are shown on Figure 4.

Existing Conditions

Presently the watershed areas are sparsely developed and remain "semi-rural," and in the upper watershed areas, largely undeveloped. Steamboat Creek begins at the outflow of Little Washoe Lake which is about 13 miles upstream from the proposed dam site. From its outlet, the stream flows through Pleasant Valley, Steamboat Valley, and the Upper Truckee Meadows. The tributary area includes the watersheds of Thomas, Whites, Browns, Jones, and Galena Creeks which originate in the Carson Range and flow northeasterly to join Steamboat Creek from the west. Bailey Canyon Creek, which originates in the Virginia Range, flows northwesterly and joins Steamboat Creek from the east. The maximum elevations in the tributary areas range from about 10,800 feet in the headwater regions of Galena to 7,400 feet in the upper reaches of Bailey Canyon Creek. In the lower study area the elevations range from about 5000 feet at the outlet of Little Washoe Lake to 4410 at the Huffaker Detention site.

Annual precipitation in the study area ranges from about 40 inches in the headwaters of

TABLE I
100 - YEAR DISCHARGES (cfs)
FROM PREVIOUS STUDIES

CONCENTRATION POINTS	CURRENT FEMA VALUES (Ref 5)	CORPS 74 STUDY (Ref 26)	CORPS 72 STUDY (Ref 25)	CORPS 80 STUDY (Ref 20)	SCS 80 STUDY (Ref 27)	SEA REPORT (Ref 28)
GALENA CREEK above confluence with Steamboat Creek	2560	-------	6000	3640	-------	-------
STEAMBOAT CREEK @ HWY 395	------	-------	1700	-------	-------	-------
below confluence with Galena Creek	3150	-------	8100	-------	-------	-------
@ USGS Gauge (Rhodes Road)	------		7600	4600	-------	-------
@ HWY 17	4410	-------	7400			
@ Narrows (Short Lane)	5000	-------	5400	4900	-------	-------
BAILEY CANYON above confluence with Steamboat Creek	1120	-------	4600	-------	-------	-------
THOMAS CREEK @ Steamboat Ditch	1500	3500		2500	3400	2500
@ HWY 395	-------	3900		-------	-------	-------
WHITE CREEK @ Steamboat Ditch	------	2000	-------	3900	2930	-------
@ HWY 395	-------	2300	-------	-------	-------	-------

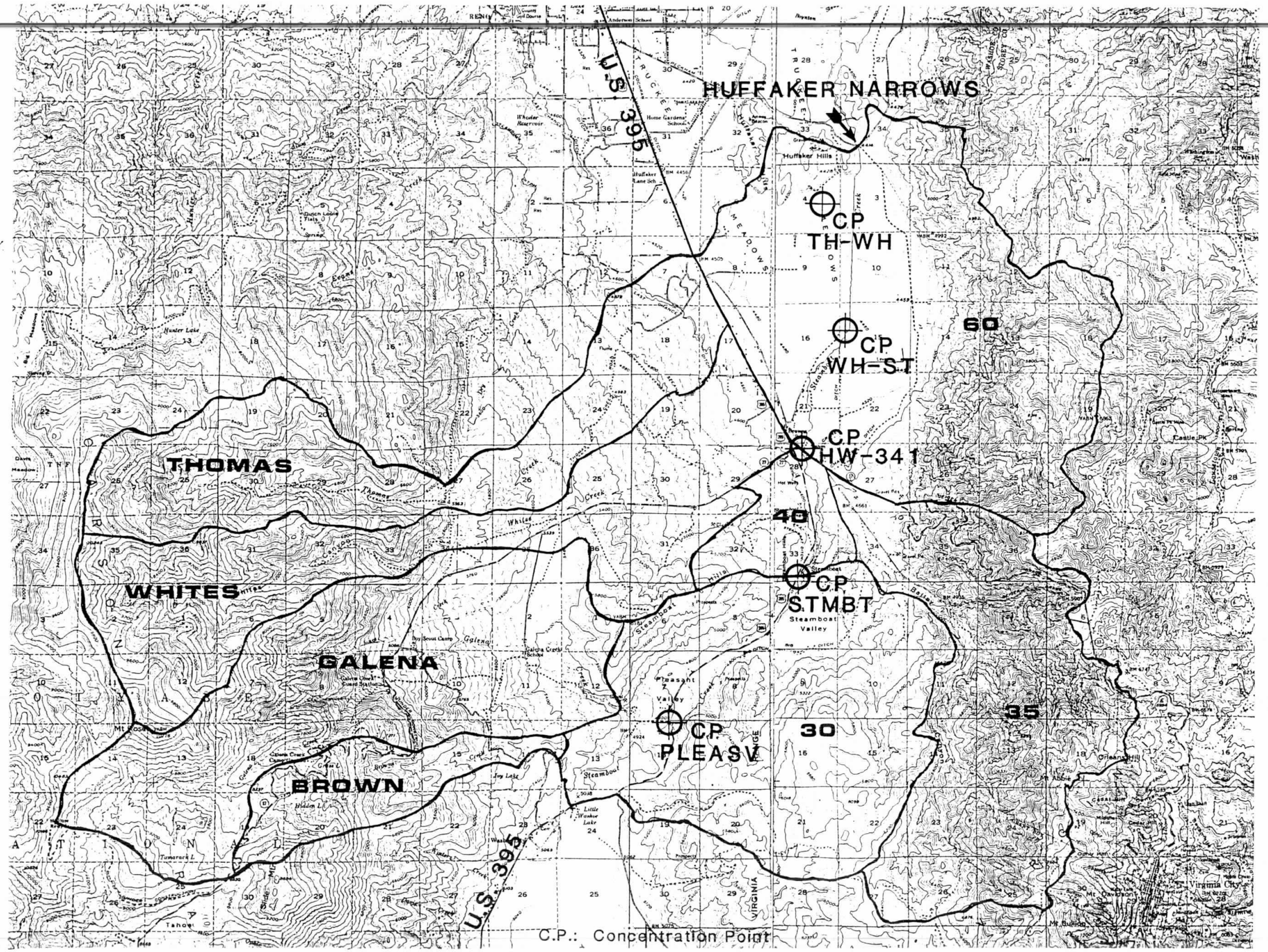

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FIGURE 4

WATERSHED MAP

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the tributary streams to 7 inches on the valley floor. Winter time precipitation usually occurs as snow in the upper areas and a snow pack accumulates during the winter season. In the lower areas, snow frequently occurs, but generally does not remain on the ground for long periods of time. During the summer months, high intensity convective type storms that produce extremely heavy rainfall of a short duration commonly occur on the valley floor and in the upper areas.

Presently the watersheds in the southern end of the study area are largely undeveloped or developed with low density residential uses, with the highest densities in the Steamboat Valley. The lower fans of Thomas and Whites Creek are also being developed for residential uses; however, the parcels tend to be larger than one acre. Until the infrastructure which will allow smaller lots, such as sewer and water service, is extended to this area, it is likely that it will remain rural in character. Residents of the area seem to prefer the type of life style which they presently maintain to that of the more urbanized lower Truckee Meadows.

Future Conditions

Several large, medium to high density, developments are presently proposed for watershed 60 (see Figure 4).

The Double Diamond Ranch is situated at the northwest corner of watershed 60. That property has a Master Plan which has been approved by the City of Reno and Washoe County. The developer has presented a tentative map for the first phase of the development which will ultimately encompass 1800 acres with 1270 acres as residential, 106 acres commercial, 85 acres for schools and the remainder for open space and recreational uses. The flood control concept which has been presented for this development is to channelize Whites and Thomas Creeks through the subdivision in a golf course and to provide detention areas for increased runoff.

The Damonte Ranch Development lies at the southern end of watershed 60. The Master Plan which was submitted to the Regional Planning Commission in March 1979 proposed a 2200 acre development with an ultimate 6000 dwelling units to be developed over a fifteen to twenty year period. Since the submittal of that plan, ownership of that property has undergone several changes and the parcel has been split into several holdings. For purposes of this study the original Master plan was used to develop impervious cover and channelization schemes for that property. While it is doubtful that the property will be developed to the density proposed in the original report, this was considered to be the density possible given the fact that it had once been approved by the local agencies.

A major arterial roadway, the Tahoe-Pyramid Link, is proposed to be built to serve the South Truckee Meadows Area. Within the area of interest, the original alignment study identified a route which would extend from State Route 341 through the central portion of the valley. While no information is presently available on an alternative alignment, the current proposed alignment shown on the Southeast Area Plan places the roadway on

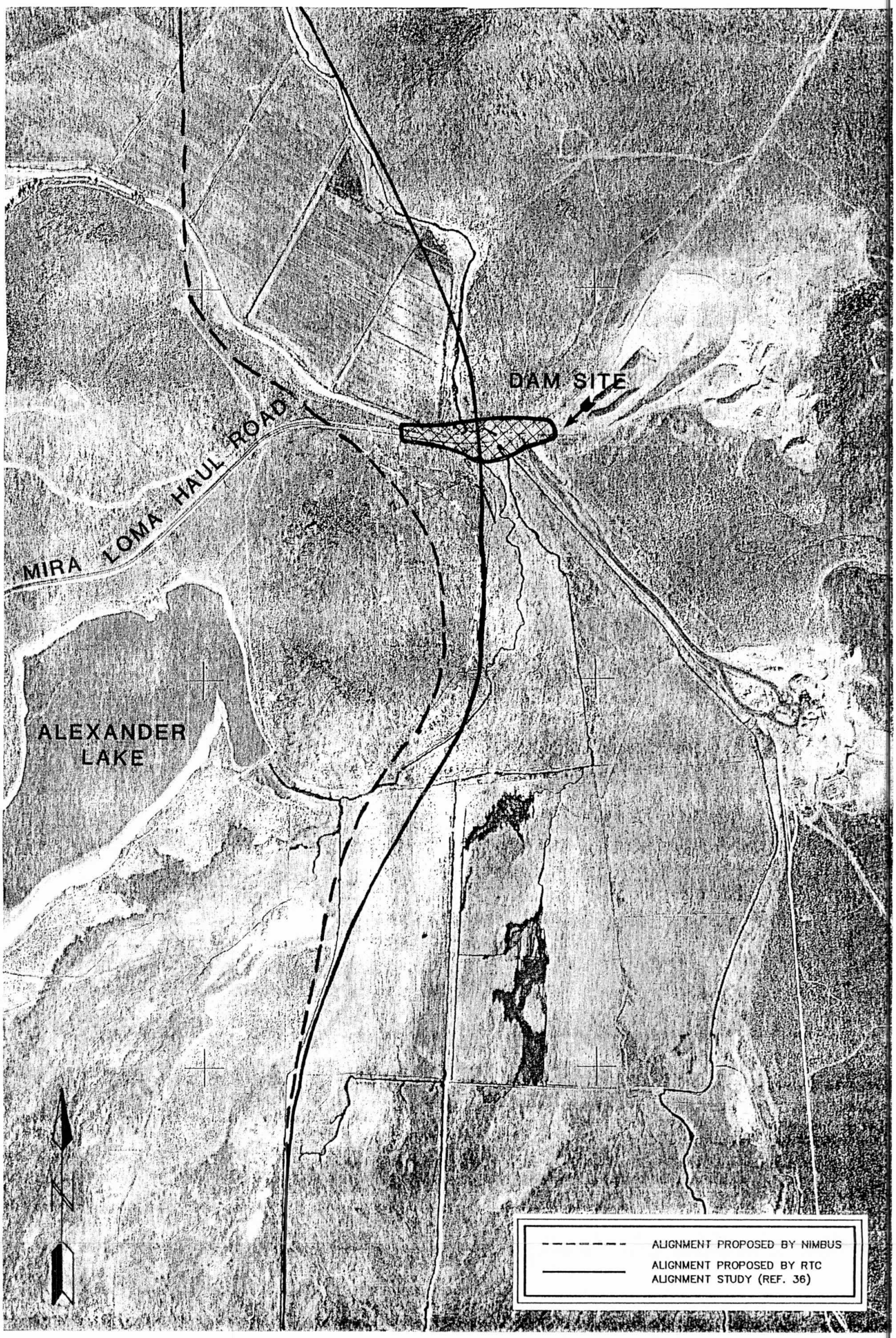

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FIGURE 5

TAHOE-PYRAMID LINK

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the easterly edge of the valley, in the vicinity of the present alignment of the Mira Loma Road.

Figure 5 is a schematic of the Tahoe-Pyramid Link alignment from the original alignment study (Ref. 36) and a suggested realignment in the vicinity of the proposed dam. This alignment will place the roadway west of the dam site and cross the narrows well above the flood pool and dam structure. This alignment will have a lesser impact on Steamboat Creek as it eliminates two crossings and the cost savings in structures will help offset the increased embankment and excavation costs. Construction of this project will have minimal impact on that alignment, except that elevation of the flood pool will have to be taken into consideration during final design of the project and compensation for any reduced storage will have to be made.

No funding is currently available for design or construction of the Tahoe-Pyramid Link and there is no projection of when funds will become available. The SEA study was performed in 1983 and several significant issues which may have a direct impact on the alignment have arisen since that time. The first is the Flood Insurance Studies and Restudies for the Cities of Reno and Sparks and Washoe County. These studies have identified regulatory floodways within the proposed alignment, and the communities are bound by their floodplain management ordinances to follow specific guidelines before allowing any development within the floodway. The second issue is a new awareness of wetlands and stricter regulatory enforcement by the Corps of Engineers. A 404 Permit will be required for any fill to be placed in a wetland and for alteration of Steamboat Creek channel. One requirement of a 404 Permit is that an in-depth alternatives analysis be conducted. This alternatives analysis may identify a feasible alternative to the proposed alignment.

Methodology

Precipitation

Precipitation depths for this study were taken from the NOAA Atlas and depth-duration data were generated using the guidelines set forth in that document. These partial duration series were then converted by Hec-1 into equivalent annual series. This data was then incorporated into a rainfall distribution, triangular in shape, which is representative of a "balanced storm." This storm will produce a mass curve which is area specific. The mass curve is developed by assuming that the most intense rainfall occurs at the midpoint of the storm, in this case at the 12th hour. The shape of the mass curve which is produced is similar to the SCS Type II curve; Figure 6 is a plot of typical rainfall distributions and is included for quick reference. A more detailed discussion of synthetic storms can be found in Ref. 16.

The intensities which are used depend upon the time interval that is selected. During the course of this study, a fifteen minute time interval was used to develop the peak flows and the hydrographs. The five minute hydrograph was developed early in the study and it produced a higher peak flow, but because of limitations with the number of time steps

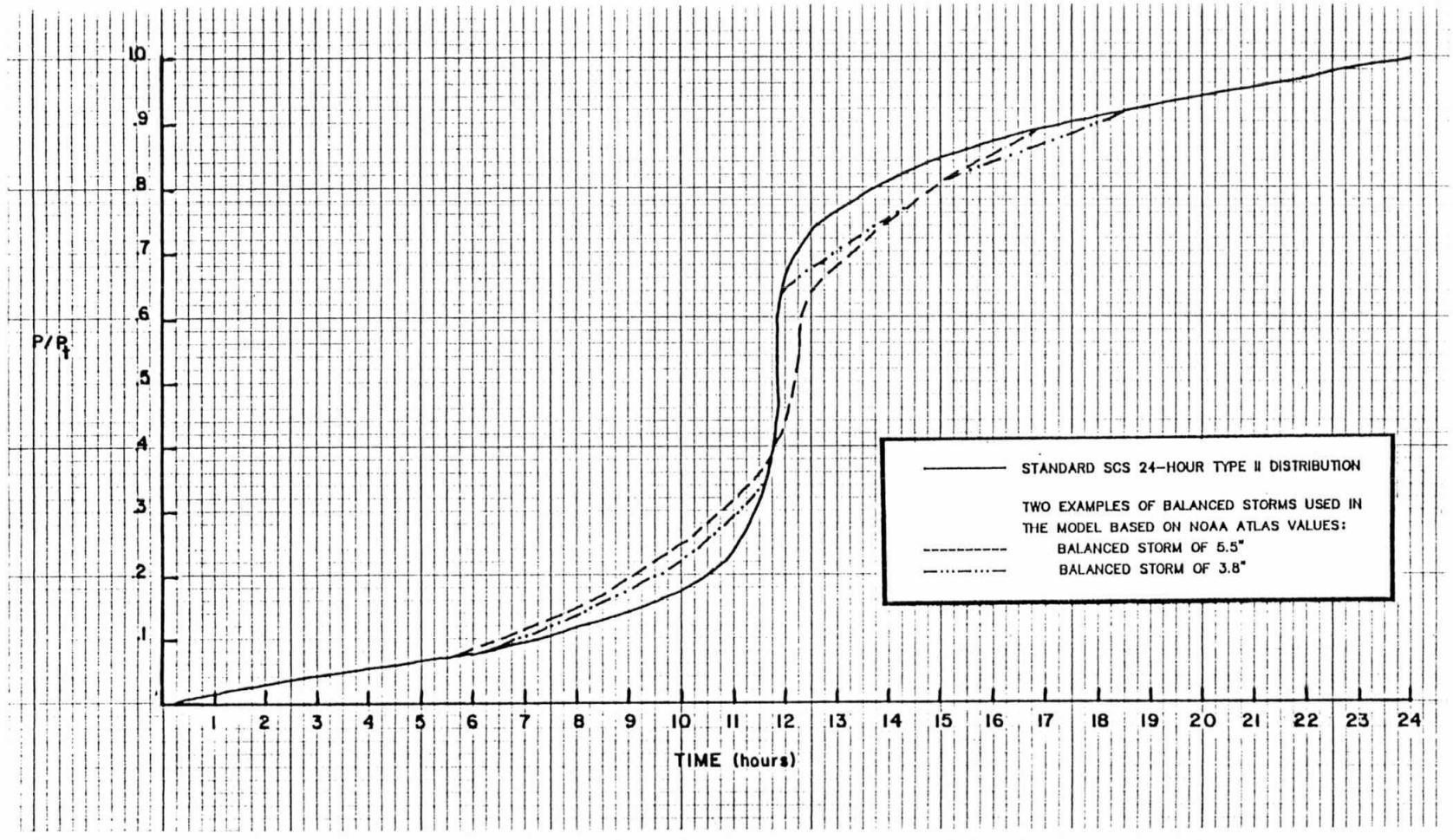

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FIGURE 6

MASS CURVES
SCS TYPE II and BALANCED STORM

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allowed by HEC-1 for hydrograph calculation, the program truncated the hydrograph at the end of 24 hours and did not compute the entire volume which could be expected from the storm. Because of the limitations of HEC-1 and the need to develop a design model which would generate a required volume for the basin, the 5 minute model and discussion of its results has not been included in this study.

Since the area tributary to the proposed basin covers 109 square miles, an aerial reduction factor was applied as recommended in the HEC-1 manual. The reduction factor for a watershed of this size produces excess precipitation which is 92.5% of point rainfall. Several discussions were held with Washoe County and the City of Reno to develop a consensus on rainfall values. As a result of these discussions, the National Weather Service was consulted on past storm patterns. They concurred that for an area of this size, that the most probable storm to cause severe flooding would be a general storm which would involve the entire watershed and which is void of snow except in the uppermost reaches. This is the type of storm which produced the floods of 1963 and is one of the largest storms of record. Warm storms which occur with a snowpack in the upper watershed will in most cases produce lower peak flows, as the higher amounts of rainfall occur in the upper slopes and are initially absorbed by the snow. Earlier studies by the Corps of Engineers also adopted this approach.

The design model produced for this study is based upon an antecedent moisture condition (AMC) which is referred to as AMC II. This condition is an average condition with 0.5 to 1.1 inches of rainfall for the preceding five days of the dormant season and 1.4 to 2.1 inches in the growing season. Isopluvials of the 100 year 24 hour precipitation are shown on Figure 7.

SCS Methodology

The entire watershed was delineated on USGS 7.5 minute quadrangles. The major watersheds were delineated and then broken into smaller subwatersheds. Figure 4 is a reduced copy of the quadrangles with the watersheds delineated. The subwatersheds were developed by reviewing watershed slope, soil types, vegetation types and cover, and rainfall amounts. The areas were planimetered to determine basin area. Slopes for use in the determination of time of concentration were calculated. Curve numbers were developed from soil types set forth in the Soil Conservation Survey for Southern Washoe County (Ref. 14). Aerial photographs were used to identify cover types and densities where they were available and detailed field investigations were performed where photography was not available.

Future conditions were simulated by increasing the percent impervious cover in the existing conditions model. This increase was based upon the proposed densities which are set forth in Area Plans prepared by the Washoe County Department of Comprehensive Planning. These plans were reviewed in a number of public hearings and then approved by the Planning Commissions and the Board of Supervisors. In addition to impervious areas, routing reaches were also modified to reflect channelization proposed by a number of large developments which have Master Plan documents on file with the Reno and Washoe County Planning Departments, as well as channelization which

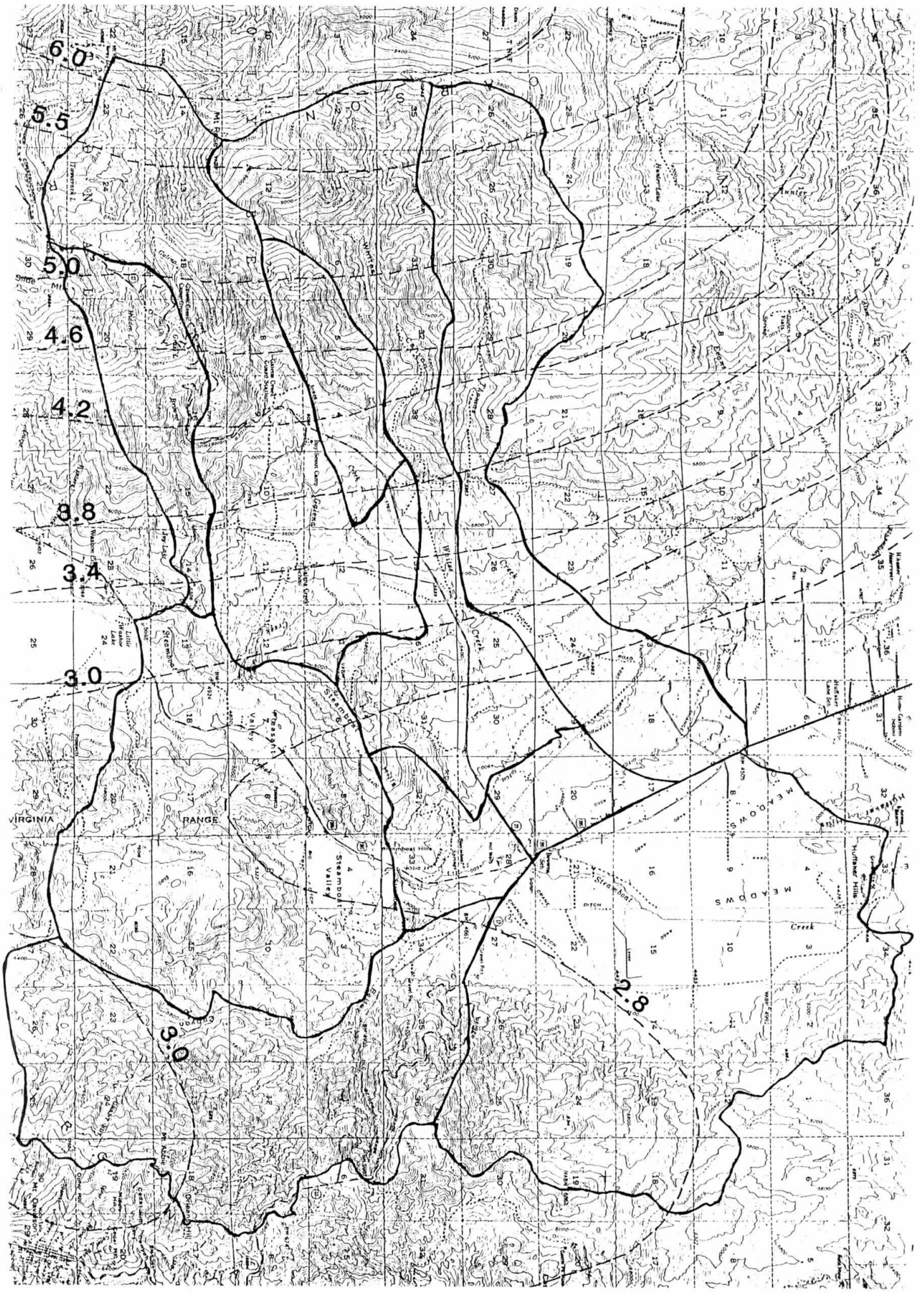

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FIGURE 7

ISOPLUVIAL OF 100-YR 24-HR PRECIPITATION

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can be expected in areas proposed for higher density. Times of concentration for those reaches proposed for channelization were also recomputed.

The routing of Thomas and Whites Creeks for future conditions was developed after a review of the Double Diamond Master Plan and a conversation with the staff of Summit Engineers regarding design concepts which are currently being considered. The proposed design of channels will limit channel velocities to an average of 6 feet per second.

Once the parameters for the computer model were established, a calibration run was produced to verify results. The calibration run was a simulation of the February 1986 event, and the rainfall used in this effort was extracted from the isohyets shown on Figure 8. This rainfall distribution was developed by Nimbus Engineers, in cooperation with the National Weather Service from raingauge data (Ref. 29) collected during the February 1986 flood event. No other calibrations were attempted as no other data was available for this stream. While calibration of the model to a single storm event does not establish its total reliability, it does assist in establishing whether results can be reasonably expected, when applying those modeling techniques to other storm events.

Time of Concentration- Times of concentration were calculated using the Upland method where appropriate. In many of the upper watershed areas the channels are well incised and in those areas Manning's equation was used to develop travel time. Basin lag was calculated as 0.6 of the time of concentration.

Hydrograph Routing-The Muskingum routing method was used to route hydrographs and combined hydrographs through most of the subwatersheds. This method determines the storage within a stable river or stream reach based upon hydraulic characteristics of the channel section and the inflow. The formula for computing storage is

$$S = K[XI + (1-X)O]$$

where K = the storage time constant for the reach
x = the weighing factor which varies between 0 and 0.5 for a given river section with the value of 0.5 causing almost a pure translation of the hydrograph.

In this application K was determined utilizing the Manning equation and calculating the travel time for each reach, then a ratio of wave velocity to channel velocity was then applied to the channel velocity. The value of X was chosen as follows:

.4 for reaches in which the flow remains in the channel
.2 for reaches with overbank flooding
.1 for flows with no defined channel (width over 1000').

The Modified Puls Method was used to route flows through the structure at State Route 341 on Steamboat Creek, and at Huffaker Narrows where the Mira Loma Haul Road crosses Steamboat Creek. These concentration points were the only areas where ponding occurs under existing conditions. Routing through the proposed detention facility was also performed using the Modified Puls method. Storage and outflow data for these routings were developed by creating a rating curve for the low flow structures and by weir flow calculations for roadway overtopping. Storage data was developed from available topographic mapping.

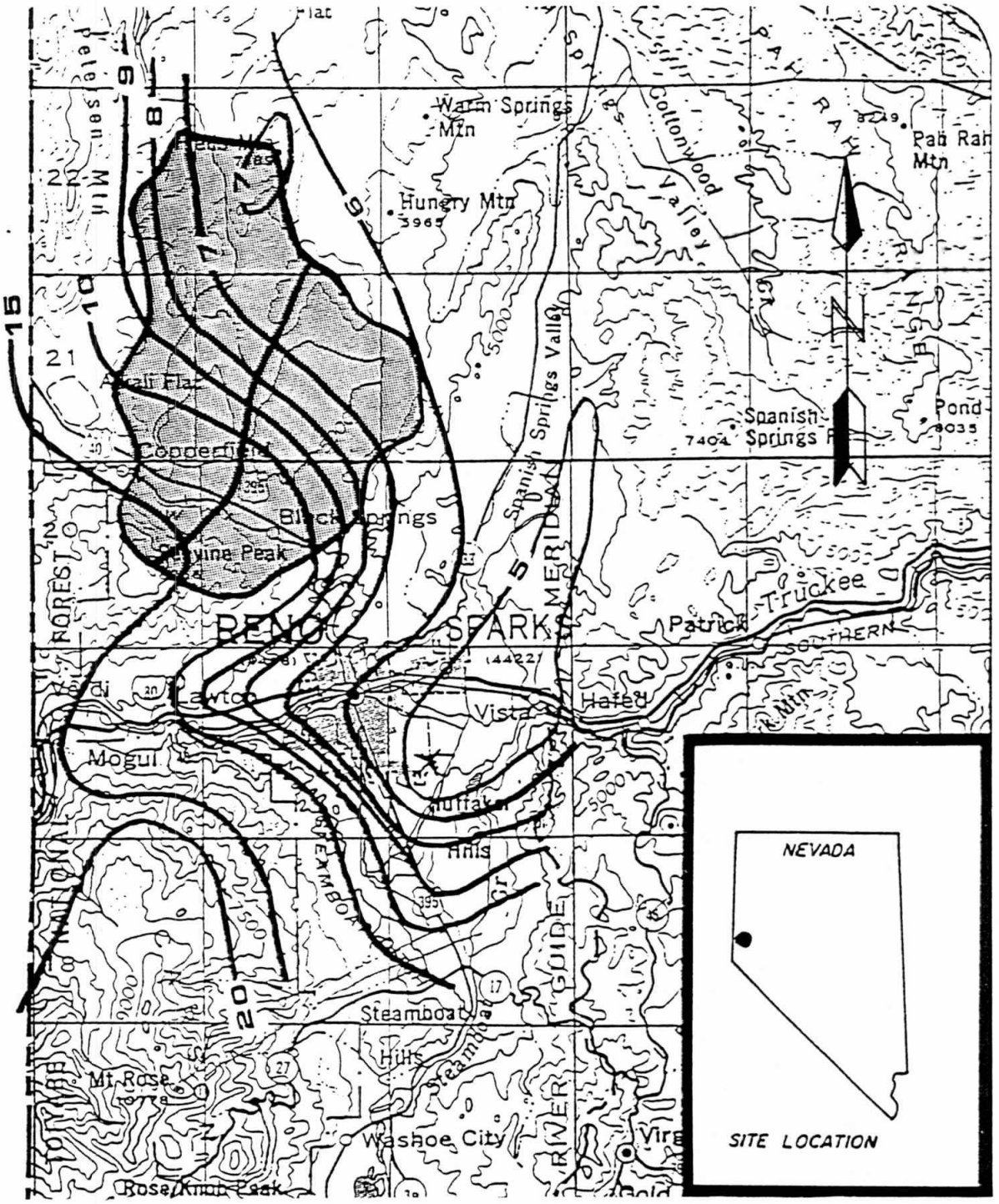

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FIGURE 8
ISOHYETAL MAP FOR FEBRUARY 1986 FLOODS

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TABLE 2
PARAMETERS FOR BASINS

BASIN	BASIN AREA SQ MILES	POINT PRECIPITATION (INCHES)	EXISTING CN	EXISTING LAG (HRS)	FUTURE IMPERVIOUS %	FUTURE LAG (HRS)
Galena Creek	18.02	4.2	66	.70	2.3	.70
Browns Creek	4.13	4.2	62	.65	0	.65
Area 30	17.8	2.9	77	.82	3	.82
Area 35 (Bailey Creek Canyon)	15.5	3.0	82	.72	2	.72
Area 40	2.63	2.8	77	.49	15	.30
Whites Creek	16.11	3.9	67	.87	6.3	.87
Area 60	23.15	2.8	76	3.70	12	1.25
Thomas Creek	11.64	4.3	66	1.17	4.3	.9

TABLE 3
MUSKINGUM ROUTING PARAMETERS

		EXISTING STEP	K	X
RT-PV	Route Galena Creek Watershed to Pleasant Valley	1	.11	.2
RT-PV	Route Browns Creek Watershed to Pleasant Valley	1	.30	.2
RT-SG	Route Steamboat Creek to Steamboat Gage	1	.32	.2
RT-341	Route combined Hydrograph to HWY 341	1	.25	.2
RT-WC	Route flows to 6000 feet downstream	1	.23	.2
WH-RT	Route Whites Creek from 395 to Steamboat Creek	1	.42	.1
RT-HN	Route combined Hydrograph to Huffaker Narrows	5	1.50	.1
RT-HN	Route Thomas Creek to Huffaker Narrows	5	1.2	.1
		FUTURE STEP	K	X
RT-PV	Route Galena Creek Watershed to Pleasant Valley	1	.11	.4
RT-PV	Route Browns Creek Watershed to Pleasant Valley	1	.30	.4
RT-SG	Route Steamboat Creek to Steamboat Gage	1	.32	.4
RT-341	Route combined Hydrograph to HWY 341	1	.25	.4
RT-DD	Route flows to end of proposed development	2	.55	.4
RT-HN	Route flows to Huffaker Narrows	3	.8	.1
RT-D	Route Whites Creek Hydrograph to end of Double Diamond	2	.53	.4
RT-DD	Route Thomas Creek to end of Double Diamond	2	.43	.4
RT-HN	Route combined flows for Thomas and Whites Creeks to Huffaker Narrows	1	.38	.1

Figure 9 is a schematic or routing diagram which summarizes the HEC 1 model for existing conditions and Figure 10 for future conditions. Tables 2 and 3 give detailed information on the parameter values for watershed evaluation and routing respectively. The input and output of the HEC 1 models are included in the Technical Appendix for this report which is a separate volume.

Results

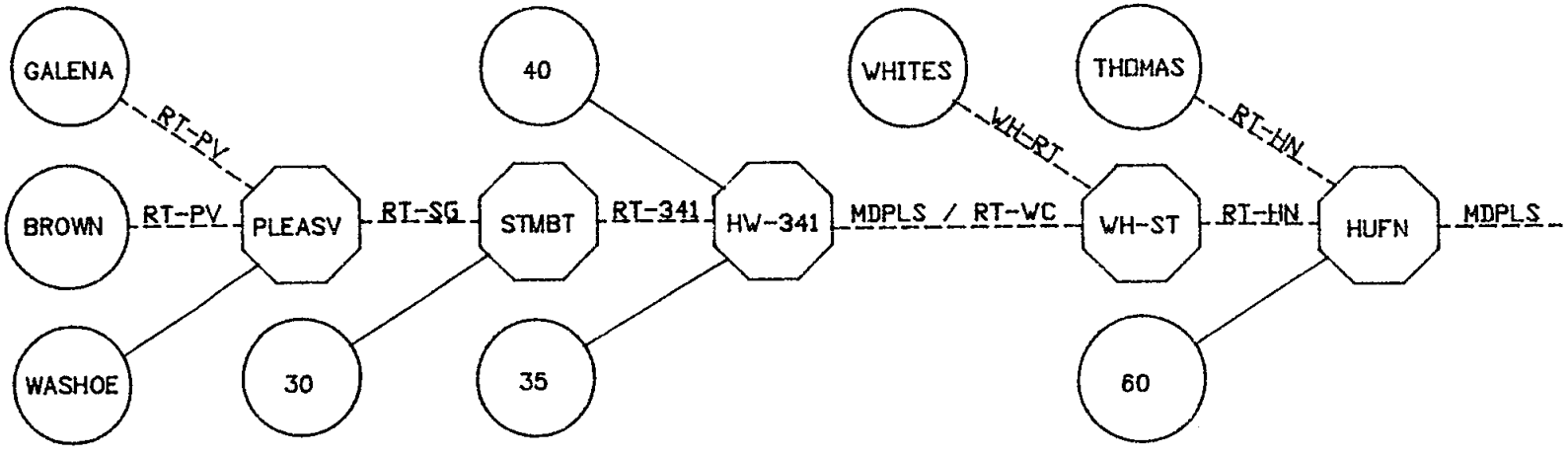
A HEC-1 model for the 10, 25 and 100 year storm was produced for each condition, existing and future. These models, as noted earlier, were prepared using aerial reduction of the point rainfall. Discharges calculated for subwatersheds are not appropriate to utilize for design purposes for channels or structures which will improve tributaries. The values for improving structures or channels on the Steamboat Creek tributaries should be produced by assuming a storm centered over the subject watershed and applying an aerial reduction factor appropriate for the size of the watershed. Separate analyses were produced for the City of Reno and for Washoe County for this purpose and readers are directed to consult his respective Public Works Departments for further information.

The following table presents in tabular form the discharges from this analysis :

TABLE 4

Vg. Highway

MODEL	@SR 341 (cfs)	Tp (hrs)	@Narrows (cfs)	Tp (hrs)	Volume (ac-ft)
100-yr existing conditions	8863	13.25	10931	15.25	8539
25-yr existing conditions	5153	13.25	5854	15.25	6103
10-yr existing conditions	3372	13.25	4590	15.50	5574
100-yr future conditions	9297	13.25	13399	14.50	9222
25-yr future conditions	5435	13.25	7597	14.50	6690
10-yr future conditions	3684	13.25	5183	14.50	5800



○ Sub – Basin

⬡ Combine Hydrographs

----- Routed Hydrograph

——— Hydrograph

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FIGURE 9

HEC-1 ROUTING DIAGRAM
EXISTING CONDITIONS

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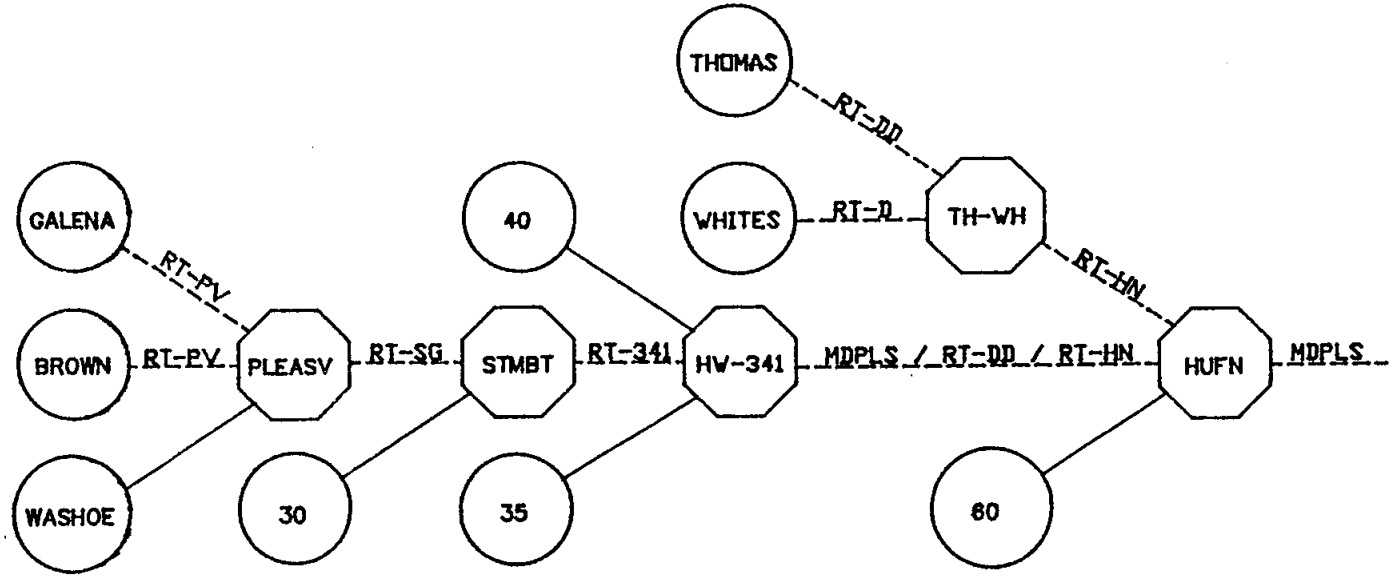

Sub – Basin

Combine Hydrographs

Routed Hydrograph

Hydrograph

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FIGURE 10

HEC-1 ROUTING DIAGRAM

FUTURE CONDITIONS

FEBRUARY 1990 JOB#: 8909

The increase in peak flows at the Narrows for future conditions is largely attributable to the assumed channelization on the Double Diamond and Damonte Ranches. Presently these properties have ill- defined channels and as Thomas, Whites and Steamboat Creeks reach this area, the majority of the flow is sheet flow across meadow or pasture land and the velocity ranges from 1 to 3 feet per second. If the flows were to be confined to channels as set forth in the Master Plans for those properties, the velocities range from 6 to 8 feet per second. As noted earlier the future conditions model was modified to reflect velocities in the range of 6 feet per second for grass- lined channels. Figure 11 is a hydrograph comparison of the two conditions which demonstrates the increased peak and the shorter time to peak of the flows at the outlet of the Narrows.

It is our understanding that conditions placed on the tentative map for the first phase of the Double Diamond Development require that the developer mitigate any increase in peak flows to Thomas and Whites Creeks. This requirement was not taken into consideration when modeling the future condition. It is assumed that it will be to the developers' benefit to participate in this project and that the participation will be deemed mitigation.

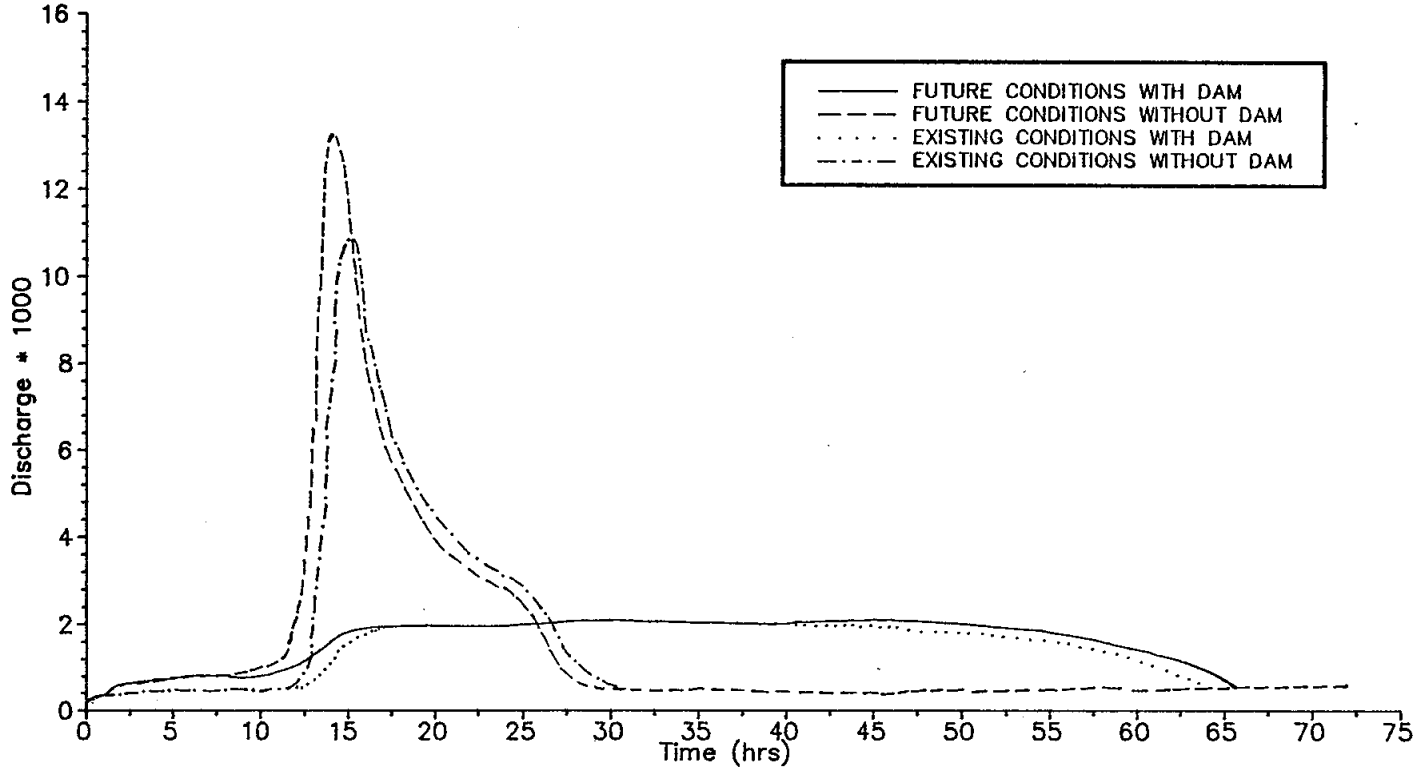

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FIGURE 11

100-YR HYDROGRAPH at Dam Site

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HYDRAULIC EVALUATION

Bella Vista Ranch

The dam structure suggested by the geotechnical report (see Appendix) is either a rock fill or earthen fill dam. Several low flow outlets were considered for the dam. The approach was to try to balance the outflow and the height of the structure to minimize the flood pool and not exceed the capacity of the Brookside Lakes Golf Course Flood Control Channel. A double 4'x10' reinforced concrete box was chosen which will allow a maximum outflow of 2100 cfs.

Earlier hydraulic evaluations of Steamboat Creek downstream of the Brookside project were reviewed to determine channel capacities and affected areas. This entire downstream area is affected by Truckee River backwater during a flood event such as that experienced in February 1986. Additionally, the Boynton Slough joins Steamboat Creek just upstream of Pembroke Drive within the Brookside project. If the dam is built, it is conceivable that the peak flow on the Boynton Slough would pass through the Pembroke structure prior to peak discharge from Huffaker. In order to develop a conservative assumption, however, the peak flow from the Washoe County FIS of 1800 cfs can be added to the 2100 cfs from the dam and the combined peak can be assumed to be 3900 cfs, or 2400 cfs lower than the present regulatory 6500 cfs. This lower flow will allow for a narrowing of the Steamboat Creek floodway. Once the Corps of Engineers levee project is built on the Truckee River, a great deal of the lower Truckee Meadows property can be reclaimed. Some channelization would be required as the present Steamboat Creek channel capacity is as low as 600 cfs in some portions of the reach.

A hydraulic evaluation of the present and the proposed condition on the downstream properties was performed utilizing HEC 2. The location of cross sections used in the evaluation are shown on Figure 12. The data for the analysis was developed from orthophotos developed for the Corps of Engineers in summer 1989.

The width of floodplain on the Bella Vista property does not dramatically decrease with the addition of the detention facility at the Narrows; however, the depth of flow is lowered approximately two feet. Under present conditions almost the entire floodplain is needed for conveyance of the flood, yet under proposed conditions, with the dam in place, much of the floodplain can be developed by encroachment, without extensive channelization. Figures 13 and 14 show the reduction in depth of flow for a typical cross section. A preliminary floodway analysis shows that more than 190 acres of the northern portion of the Bella Vista could be removed from the future condition floodplain by encroachment, under FEMA criteria.

A preliminary channel design through the Bella Vista Ranch, downstream of the dam was developed in order to size the box culverts which would be needed for the Mira Loma Drive extension. Since minimal headwater area is available, the culverts were sized to maintain open channel flow. In final design, the possibility of developing a greater headwater depth to provide pressure flow should be investigated. If that is possible, the structure sizes could be significantly reduced and result in lower costs.

Not identified

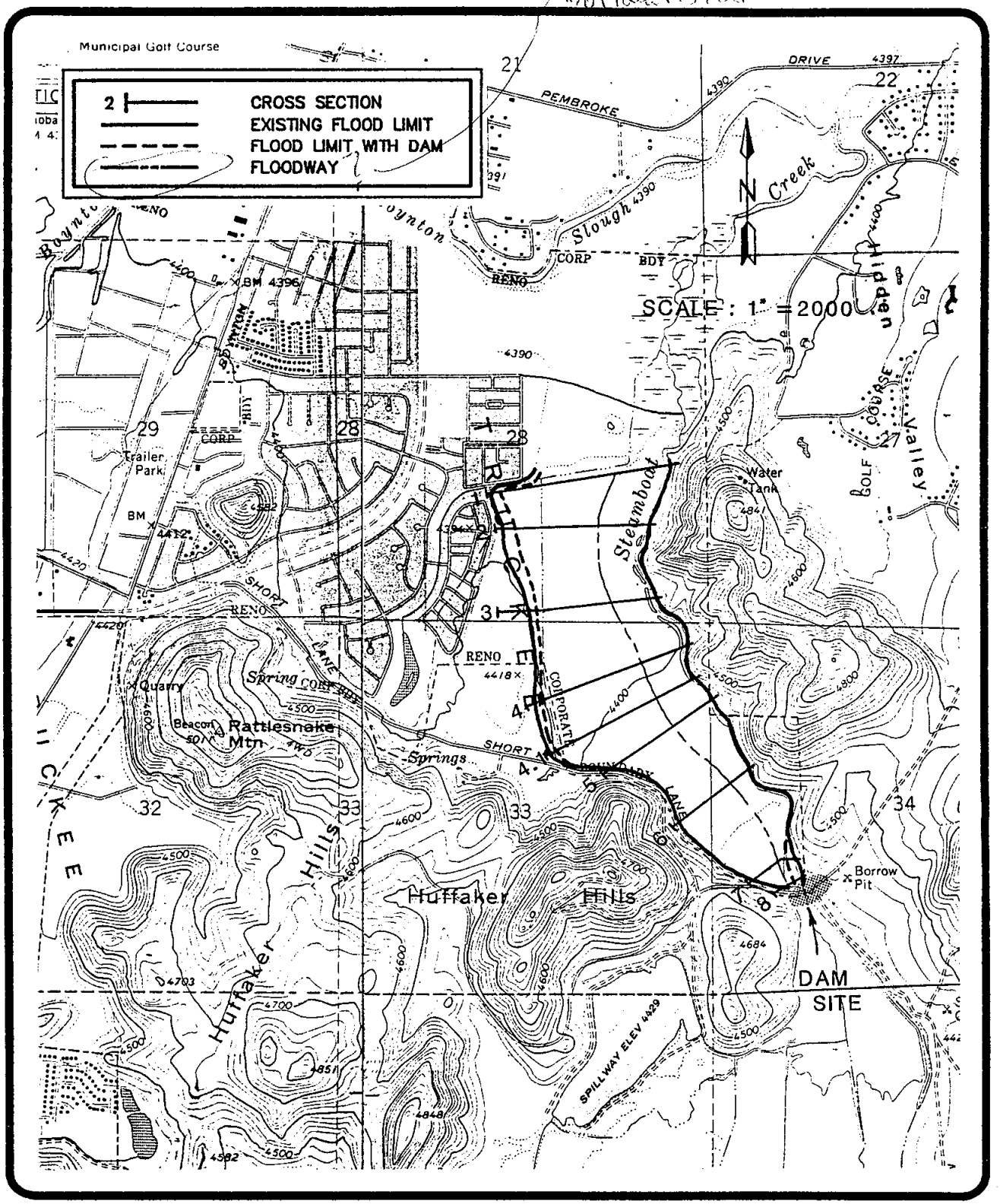

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FIGURE 12
DOWNSTREAM FLOODPLAIN and FLOODWAY

DATE: FEBRUARY 1990
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CROSS SECTION NO. 2

DOWNSTREAM OF HUFFAKER DAM SITE

(Typical of Other Cross Sections)

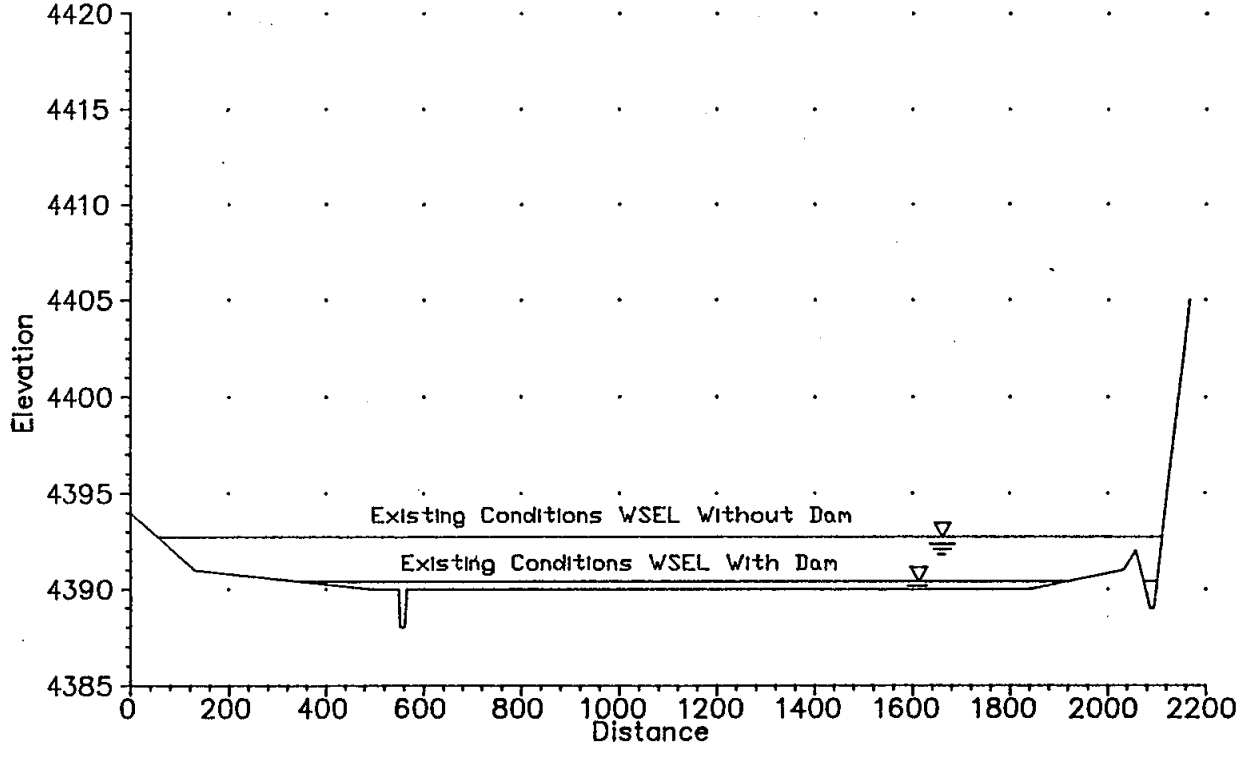

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FIGURE 13

EXISTING CONDITIONS

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CROSS SECTION NO. 2

DOWNSTREAM OF HUFFAKER DAM SITE

(Typical of Other Cross Sections)

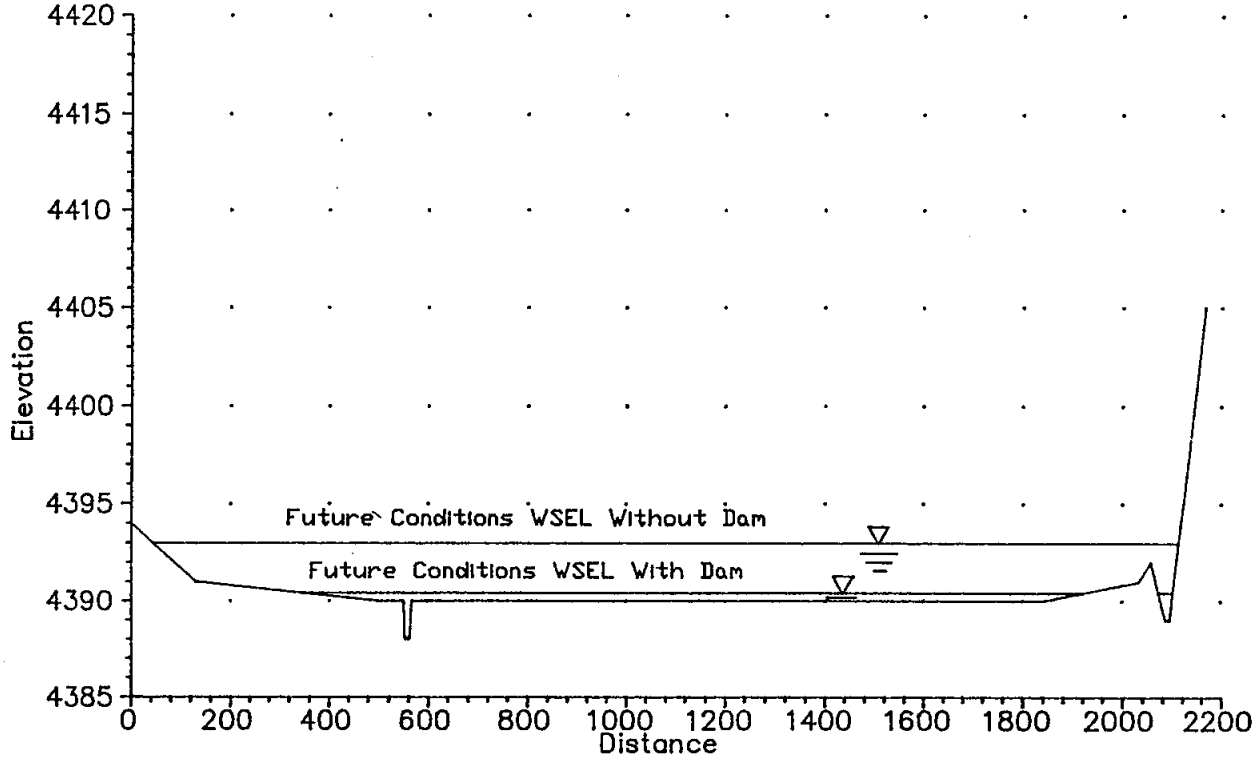

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FIGURE 14

FUTURE CONDITIONS

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The channel used to size the structures has a 100 foot bottom width with 3:1 side slopes and a flow depth of 3.5 to 5 feet. This is a section similar to the channel downstream on the Brookside Lakes project.

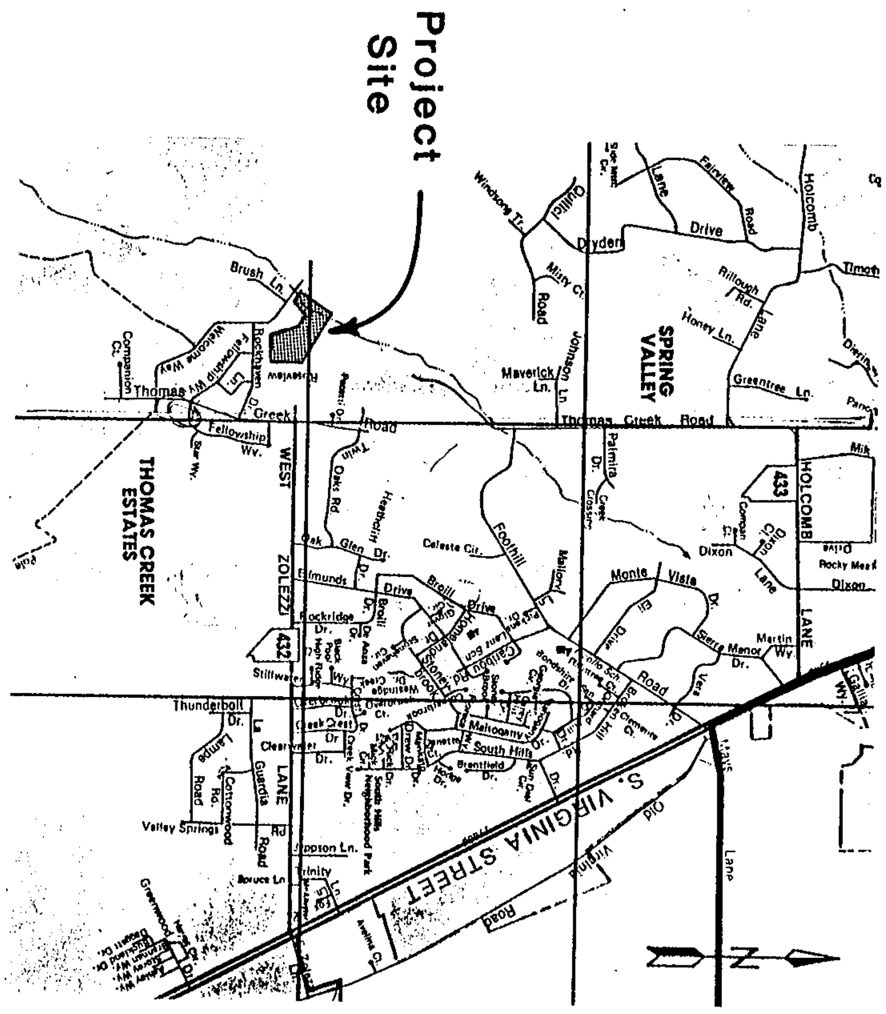
Thomas Creek Fan

One of the primary reasons for this study was to evaluate the possibility of diverting Thomas Creek flows to the Huffaker Narrows. This diversion would relieve flooding near Patriot Boulevard and in the Longley Lane area. A hydraulic analysis of Thomas Creek during a 100 year flood event (i.e. a 100 year storm centered over the Thomas Creek basin) at South Virginia Street was performed in order to evaluate the flow split under existing conditions. Presently approximately 1050 cfs flows northeasterly over Holcomb Lane and across Virginia Street and an additional 100 cfs flows easterly across Virginia Street. Those flows combine and will become concentrated at the newly constructed Interstate 580 and proceed northeasterly through the freeway and concentrate near Longley.

During the course of this study, several channel alignments were identified to serve as a remedy for this situation. Due to the length of the channel improvements that would have to be constructed, the development in the lower watershed, the right-of-way needed and the lack of capacity at South Virginia Street, full channelization of Thomas Creek appears to be too costly to consider at this time. The lack of capacity at south Virginia is caused by the vertical alignment of the present roadway. Current plans for the widening of that roadway do not include elevation of the roadway. The access to commercial properties along the road would become a problem and a significant amount of right of way would be required. The budget for the current project will not allow those types of expenditures. In lieu of channelization, a preliminary assessment of possible detention sites was conducted.

The concept of detention for Thomas Creek would be to limit the peak discharge to the capacity of the present channel, approximately 300 cfs. The site which was identified for a basin on Thomas Creek is shown on Figure 15. This concept has a number of advantages to a number of different parties. The Thomas Creek fan has been identified in the preliminary draft of the Regional Water Resource Plan and by Westpac Utilities as a potential site for a spreading basin to promote ground water recharge. The Nevada Department of Transportation has reviewed the concept and is interested in further study to determine the cost savings which may be achieved in structures planned for South Virginia Street widening and for the extension of Interstate 580. The developers of the Double Diamond Ranch and the Double Diamond commercial site would save a considerable sum in channel excavation costs and in needed channel rights-of-way, if the flows were reduced to ten percent of present.

This detention facility would not significantly affect the design for the Huffaker Basin, but it would allow the full Thomas Creek flows to ultimately be delivered there. The combination of the two basins would solve a number of flooding problems in the South Truckee Meadows. Further study is needed to investigate this proposal and recommendations are included in the final section of this report for further action.



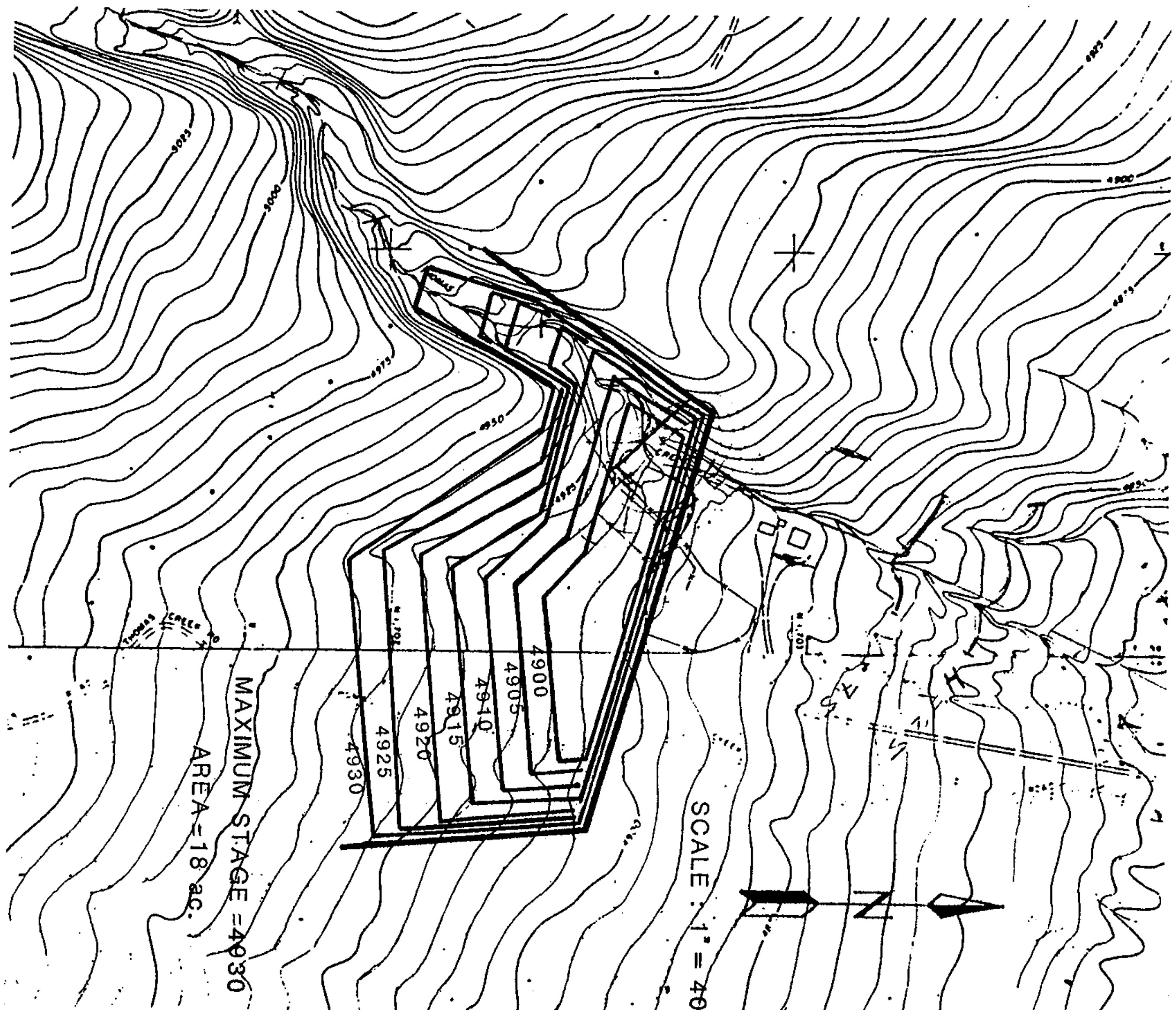


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FIGURE 15

PROPOSED THOMAS CREEK DETENTION BASIN

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STRUCTURE SITING AND CONFIGURATION

The site proposed for the Huffaker Hills Detention Facility is the present alignment of the Mira Loma Haul Road between the Huffaker Hills and the western slope of the Virginia Range. This area is known as the Huffaker Narrows and is a natural constriction in the Steamboat Creek floodplain on the Bella Vista Ranch. The site is also the confluence of Whites, Thomas and Steamboat Creeks.

The area immediately upstream of the dam is undeveloped and presently used as pasture for cattle grazing. The adjacent areas are also undeveloped, although as previously noted plans are underway for large scale residential and commercial development. Since the land is not developed, plans can be prepared to be compatible with the detention basin as building occurs.

Immediately downstream of the dam site, the northern portion of the Bella Vista property is still being utilized for agriculture, but a portion of the property has been annexed to the City of Reno. Utility services are available on the properties to the north and west of the Bella Vista, and those services have been sized to accommodate full development of that portion of the property. It is quite likely that in the near future this parcel will be developed. The siting of the dam upstream of that property will provide the benefit of a decreased flood depth and velocity and a flow that can be easily contained in a channel, if desired.

Adjacent to the Bella Vista Ranch's northern boundary is the Brookside Lakes Golf Course, which is currently being constructed by the City of Reno and completion is imminent. The golf course was developed within the floodway of Steamboat Creek and the greatest portion of the flow during a 100 year event is now contained within a flood control channel and the central wetlands. Property adjacent to the golf course has been master planned for residential development and a tentative map has been approved for the first phase. The developer of that project is required to build a portion of Mira Loma Drive as a condition of project approval. That project would certainly benefit from a reduced discharge and structures that are now planned as bridges could be downsized to box culverts.

Two configurations (or alignments) were examined for the actual dam structure. The first alignment follows the present alignment of the Mira Loma Haul Road and a portion of the structure will be within the 80 foot right-of-way presently owned by Washoe County. The concept is to use the top of the dam to replace the present roadway. This configuration will involve the least environmental impacts and the area of wetlands to be filled would be less than one acre. A 404 Permit would not be required for a public agency, if the wetlands impacted are less than an acre, as it can be constructed under a nationwide permit.

The second alignment evaluated is shown on Figure 16. It appeared to be a preferable alignment because it would involve less fill; however, the savings in fill, 7,000 cubic yards, will be more than offset by the cost of relocating Mira Loma Haul Road. This alignment will also require the purchase of a greater amount of right-of-way for the structure itself. Since the cost savings in fill would be more than offset by road relocation, additional right-of way and

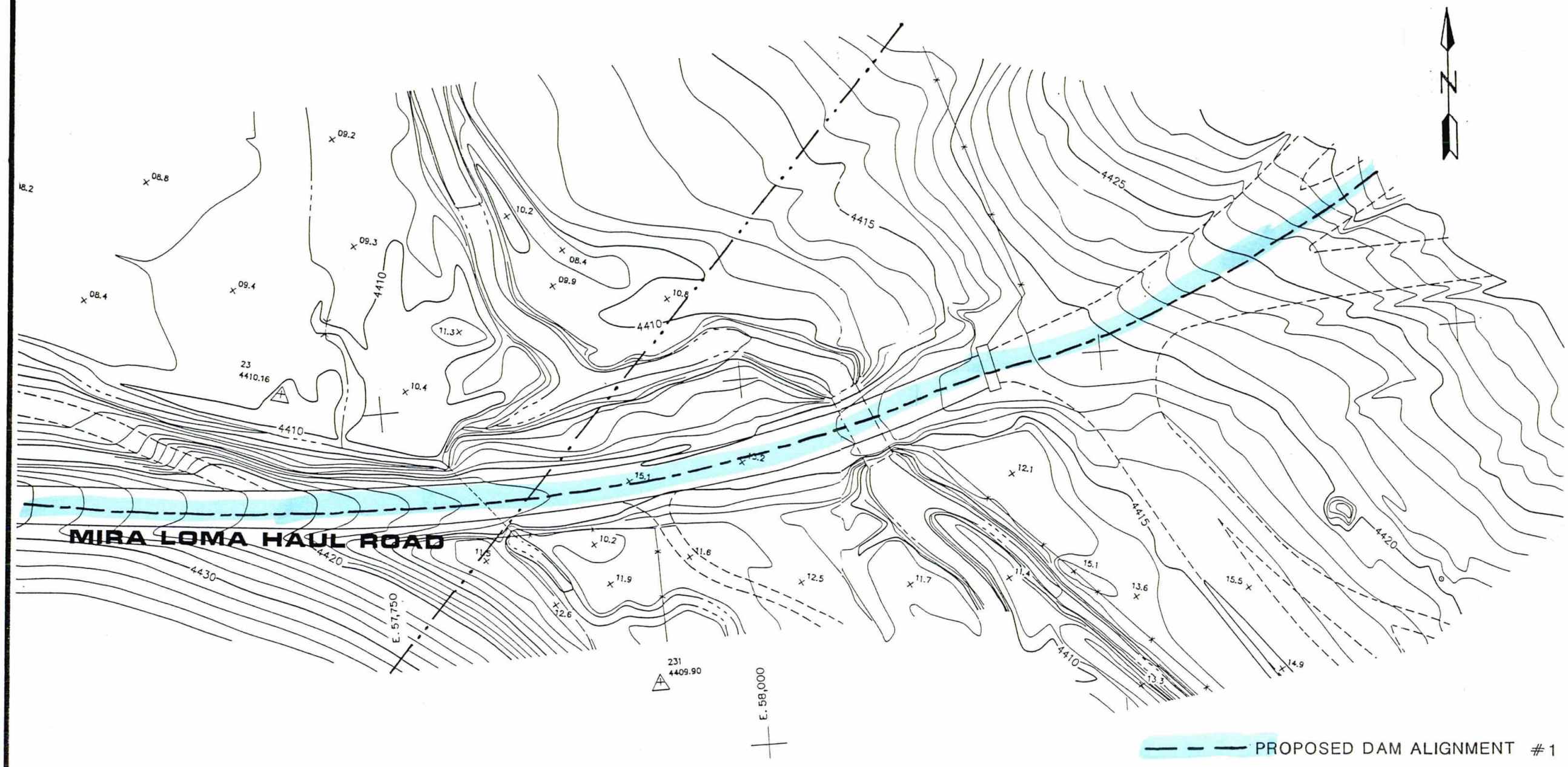

FIGURE 16

PROPOSED DAM ALIGNMENT

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permitting costs, this alignment was not considered and final cost estimates were not developed for the dam at this location.

As noted earlier, the geotechnical report recommended a rockfill or earthfill dam. This recommendation was based upon the poor foundation conditions that were encountered in their investigation. The area of the east abutment was found to be suitable for an emergency spillway as it is a rock outcropping. Hydraulic evaluations of a structure which would pass a Probable Maximum Flood (PMF) through a spillway, revealed that the flood pool would become much more extensive than originally anticipated and that right-of-way costs would become prohibitive. In order to minimize costs, the concept of a dam with an emergency spillway was rejected in favor of developing a 100 year design which would be capable of withstanding overtopping in a PMF event. The plan and profile of the preferred dam is shown in Figure 17.

The analysis prepared for this report is based upon a 100 year 24 hour design storm. No calculation of PMF flows were included in the scope of services. The values which were developed by the Corps of Engineers have been utilized for preliminary analyses. A rockfill structure can withstand overtopping for some period of time; however, it will not withstand prolonged overtopping without the addition of some type of facing. Further discussions were held with the geotechnical consultants, Harding Lawson and Associates, and it was agreed that concepts that should be further explored would be an earthfill or rockfill structure which would be faced with roller compacted concrete (or soil cement), rock or riprap covered with welded wire fabrics, or gabions (wire baskets filled with rock). Typical sections of a dam with these type of facings can be found on Figures 18 and 19.

Preliminary analysis of the impacts of a PMF event, indicates that the detention structure will have very little effect on the flooding downstream. The flood pool will be "drowned out" and the peak flows will be minimally reduced. During the design concept phase a dambreach analysis should be performed. That anaysis was not included in the scope of work for this project.

FLOOD POOL ALTERNATIVES

Three alternatives were evaluated for the flood pool configuration. Due to the extremely flat terrain, levees to protect the existing sand and gravel operation and planned development on the Double Diamond are needed. These levees were discussed with the local sponsors and with the Corps of Engineers and it was determined that they sould be built to the elevation of the flood pool which will be developed by passing the PMF through the structure.

The first option was construction of the dam with no other structural improvements except the protection of the existing sand and gravel mining operation. This alternative is shown on Figure 20. As can be noted on the figure, this alternative will inundate a large area of the Double Diamond project which has already been master planned. Efforts have been made

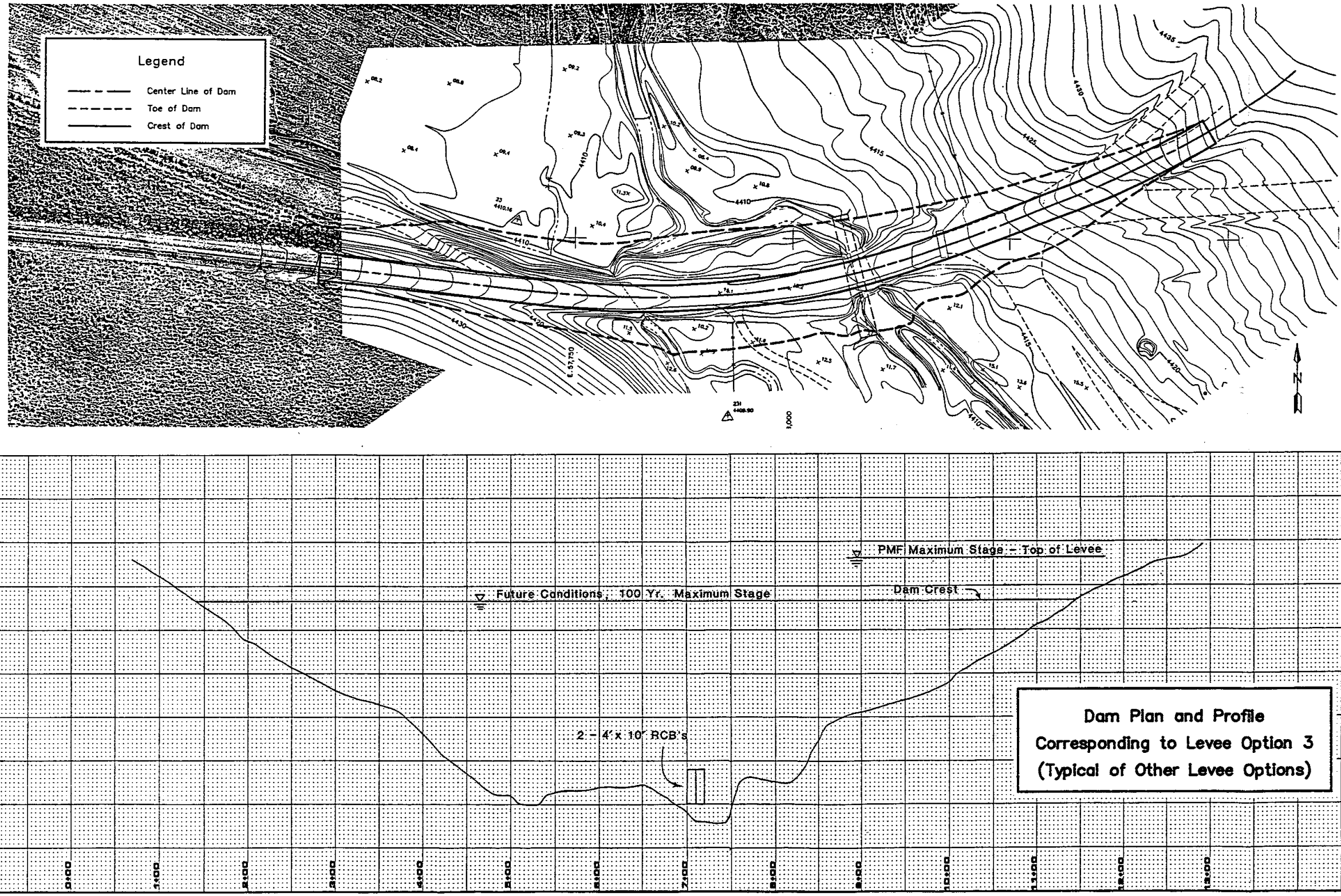

FIGURE 17

DAM PLAN AND PROFILE

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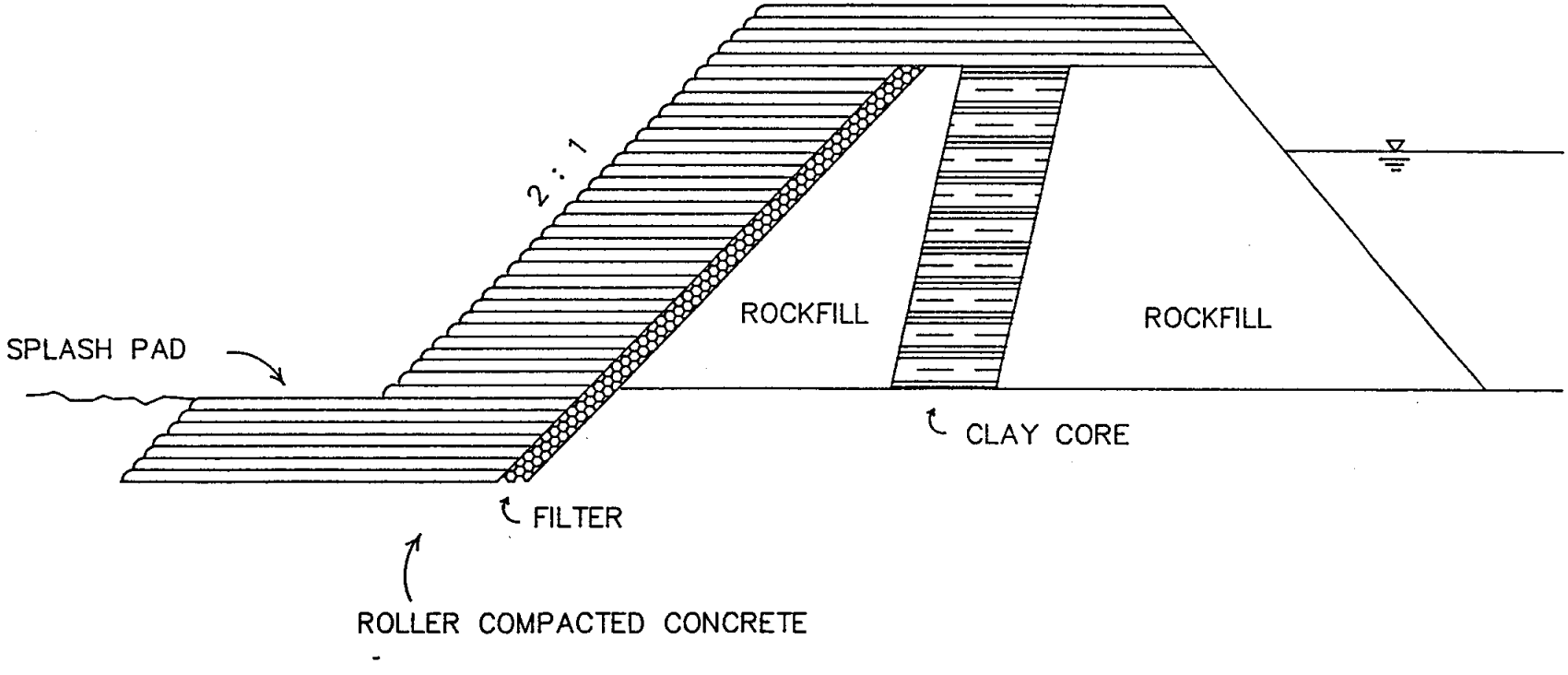

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FIGURE 18

RCC FACED DAM
TYPICAL CROSS SECTION

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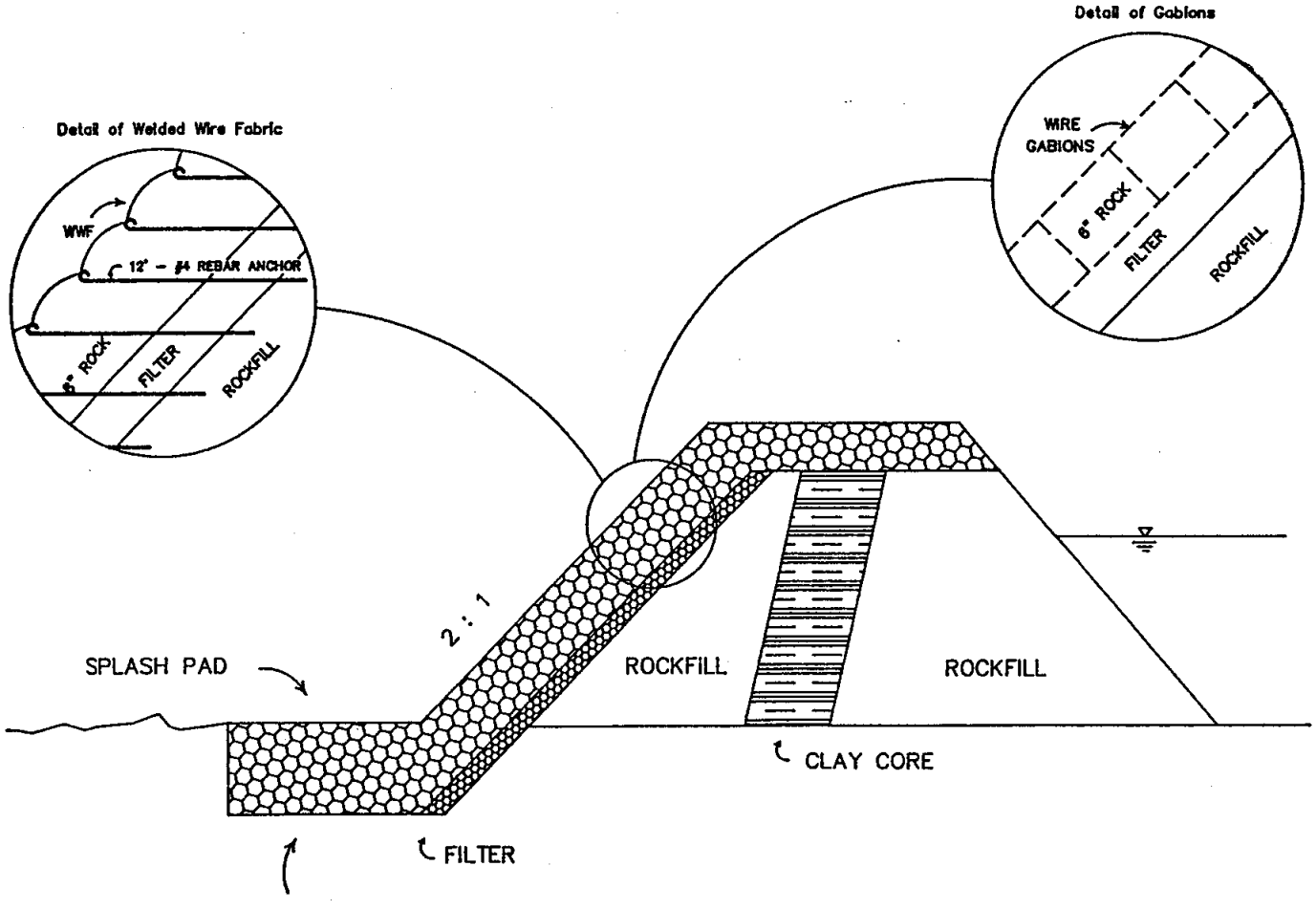

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FIGURE 19

GABION OR WWF FACED DAM TYPICAL CROSS SECTION

DATE : FEBRUARY 1990

JOB # : 8909

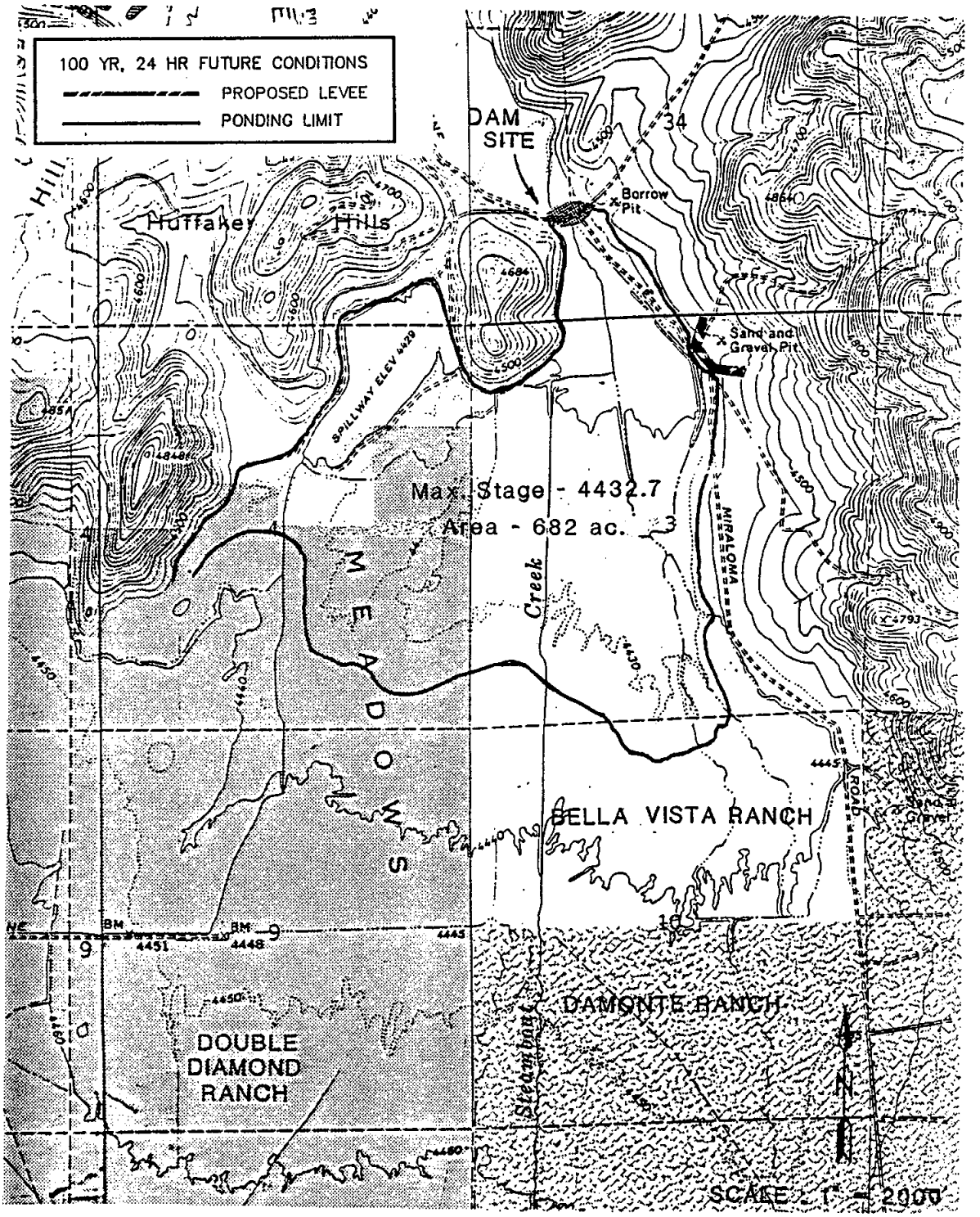

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FIGURE 20

DETENTION DAM
without levee
OPTION 1

DATE: DECEMBER 1989
JOB #: 8909

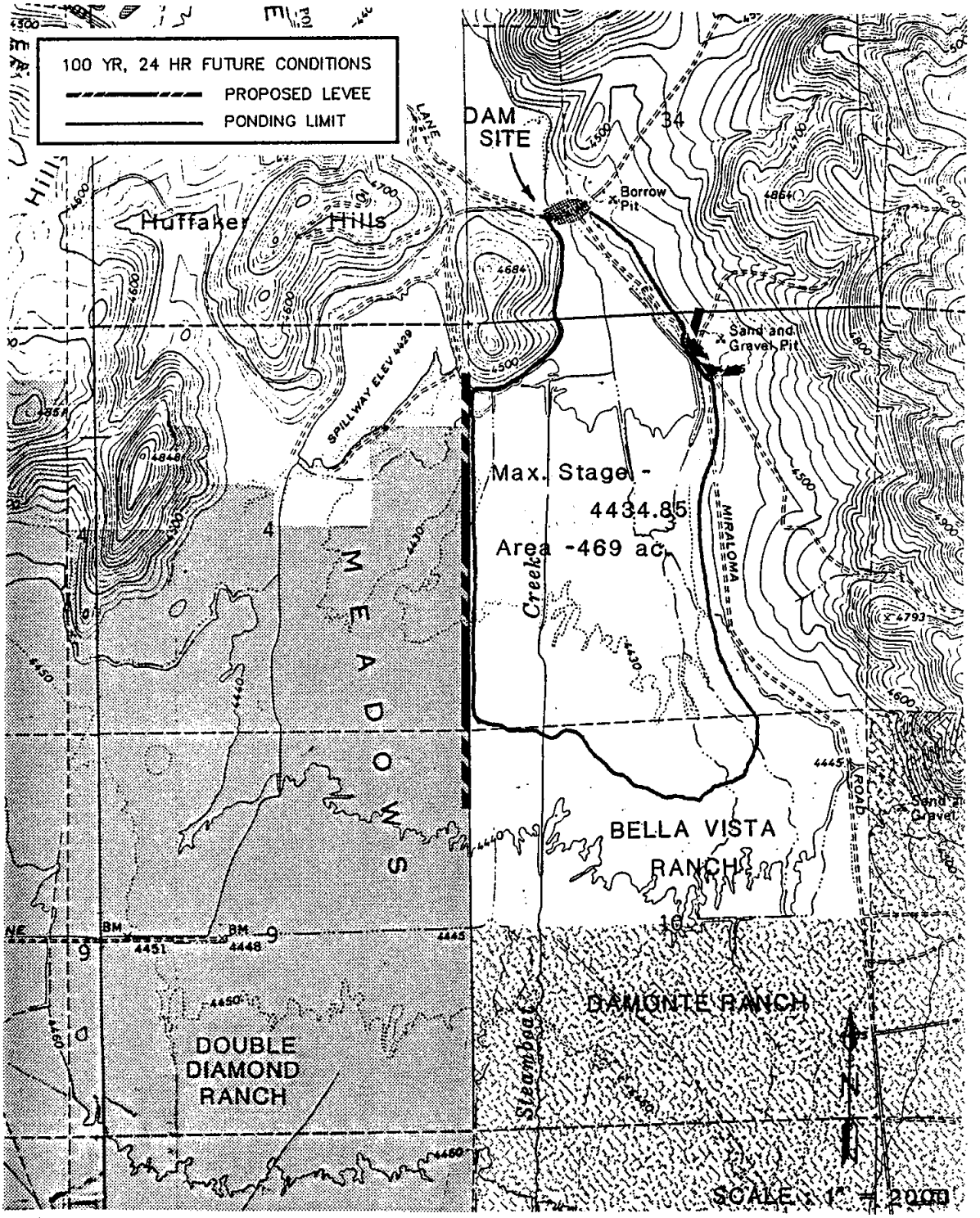

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FIGURE 21

DETENTION DAM with levee OPTION 2

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JOB #: 8909

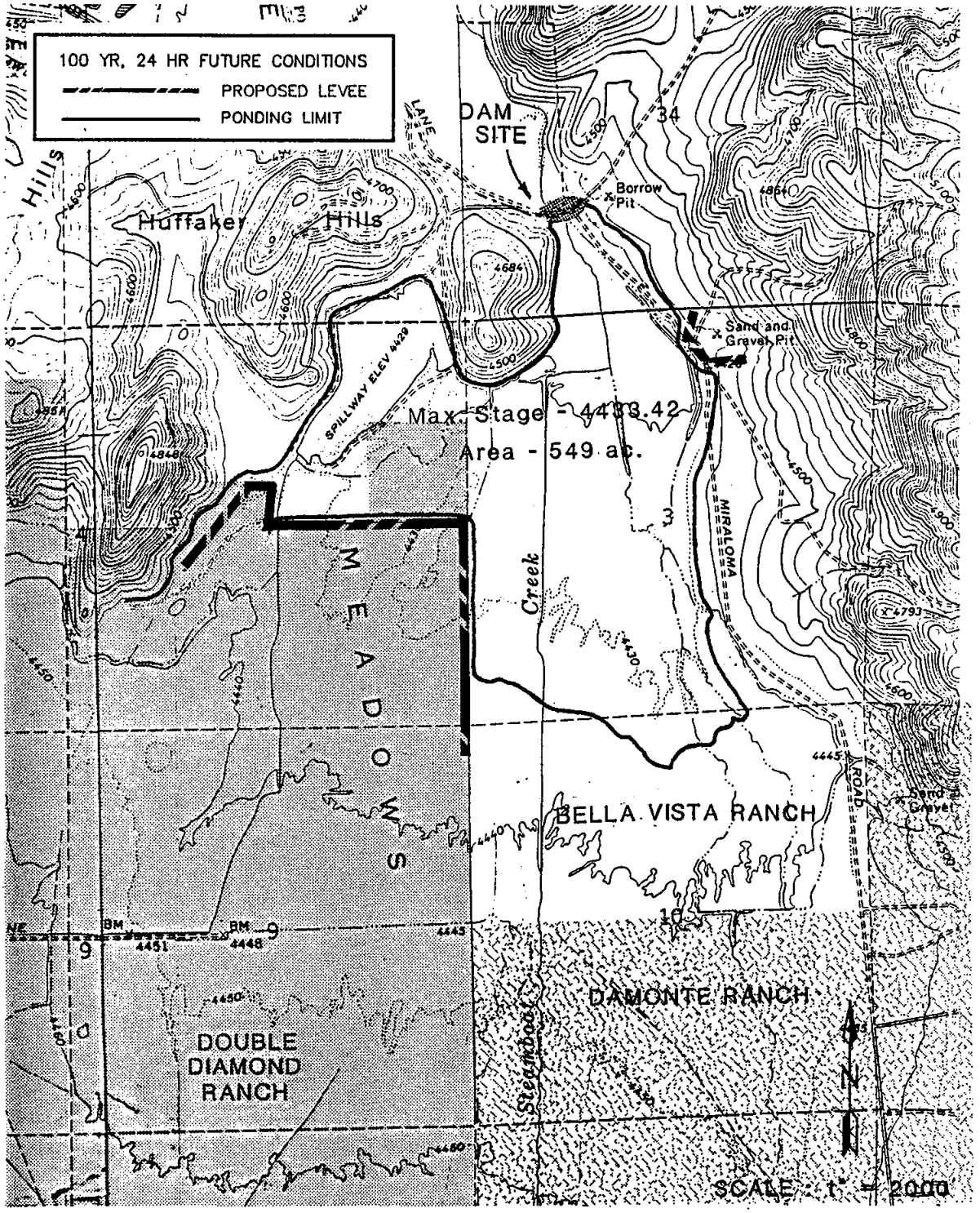

FIGURE 22

DETENTION DAM with levee OPTION 3

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during the course of this study to minimize impacts on the Double Diamond because of this Master Planning effort.

This first alternative would produce a project with the greatest amount of flexibility and with the least amount of environmental impact. If the entire holdings of the Bella Vista which are upstream of the dam structure could be acquired, perhaps a trade could be developed for some of the affected Double Diamond property. This configuration would allow the Double Diamond to develop a more natural drainage pattern. A portion of that development also includes a golf course which could be placed within the fringe of the proposed flood pool.

The second option, which is shown on Figure 21, includes the dam, levee protection for the sand and gravel operation and the Double Diamond project. This would be a feasible option; however, it will require the addition of drainage structures through the levee or a pumping station in order to provide drainage for the northern part of the Double Diamond. That area could be completely filled and regraded to drain to the southwest. The Thomas Creek channel would have to remain on its present alignment along Mays Lane in order reach the basin with this option. No official wetlands delineation exists for the Bella Vista property so the impacts of the levees on wetlands, and the possible complications of meeting Section 404 requirements would have to be addressed.

The height of the levee that would protect the Double Diamond development would be an average of 10 feet high with a maximum height of 18.7 feet. This would certainly have a visual impact on the proposed development. It would also impact the grading and drainage scheme. Currently no grading plans are available for the project. It is assumed that some fill would be required for the lower elevations near the north east property corner, but in general the present contour of the land would be maintained.

The third alternative includes the dam, levee protection for the sand and gravel operation, inundation of the northern forty acres of the Double Diamond, and a levee to protect the remainder. The configuration for the option is shown on Figure 22. This option appears to be much more desireable than option 2, because it would give some flexibility to the Double Diamond for drainage, and Thomas Creek could enter the detention pool at the northwesterly corner of the levee or on the Mays Lane alignment. The levees required for this option are quite high but not as extensive as those for option 2, with a maximum levee height of 10 feet and an average height of 6 feet.

Cost estimates for each flood pool option in conjunction with the recommended dam designs have been prepared and are summarized in Table 5. The supporting data for these estimates are included in the appendix. The cost for right-of-way is based upon the purchase of the footprint for the dam and levees, as well as the area of inundation of the 10 year flood pool; the cost for the 100-year pool is included as an easement. The cost for acreage was based upon figures obtained from the Washoe County Public Works Department staff and a comparison of the recent sales price of the unimproved Double Diamond property. This value is considered to be high for the southern Bella Vista which is wetlands, and a great portion will also lie within the Steamboat Creek floodway, if a detailed Flood Insurance Study were to be conducted. A proper appraisal will be needed after wetlands and floodways are delineated. Also included in fee is the cost of the Double Diamond land which lies in the 100-year flood

pool. Construction costs were based upon recent bid prices in the vicinty and upon values obtained from Reference 43.

TABLE 5 COST ESTIMATES

COST SUMMARY – LEVEE OPTION 1

RCC FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		249,600
Roller Compacted Concrete Facing		994,500
Levees		72,005
Mira Loma		952,369
	Sub Total =	2,630,856
Right of Way		3,220,750
Contingencies (20% Const. Cost)		526,171
Engineering and Construction Mgmt. (12% Construction Cost)		315,703
	TOTAL COST =	6,693,480

what portion is from Double Diamond? cost sharing?

GABION FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		249,600
Gabion Facing		715,500
Levees		72,005
Mira Loma		952,369
	Sub Total =	2,351,856
Right of Way		3,220,750
Contingencies (20% Const. Cost)		470,371
Engineering and Construction Mgmt. (12% Construction Cost)		282,223
	TOTAL COST =	6,325,200

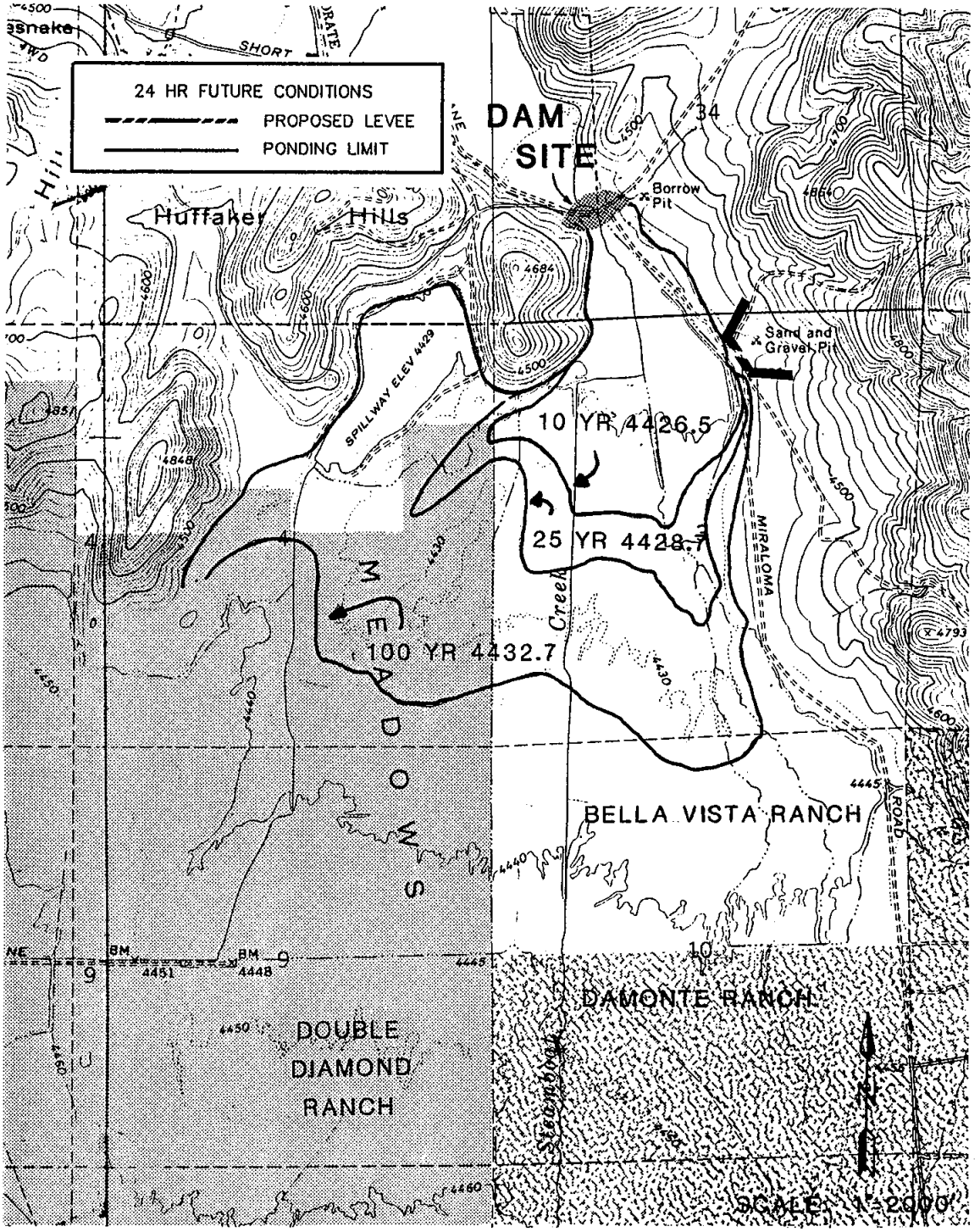
WELDED WIRE FABRIC FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		249,600
Welded Wire Fabric Facing		151,388
Levees		72,005
Mira Loma		952,369
	Sub Total =	1,787,744
Right of Way		3,220,750
Contingencies (20% Const. Cost)		357,549
Engineering and Construction Mgmt. (12% Construction Cost)		214,529
	TOTAL COST =	5,580,572

COST SUMMARY – LEVEE OPTION 2

RCC FACE	
Structure at Dam	130,485
Roadways at Dam	80,897
Clearing and Grubbing	24,500
Excavation at Dam	66,500
Filter	60,000
Placed Rockfill	300,000
Roller Compacted Concrete Facing	994,500
Levees	572,961
Mira Loma	952,369
Sub Total =	3,182,212
Right of Way	2,122,250
Contingencies (20% Const. Cost)	636,442
Engineering and Construction Mgmt. (12% Construction Cost)	381,865
TOTAL COST =	6,322,770
GABION FACE	
Structure at Dam	130,485
Roadways at Dam	80,897
Clearing and Grubbing	24,500
Excavation at Dam	66,500
Filter	60,000
Placed Rockfill	300,000
Gabion Facing	715,500
Levees	572,961
Mira Loma	952,369
Sub Total =	2,903,212
Right of Way	2,122,250
Contingencies (20% Const. Cost)	580,642
Engineering and Construction Mgmt. (12% Construction Cost)	348,385
TOTAL COST =	5,954,490
WELDED WIRE FABRIC FACE	
Structure at Dam	130,485
Roadways at Dam	80,897
Clearing and Grubbing	24,500
Excavation at Dam	66,500
Filter	60,000
Placed Rockfill	300,000
Welded Wire Fabric Facing	151,388
Levees	572,961
Mira Loma	952,369
Sub Total =	2,339,100
Right of Way	2,122,250
Contingencies (20% Const. Cost)	467,820
Engineering and Construction Mgmt. (12% Construction Cost)	280,692
TOTAL COST =	5,209,862

COST SUMMARY – LEVEE OPTION 3

RCC FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		267,000
Roller Compacted Concrete Facing		994,500
Levees		458,913
Mira Loma		952,369
	Sub Total =	3,035,164
Right of Way		2,455,375
Contingencies (20% Const. Cost)		607,033
Engineering and Construction Mgmt. (12% Construction Cost)		364,220
	TOTAL COST =	6,461,791
GABION FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		267,000
Gabion Facing		715,500
Levees		458,913
Mira Loma		952,369
	Sub Total =	2,756,164
Right of Way		2,455,375
Contingencies (20% Const. Cost)		551,233
Engineering and Construction Mgmt. (12% Construction Cost)		330,740
	TOTAL COST =	6,093,511
WELDED WIRE FABRIC FACE		
Structure at Dam		130,485
Roadways at Dam		80,897
Clearing and Grubbing		24,500
Excavation at Dam		66,500
Filter		60,000
Placed Rockfill		267,000
Welded Wire Fabric Facing		151,388
Levees		458,913
Mira Loma		952,369
	Sub Total =	2,192,052
Right of Way		2,455,375
Contingencies (20% Const. Cost)		438,410
Engineering and Construction Mgmt. (12% Construction Cost)		263,046
	TOTAL COST =	5,348,884



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3710 Grant Dr., Suite D · Reno, NV 89509
MAIL: P.O. Box 10220 · Reno, NV 89510
(702) 689-8630

FIGURE 23

PONDING LIMITS

DATE : FEBRUARY 1990
JOB # : 8909

RECOMMENDATIONS AND CONCLUSIONS

The purpose of this study was to assess the feasibility of a detention facility for flood control in the Upper Truckee Meadows. Three possible options have been identified for the facility and each is feasible. Other considerations for this facility which have not been discussed are:

1. the preservation of open space and wetlands.
2. potential wetlands enhancement.
3. possible water quality improvement.
4. possible open space recreational uses.
5. reduction of peak flood stage at Vista on the Truckee.
6. potential for open water areas for waterfowl.

The Upper Truckee Meadows is currently the site of a local controversy involving the preservation of wetlands. The Nevada State Highway Department, Double Diamond Commercial Site, and the Double Diamond Development are all required to meet the provisions of Section 404 of the Clean Water Act and preserve wetlands now existing on properties where construction is proposed. If the wetlands cannot be preserved, the creation of new wetlands will be required. The area which will be reserved for a flood pool if this facility is built would be an ideal area in which to construct new wetlands.

The construction of new wetlands will have a beneficial effect on water quality in the Steamboat Creek and the Truckee River. Other options which could be explored for the water quality improvement would be the construction of sedimentation ponds. These ponds would reduce the amount of sediment in Steamboat Creek and provide open water areas for waterfowl. The upper elevations of the proposed detention area may be suitable for use as recreational facilities, i.e. soccer fields, baseball diamonds, etc. With the incorporation of open water ponds, a possible interpretive center could be developed for wildlife observation.

The Corps of Engineers is currently proceeding with preparation of a General Design Memorandum for construction of a large flood control facility within the Truckee Meadows. The design concept includes the construction of a detention basin on the University Farms property adjacent to the Truckee River. This basin is intended to store the increase in peak flows which will occur at the Vista gauge as a result of channelization and construction of levees which will confine overbank flows to the channel.

It is possible that the detention facility at Huffaker Hills will lower those peak flows sufficiently to eliminate the need for the basin proposed at the University Farms. In order for Huffaker Hills to be incorporated into the Corps of Engineers Project, an agreement would have to be signed prior to construction of the facility. The Huffaker basin and the construction of Mira Loma Drive could be considered to be a replacement of the Pembroke Bridge relocation and University Farms basin. The costs for those facilites which is given in the Corps of Engineers February 1985 Feasibility Report for the Truckee Meadows Project is $3.6 million for Pembroke and $ 13,690,000 for the basin (both costs are in 1985 dollars).

Listed below are the advantages and disadvantages of all three configuration options which have been discussed in this report, along with a no-build option.

Option No. 1
Advantages
-No levees required to protect residential uses
-Lower construction cost
-Preservation of all existing wetlands
-Natural drainage can be maintained
-Lower maintenance cost
-Lower flood pool
-Reduced floodway on northern Bella Vista (190+acres)

Disadvantages
-Large amount of Double Diamond inundated

Option 2
Advantages
-All flood pool remains on southern Bella Vista
-Reduced floodway on northern Bella Vista (190+acres)

Disadvantages
-Pumping station or other special drainage structures required
-Levee heights excessive
-Thomas and Whites Creeks must enter south end

Option 3
Advantages
-Lower construction cost than option 2
-Drainage patterns for Whites and Thomas Creeks maintained
-Reduced floodway on northern Bella Vista (190+acres)

Disadvantages
-Levees protect residential development
-40 acres of Double Diamond needed
-Restricts Double Diamond grading and drainage

No-Build Option
Advantages
-No capital cost to county or City

Disadvantages
-Detention required for Damonte and Double Diamond
-Structural measures to return channelized flow to sheet flow
-Increased cost for all weather access to Hidden Valley

-University Farms detention basin required for Corps project
-The major portion of the Bella Vista remains in the floodway

It is our recommendation that the options one and three be further explored. Either option would develop a project which would benefit the Truckee Meadows area. The rock filled dam should be used as the basis for design with suitable facing or armouring to be explored in more depth once further geotechnical studies are developed.

Further action that needs to be taken prior to beginning final design of a structure includes preparing a submittal to the Corps of Engineers. This submittal should request a formal statement from the Corps on inclusion of the basin into the Truckee Meadows project and an agreement on design requirements for the facility, if it can be constructed by locals and included within the project. To date informal discussions have been held with them, but no written information has been exchanged.

Further geotechnical investigation is needed prior to beginning design, in order to establish the extent of unsuitable foundation material that must be excavated. Borings will also be needed along levee alignments to determine the potential settlement of those structures.

The Thomas Creek basin should be pursued as a separate project. This basin would remove a number of residences from the floodplain and would benefit downstream developers. Preliminary discussions were held with the Nevada Department of Transportation during the course of this study, and they have indicated that they would endorse the proposal and possibly participate in funding. The basin was also discussed with representatives of large parcel owners and they indicated that they felt that the project should be pursued.

The Thomas Creek basin could possibly qualify for a fifty-fifty cost sharing as a small watershed project with the Corps of Engineers. This funding can be pursued by requesting a reconnaissance level study and letting the Corps do the preliminary work which will take about 2 1/2 years, or the predesign can be done by a local sponsor working with the Corps and the project could be funded within one year. The construction time table for the extension of Interstate 580 may dictate the latter option.

Since a number of issues remain unresolved at the completion of this study, it is difficult to develop a specific recommendation; however, it is important to note that a dam at the Huffaker Narrows can provide cost savings in the following areas:

$3,600,000 Pembroke Drive relocation
13,690,000 University Farms structure and land
150,000 Wetlands mitigation for I-580
1,400,000 Additional cost for Mira Loma Drive
500,000 Detention cost for Double Diamond (land and excavation)
500,000 Detention cost for Damonte Ranch (land and excavation)

Additionally, 190 acres of the northern portion of the Bella Vista Ranch would be removed from the floodway, increasing the value of that land from $6500 per acre to over $20,000 per acre, an increase of more than $2,500,000. Construction of the detention facility will also assist the Reno Cannon Airport Authority in their efforts to remove the waterfowl from the

airport approach area. This benefit is difficult to quantify. Aircraft have in the past lost an engine and been forced to make an emergency landing; elimination of the cost of repair for the aircraft and the potential for loss of life would be the greatest benefits of reducing the waterfowl population within the airport approach and property boundary.

In summary, this detention basin project has definite benefits to the Truckee Meadows area. Those benefits exceed the estimated project cost for any of the options explored. The approach which we recommend for pursuing the project is to begin preliminary talks with the owners of the Bella Vista and the Double Diamond to explore their level of interest in the project. Previous indications from the owner of the Bella Vista were that he did not favor the project and would not cooperate. If the benefits of the proposed project are properly presented, he may be persuaded to change his approach. Conversations with Summitt Engineering have indicated that at least 40 acres will be required for on-site detention for the Double Diamond Project. Incorporation of that 40 acres into the detention facility would accomplish a great deal more good than maintaining a separate basin.

Our recommendation is that Option 1 be pursued as the preferred alternative:

1. The dam site, the 10 year flood pool and the levee footprint be purchased in fee, as well as the 100-year flood pool easement on the Bella Vista. The negotiated purchase price should take into account at least 50% of the furture increase of the land value of the downstream property ($1,000,000 approx.). If ranching operations continue on the Bella Vista the easement can be used for grazing. When the Corps project is built, the remaining property will be purchased in fee (see number 5 which follows).

2. An easement should be negotiated with the Double Diamond at no cost. Granting of the easement will relieve the Double Diamond of their obligation to construct and maintain stormwater detention facilities. The easement can be used for recreation and open space. Engineering fees for a project redesign or density transfer credits could also be offered.

3. The rockfill dam with gabions or welded wire fabric and rip-rap facing be built to the level of the 100-year flood pool. This structure is the least costly, more aesthetically pleasing and the foundation excavation will cause the least amont of disturbance. It is our opinion that this structure would be the safest and the least costly to maintain due to its flexibility.

4. An agreement should be negotiated with the Brookside Lakes Partnership, that the Mira Loma Drive extension will be built by them concurrently with the dam.

5. An agreement should be reached with the Corps of Engineers and formalized, that this project is being built in lieu of the Pembroke bridge and the University Farms Detention Basin and is being built to a satisfactory standard. The remaining flood pool easement should then be purchased in fee from the

Bella Vista with a portion of the funds designated for the wildlife enhancement element in the Corps budget.

If the above outlined approach is pursued sucessfully, the detention facility can be built by local interests for approximately $ 3.5 million actual expense. Contributions toward the facility should be sought from the owners of the Damonte Ranch, Double Diamond Commercial site. the Nevada Department of Transportation, and the Washoe County Airport Authority.

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APPENDIX

GEOTECHNICAL REPORT

A Report Prepared for:

Nimbus Engineers
3710 Grant Drive, Suite D
Reno, Nevada 89509

PRELIMINARY GEOTECHNICAL INVESTIGATION
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

HLA Job No. 19,526,001.05

Prepared by:

Heidi L. Lohn
Staff Engineer

Scott S. Smith
Civil Engineer - 6853 (NV)

Harding Lawson Associates
940 Matley Lane
Reno, Nevada 89502
(702) 329-6123

November 10, 1989

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I. INTRODUCTION

General

This report presents the results of our preliminary geotechnical investigation for the proposed embankment dam and dikes for the Huffaker Hills Detention Basin. The embankment dam will be located at the north end of the South Truckee Meadows where the Mira Loma Haul Road crosses Steamboat Creek. The detention basin is intended to retain runoff from the 100 year storm event. This will result in a water storage elevation of approximately 4,435 feet. This will require a maximum embankment elevation of approximately 4,440 feet, resulting in a maximum embankment height of approximately 30 feet. In addition to the main embankment dam, it will be necessary to construct dikes along the Mira Loma Haul Road and in front of Alexander Lake to prevent the retained flood waters from flooding the existing haul road and gravel operations, and Alexander Lake, respectively.

Our original scope of services was based on an embankment alignment approximately parallel to and immediately south of the Mira Loma Haul Road. Our exploration trenches were therefore located for this scheme. However, as can be seen from Plate 2, the current alternative embankment alignment is slightly north of the Mira Loma Haul Road. Subsoil evaluations were made by applying the findings from the exploration holes south of the Mira Loma Haul Road to the alternative alignment. It should be recognized the conditions represented may not accurately represent actual conditions along other alignments.

Purpose

The preliminary geotechnical investigation was intended to evaluate geologic conditions at the proposed site. This included an evaluation of the foundation characteristics at the proposed embankment dam location and at the proposed location of the dikes. A potential location or design

scheme for the emergency spillway was also considered. Near site embankment borrow source alternatives were also investigated.

Scope

The scope of our services included the following:

1. Review available published and unpublished geologic literature.
2. Perform one day of geologic field mapping.
3. Perform one day of subsurface foundation exploration with a backhoe at the proposed main embankment and dike locations.
4. Analyze the field and office geotechnical data.
5. Prepare a written report containing:
   a. Plans showing summary of geologic mapping and location of trenches.
   b. Summary logs of trenches and laboratory testing.
   c. Preliminary conclusions and recommendations with regard to:
      - Foundation Support.
      - Evaluation of alternative embankment sections.
      - Evaluation of emergency spillway schemes.

II. FIELD EXPLORATION

Geologic Field Mapping

Our geologist mapped geologic exposures in the field. The results of our literature review and geologic field mapping are summarized on the geologic map on Plate 2. The map summarizes the major geologic formations.

Subsurface Exploration

A total of 6 test pits were excavated utilizing a rubber tired backhoe. Test Pits No. 1, 2, and 3 were located immediately south of the Mira Loma Haul Road near the alternative embankment alignment (Plate 2). Test Pit No. 4 was located farther south along the Mira Loma Haul Road where a dike may be required to protect the road and the gravel operation (Plate 1). Test Pit Nos. 5 and 6 were located south of Alexander Lake at the location where a dike may be required to protect the lake from flooding (Plate 1).

The trenches were logged and sampled by our field geologist. A pocket penetrometer was utilized to obtain an indirect measure of the unconfined compressive strength of some of the layers. Summary logs of the test pits are summarized in Plates 3 through 5. A direct shear laboratory test was performed. Results from the pocket penetrometer and the laboratory tests are summarized on the logs. The soils were characterized according to the Unified Soil Classification Method ASTM D-2487, as indicated in the Key to Test Data on Plate 6.

III. SITE CONDITIONS

Geology

The geology map on Plate 2 summarizes the results of our geology literature review and field mapping. The abutments of the embankment will be founded in the weathered, ryolite-dacite. The level valley area is underlain mainly by pleistocene lake deposits with some recent alluvium associated with the active drainages and fill soils associated with the road. No known faults cross this area.

Surface Conditions

The Mira Loma Haul Road crosses the site from east to west. It is built on fill soils. Steamboat Creek flows through the valley floor and under the road in a large culvert/bridge. The valley floor is covered with grass with varying amounts of brush. The abutment areas are covered with grass and sage brush.

Subsurface Conditions

Variable subsurface conditions were encountered in the three test pits at the proposed embankment location. Test Pit Nos. 1 and 2 encountered loose to dense silty sands and sands to a depth of approximately 4 feet. Two layers of peat were encountered in Test Pit No. 1 and one layer of peat was encountered in Test Pit No. 2 in this upper 4 feet. These peat layers ranged from 3 to 4 inches in thickness. A 1 foot thick layer of a soft silt was encountered at a depth of 2 feet in Test Pit No. 1. This silt exhibited very low compressive strength as indicated by the pocket penetrometer values. Stiff silty clay and sandy silt were encountered in the remainder of Test Pits Nos. 1 and 2 to full depth of the trenches. Test Pit No. 3 encountered medium dense to dense sand and silty sand. No peat was encountered in this test pit. All three test pits had heavy root growth from 8 to 12 inches deep. Groundwater was encountered at a depth ranging from 4 to 5 feet below grade.

Test Pit Nos. 4, 5, and 6 encountered loose to dense silty sands and sands. A 3 foot thickness of a stiff clay with sand was encountered at a depth of 5 feet in Test Pit No. 5. Groundwater was encountered at a depth of approximately 9, 6, and 4-1/2 feet in Test Pit Nos. 4, 5, and 6, respectively.

IV. CONCLUSIONS AND RECOMMENDATIONS

Foundation Support

The soft silt and peat layers encountered in Test Pit Nos. 1 and 2 are not adequate foundation materials for the proposed embankment. These materials will require overexcavation to depths of at least 5 feet. A final design foundation investigation will be required to delineate the area underlain by these materials that will require overexcavation. Deep borings should be drilled to confirm that the deeper foundation soils are adequate.

The subsoils encountered in Test Pit Nos. 4, 5, and 6 will provide adequate foundation support for the perimeter containment dikes that may be required.

Embankment Section

The embankment can be constructed either as a homogeneous earth-fill or as a rock fill with an earth-fill core. Depending on the final gradation of the earth-fill the homogeneous earth-fill dam may require a downstream blanket drain. Either scheme will provide the necessary retention for the 2 to 3 days the embankment would be required to impound water during storm conditions. For preliminary design purposes, the earth-fill embankment can be assumed to be constructed with 2:1 (horizontal:vertical) upstream and downstream slopes.

The rock fill embankment can be assumed to be constructed with 1.4:1 upstream and downstream slopes.

Borrow for the earth-fill could be obtained from the BLM borrow pit immediately east of the site. This material would require screening to remove the sizes larger than 6 inches. Based on gradation tests performed in this pit by the Nevada Department of Transportation (NDOT), on the order of 20 to 50 percent by weight of the material may be greater than 6 inches.

Borrow for the earth-fill embankment may also be obtained from the pasture land south of the project site. However, the thickness of available borrow material is limited because of the stripping that will be required to remove the organic laden surface soils and the shallow depth to groundwater. A very large area will therefore have to be borrowed to obtain the required volume.

Borrow for the rock fill scheme could be obtained from the existing rock quarry immediately east of the project site.

Emergency Spillway

An emergency spillway would not be required for the rock fill embankment scheme. Flood water can be allowed to overtop the embankment in a sheet flow.

The emergency spillway can be located in the left abutment in the case of the earth-fill embankment scheme. Depending on a ruling from the State Engineer, it may not be necessary to line the spillway. Unlined spillways excavated into bedrock have been allowed in the past, especially in the case of flood retention basins that impound water on an infrequent basis.

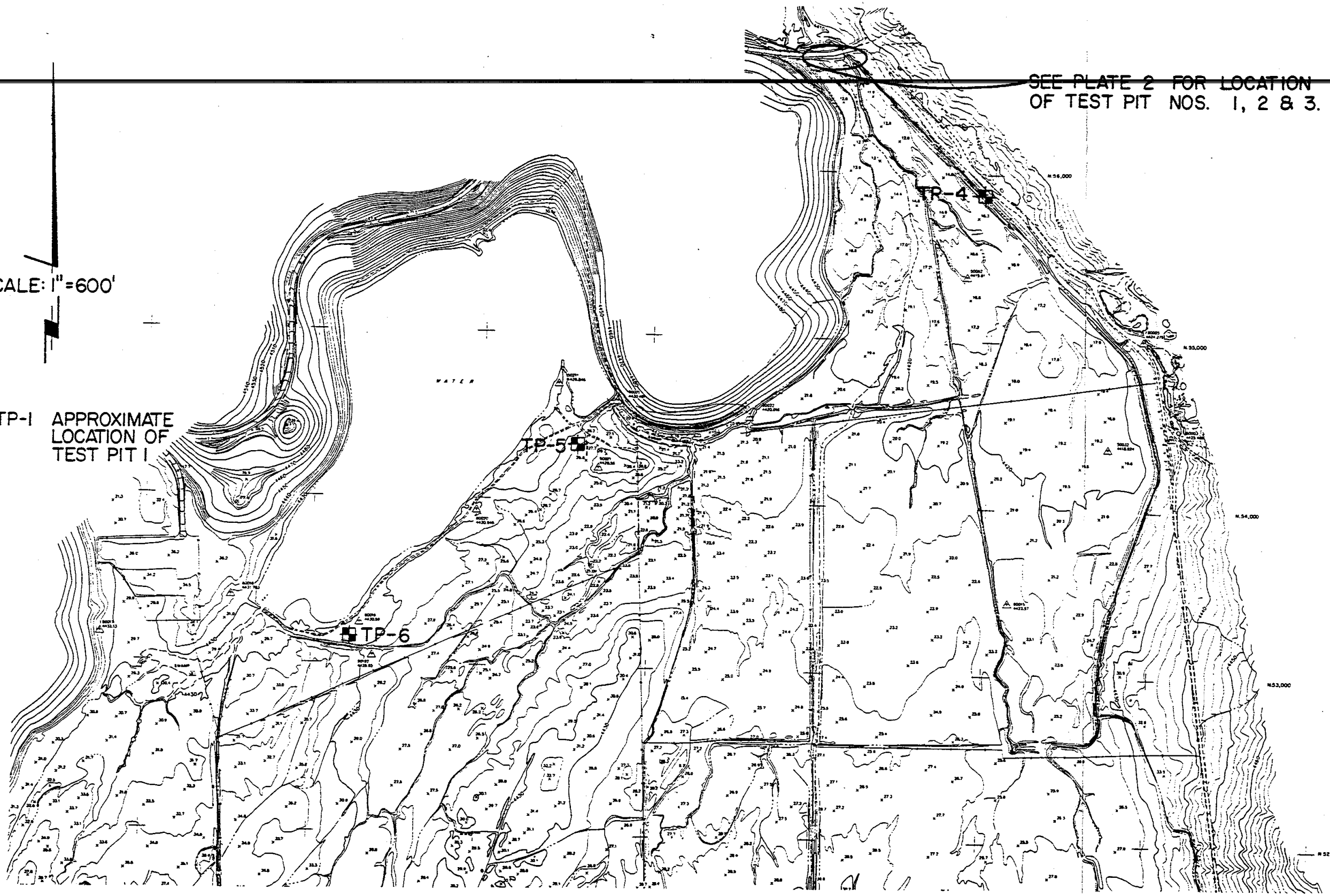
PLATES

Plate 1	Location of Test Pits
Plate 2	Geologic Map
Plates 3 through 5	Logs of Test Pits
Plate 6	Unified Soil Classification and Key to Test Data

SCALE: 1"=600'

TP-1 APPROXIMATE LOCATION OF TEST PIT 1

SEE PLATE 2 FOR LOCATION OF TEST PIT NOS. 1, 2 & 3.



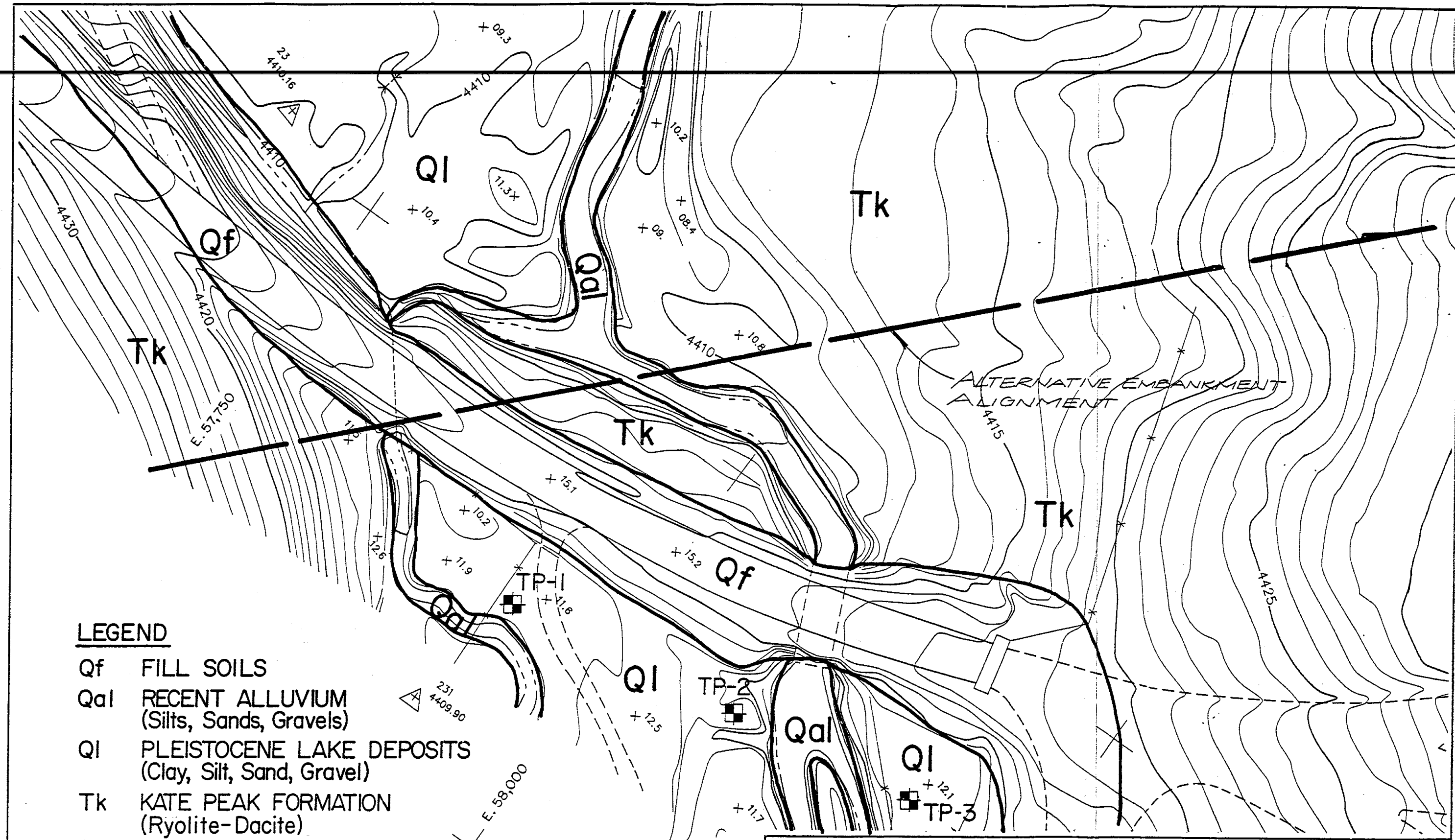
Harding Lawson Associates
Engineers and Geoscientists

LOCATION OF TEST PIT
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE 1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	19526,001.05				

109463



LEGEND

Qf	FILL SOILS
Qal	RECENT ALLUVIUM (Silts, Sands, Gravels)
Ql	PLEISTOCENE LAKE DEPOSITS (Clay, Silt, Sand, Gravel)
Tk	KATE PEAK FORMATION (Ryolite-Dacite)

TP-1 APPROXIMATE LOCATION OF TEST PIT 1

Harding Lawson Associates
Engineers and Geoscientists

SURFACE GEOLOGY MAP
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	19526,001.05				

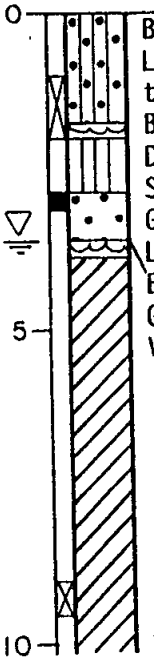
109463

LOG OF Test Pit 1

Equipment Backhoe

Elevation 4412 ± Date 10/18/89

Laboratory Tests	Moisture Content (%)	Dry Density (pcf)	Pocket Pen. (T/ft^2)	Depth (ft)	Sample
			1.25	0	
			1.50		
			0.25		
			0.50		
DS 1200 (500)	30	86	0.20		
				5	
				10	



BROWN SILTY SAND (SM)
Loose to medium dense, moist, roots to 8 inches
BLACK PEAT (PT)
DARK BROWN SILT (ML)
Soft, moist, organic odor
GRAY POORLY GRADED SAND (SP)
Loose, wet
BLACK PEAT (PT)
GRAY-BLACK SILTY CLAY (CH)
Very stiff, saturated, organic odor

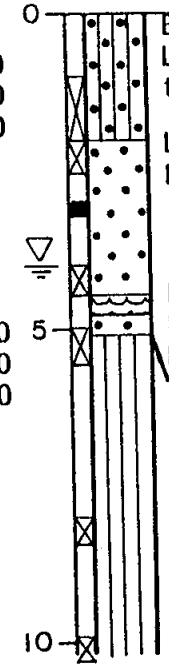
Trench terminated at 11.3 feet
Free water measured at 4.0 feet on 10/18/89

LOG OF Test Pit 2

Equipment Backhoe

Elevation 4411 ± Date 10/18/89

Depth (ft)	Sample
0	
2.50	
0.50	
1.00	
2.00	
2.00	
2.50	
5	
10	



BROWN SILTY SAND (SM)
Loose to medium dense, moist, roots to 9 inches

LIGHT GRAY POORLY GRADED SAND (SP)
Dense, moist, roots

BLACK PEAT (PT)
DARK BROWN POORLY GRADED SAND (SP)
Medium dense, saturated
GRAY-BROWN SANDY SILT (ML)
Stiff, saturated

Color change to dark gray
Cobbles at 10.0 feet
Trench terminated at 12.0 feet
Free water measured at 4.0 feet on 10/18/89

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOG OF TEST PITS 1 AND 2
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE 3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	19,526,001.05		11/3/89		

Laboratory Tests

Moisture Content (%)

Dry Density (pcf)

Pocket Pen. (T/ft^2)

Depth (ft) | Sample

LOG OF Test Pit 3

Equipment Backhoe

Elevation 4412 ± Date 10/18/89

0		BROWN POORLY GRADED SAND WITH SILT (SP), Medium dense, moist, roots to 1.0 feet
	3.00	BROWN SILTY SAND (SM)
	4.00	Dense to very dense, moist
	3.50	Cobbles at 3.0 feet
▽ 5		BROWN POORLY GRADED SAND WITH SILT AND GRAVEL (SP), Dense, saturated
10		Trench terminated at 10.0 feet Free water measured at 5.0 feet on 10/18/89

Depth (ft) | Sample

LOG OF Test Pit 4

Equipment Backhoe

Elevation 4418 ± Date 10/18/89

0	BROWN POORLY GRADED SAND WITH SILT (SP), Loose to medium dense, moist, roots to 8 inches
	Gravel and large cobbles at 3.0 feet
	BROWN-GRAY SILTY SAND (SM)
5	Loose to medium dense, moist to saturated
	Color change to gray, increasing density
	Large cobbles below 7.0 feet
▽	
10	Trench terminated at 10.0 feet Free water measured at 9.0 feet on 10/18/89

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOG OF TEST PITS 3 AND 4
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE 4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	19,526,001.05	SSJ	11/3/89		

Laboratory Tests

Moisture Content (%)

Dry Density (pcf)

Pocket Pen. (T/ft²)

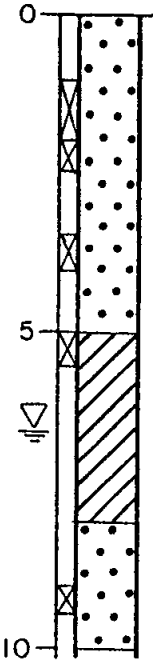
Depth (ft)

Sample

LOG OF Test Pit 5

Equipment Backhoe

Elevation 4428 ± Date 10/18/89



0

BROWN POORLY GRADED SAND WITH CLAY AND GRAVEL (SP), Dense, moist, trace silt, roots to 1.0 feet

Increasing silt, decreasing gravel

5

BROWN CLAY WITH SAND (CH)
Stiff, moist, occasional calcification

BROWN POORLY GRADED SAND (SP)
Dense, saturated, weathered cobbles

10

Trench terminated at 10.0 feet
Free water measured at 6.5 feet on 10/18/89

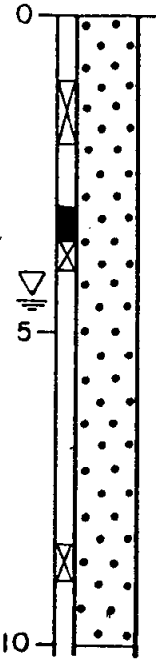
Depth (ft)

Sample

LOG OF Test Pit 6

Equipment Backhoe

Elevation 4430 ± Date 10/18/89



0

BROWN POORLY GRADED SAND (SP)
Loose to dense, moist to saturated
increasing gravel

Occasional calcification

5

Cobbles at 9.0 feet

10

Trench terminated at 10.0 feet
Free water measured at 4.5 feet on 10/18/89

HLA

Harding Lawson Associates
Engineers, Geologists & Geophysicists

LOG OF TEST PITS 5 AND 6
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE **5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
RLH	19,526,001.05	SB	11/3/89		

6196

MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP		POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC		CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP		POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL		ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION - ASTM D2487-85

Perm	—	Permeability
Consol	—	Consolidation
LL	—	Liquid Limit (%)
PI	—	Plastic Index (%)
G_s	—	Specific Gravity
MA	—	Particle Size Analysis
■	—	"Undisturbed" Sample
☒	—	Bulk or Classification Sample

Shear Strength (psf) ↓ ┌ Confining Pressure ↓

TxUU (FM) or (S)	3200	(2600)	—	Unconsolidated Undrained Triaxial Shear (field moisture or saturated)
TxCU (P)	3200	(2600)	—	Consolidated Undrained Triaxial Shear (with or without pore pressure measurement)
TxCD	3200	(2600)	—	Consolidated Drained Triaxial Shear
SSCU (P)	3200	(2600)	—	Simple Shear Consolidated Undrained (with or without pore pressure measurement)
SSCD	3200	(2600)	—	Simple Shear Consolidated Drained
DSCD	2700	(2000)	—	Consolidated Drained Direct Shear
UC	470		—	Unconfined Compression
LVS	700		—	Laboratory Vane Shear

KEY TO TEST DATA

Harding Lawson Associates
Engineers and Geoscientists

UNIFIED SOIL CLASSIFICATION AND
KEY TO TEST DATA
HUFFAKER HILLS DETENTION BASIN
WASHOE COUNTY, NEVADA

PLATE **6**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	19,526,001.05	SS	11/3/89		

DISTRIBUTION

6	Copies:	Nimbus Engineers 3710 Grant Drive, Suite D Reno, Nevada 89509
1	Copy:	Bound Report File
1	Copy:	Novato
1	Copy:	Job File

QUALITY CONTROL REVIEWER:

Dan L. Dyer
Associate Engineer

COST ESTIMATING INFORMATION

ROCKFILL DAM

ITEM DESCRIPTION	COST	/ UNIT	UNITS	COST
Structures				
- 2-4x10 at Dam Outlet - Concrete	375	/ cu.yd.	259	97,125
- Steel	1,200	/ ton	28	33,360
		Sub Total =		130,485
Roadways				
- Dirt road to gravel pit (Scraper)	1,500	/ day	1	1,500
- 4" AC on top of Dam	100	/ cu.yd.	370	37,000
- 6" ABC on top of Dam	27	/ cu.yd.	556	15,012
- Prime Coat	0.39	/ sq.yd.	3,333	1,300
- Dust Palative	0.33	/ sq.yd.	8,000	2,640
- Scale Relocation	1,500	ea.	1	1,500
- Guard Rail	12	/ lf	1,900	21,945
		Sub Total =		80,897
Clearing and Grubbing	3,500	/ ac.	7	24,500
Excavation at Dam Base (400 x 180 x 5' of organics)	5	/ cu.yd.	13,300	66,500
- Filter (bet. rockfill and facing)	15	/ cu.yd.	4,000	60,000
PLACED ROCKFILL DAM (includes impervious core)				
Option 1, Crest @ 4432.7	6	/ cu.yd.	41,600	249,600
Option 2, Crest @ 4434.9	6	/ cu.yd.	50,000	300,000
Option 3, Crest @ 4433.5	6	/ cu.yd.	44,500	267,000

ITEM DESCRIPTION	COST / UNIT	UNITS	COST
DAM FACING COSTS (slope protection)			
- Roller Compacted Concrete	65 / cu.yd.	15,300	994,500
- Gabions (complete)	100 / cu.yd.	7,155	715,500
- Welded Wire Fabric			
6 x 6 wire mesh	37 / 100 sf	1,088	40,256
#4 rebar anchors, 3' o.c.	1,200 / ton	48.5	58,200
Rockfill	6 / cu.yd.	8,822	52,932
		WWF TOTAL =	151,388

Structure under levee - 48" RCP w/ flap gate - 100'
(Levee OPTION 2 only - Double Diamond Drainage)

- concrete	375 / cu.yd.	37	13,875
- steel	1,200 / ton	2.9	3,480
- flap gate	8,000 ea.	1	8,000
		Sub Total =	25,355

LEVEE COSTS (at PMF WSEL)

ITEM DESCRIPTION	COST / UNIT	UNITS	COST
**** OPTION 1 ****			
- Compacted levee around gravel pit	5 / cu.yd.	13,944	69,720
- Hydroseeding	0.36 / sq.yd	6,347	2,285
		SUB TOTAL =	72,005
**** OPTION 2 ****			
- Compacted levee around Double Diamond	5 / cu.yd.	87,026	435,130
- Compacted levee around gravel pit	5 / cu.yd.	19,090	95,450
- Hydroseeding	0.36 / sq.yd.	47,294	17,026
- Structure (see above)			25,355
		SUB TOTAL =	572,961
**** OPTION 3 ****			
- Compacted levee around Double Diamond	5 / cu.yd.	72,429	362,145
- Compacted levee around gravel pit	5 / cu.yd.	15,767	78,835
- Hydroseeding	0.36 / sq.yd.	49,813	17,933
		SUB TOTAL =	458,913

MIRA LOMA ROAD

ITEM DESCRIPTION		COST / UNIT	UNITS	COST
STRUCTURES				
- 1-5x10 at Mira Loma	- Concrete	375 / cu.yd.	72	27,000
	- Steel	1,200 / ton	8.6	10,320
- 5-5x10 at Mira Loma	- Concrete	375 / cu.yd.	356	133,500
	- Steel	1,200 / ton	41.6	49,920
EARTHWORK				
- Compacted Fill		5 / cu.yd.	52,800	264,000
- Excavation		5 / cu.yd.	21,000	105,000
ROADWAY				
- 4" AC		100 / cu.yd.	2,300	230,000
- 6" ABC		27 / cu.yd.	3,500	94,500
- Prime Coat		0.39 / sq.yd.	20,400	7,956
- Dust Palative		0.33 / sq.yd.	7,700	2,541
MISCELLANEOUS				
- Clearing and Grubbing		3,500 / acre	7	24,500
- Hydroseeding		0.36 / sq.yd.	8,700	3,132
			SUB TOTAL =	952,369

LAND ACQUISITION COSTS

ITEM DESCRIPTION	COST / UNIT	UNITS	COST
*** OPTION 1 ***			
- Double Diamond	6,500 / ac.	165	1,072,500
- 10 yr flood pool	6,500 / ac.	263	1,709,500
- Dam and Levee footprint	6,500 / ac.	4	26,000
- 100 yr flood pool, easement	1,625 / ac.	254	412,750
		TOTAL LAND COST =	3,220,750
*** OPTION 2 ***			
- 10 yr flood pool	6,500 / ac.	263	1,709,500
- Dam and Levee footprint	6,500 / ac.	12	78,000
- 100 yr flood pool, easement	1,625 / ac.	206	334,750
		TOTAL LAND COST =	2,122,250
*** OPTION 3 ***			
- Double Diamond	6,500 / ac.	37	240,500
- 10 yr flood pool	6,500 / ac.	263	1,709,500
- Dam and Levee footprint	6,500 / ac.	13	84,500
- 100 yr flood pool, easement	1,625 / ac.	259	420,875
		TOTAL LAND COST =	2,455,375

Hand Delivered

Nimbus Engineers
240 Linden St., Suite B • Reno, NV 89502
Mail: P.O. Box 10220 • Reno, NV 89510
(702) 689-8630

LETTER OF TRANSMITTAL

DATE	JOB NO.
3/1/90	8909

ATTENTION: Steve Varela

RE: Huffaker Hills

TO: City of Reno - Engineering Dept

WE ARE SENDING YOU ☑ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☑ Report

COPIES	DATE	NO.	DESCRIPTION
1	2/28/90		Final Draft - Huffaker Report

THESE ARE TRANSMITTED as checked below:

☑ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
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☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☑ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19_____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS

All discussed changes have been made. Please give us your comments ASAP so we can print the Final Version

Thank you

COPY TO Floyd Vice

SIGNED: Peggy Bowker

If enclosures are not as noted, kindly notify us at once.